Earth Observation & Geo-information Sciences for Environment and Development in Africa: Global Vision and Local Action Synergy

Abstract Book

El Jadida, Morocco, October 29 - November 2, 2012
USE OF ALOS AND LANDSAT DATA FOR MAPPING AND ANALYSIS OF LINEAMENT IN THE CENTRAL SAHEL (WESTREN MOROCCO).

Adnane Habib\textsuperscript{1}, Nadia Akdim\textsuperscript{1} & Kamal Labbassi\textsuperscript{1}\textsuperscript{1}
1. Department of Earth Sciences, Faculty of Sciences, Chouaib Doukkaly University, El Jadida, Morocco

KEYWORDS: ALOS, LANDSAT, lineaments, mapping, analysis, central Sahel

ABSTRACT
In the Sahel of Abda-Doukkala, the advance of salt water intrusion related to the over exploitation of groundwater and to the coastal degradation is a major problem in this region, where groundwater is the only water supply resources. Consequently, several hydrogeological investigations were started in this region to ensure a good water supply for local people, agriculture and industry. In this work, several techniques for extracting lineaments were applied to ALOS and LANDSAT datasets in the central Sahel (between Sidi-Moussa and Oualidia), including different types of enhancement, and the application of different directional filters on PCA products derived from the original images. The extracted lineaments were evaluated through the published geological and hydrogeological maps for the study area, using GIS overlay operations. Statistical analyses were also performed to determine the length, density of lineaments. This new documents generated will allow a better understanding of the relationship fracturing - water circulation, and identification of areas of recharge and mineralization, and also allow the orientation of the hydrogeological exploration in this area; and this aims will be object of the next publication.

ROBUST SATELLITE TECHNIQUES (RST) FOR NATURAL ENVIRONMENTAL AND TECHNOLOGICAL HAZARDS MONITORING IN AFRICA

Valerio Tramutoli
University of Basilicata, Department of Engineering and Physics of the Environment, via dell’Ateneo Lucano 10, 85100 Potenza, Italy

ABSTRACT
Change detection methods based on satellite observations are usually fixed-threshold, single-image oriented and very difficult to extend to different geographical areas or to different satellite sensors. Generally, when satellite data are used to give quantitative measurements, the difficulty to correctly estimate spectral atmospheric transmittance (requiring ancillary data not always, not everywhere available) can be responsible of highly biased estimates. On the other hand a number of satellite remote sensing applications (mainly devoted to environmental monitoring or, from a wider point of view, to change detection problems) for which the use of satellite data in se might be sufficient and effective. In this context, a different approach to Earth surface and atmosphere monitoring, at the same time reliable and exportable (on different satellite sensors and geographic areas) has been proposed several years ago (Tramutoli, 1998) and named RAT (Robust AVHRR Technique) by the name of the radiometer (Advanced Very High Resolution Radiometer aboard the American National Oceanographic and Atmospheric Administration satellites) there considered as test-sensor. Since then most of the announced RAT applications have demonstrated their reliability as well their exportability on different satellite sensors and geographic areas. Such intrinsic exportability on different satellite instruments suggested to refer to RAT approach using, instead, the more general RST (Robust Satellite Techniques) acronym. In order to monitor short (SSC) and M-LSC (medium-long) scale changes (in the space and/or time domain) the first RST requirement is the characterisation of the signal behaviour in normal (i.e. unperturbed) conditions. In fact no signal can be interpreted as anomalous in se but only as a consequence of

the comparison with some, preliminarily defined, normal behaviour (Tramutoli, 1998). The second RST step is the establishment of change detection criteria which should be specified for each considered phenomenon class and chosen technology as well as for the time and place of the observation. In fact it is quite obvious that the same signal, which is normally observable at a specific time and place, might result anomalous when it is considered in a different time and/or place. Finally suitable criteria for space/time anomaly-detection should also take into account of the normal (here intended as not related to the specific studied phenomenon) space/time variability of the signal. In order to detect anomalies in the realization $V(r,t)$ of the space/time process $V(r,t)$ on the image at hands ($t=t'$) the Absolutely Local (the double “l” is intentionally used in order to indicate a punctual reference both to a specific place and time) index of Change of the Environment (ALICE) $\Theta_V(r,t,t')$ is computed as follows:

$$\Theta_V(r,t,t') = \frac{[V(r,t) - V_{REF}(r)]}{\sigma_V(r)}$$

where $\mu_V(r)$ and $\sigma_V(r)$ are the mean and the standard deviation computed for each location $r$ on the base of homogeneous, cloud-free, historical records collected under similar observational conditions (e.g. time of the day, month of the year, etc.) in the past. RST approach has been successfully applied up to now using both polar (like NOAA and EOS) and geostationary (like Meteosat) satellites, optical and microwaves sensors, to several natural, technological and environmental hazards. For sake of brevity main applications and some indication on the used sensors and spectral bands can be found in Table I together with the most recent published papers to which the reader is addressed for details and further references on the other applications of RST. So far, almost everywhere this new approach has been tested, significant improvements (in terms of higher sensitivity and reduced false alarm rates) have been reached encouraging its extension towards other environmental emergencies and different instrumental packages. Several other important environmental processes exist, to which a similar rationale could be easily extended: quite all environmental applications, whose main target is the detection of change in progress and the evaluation of its local amount. These are also the conditions for which RST approach can produce its best results. In particular significant results have been so far achieved by applying RST to optical and microwaves passive sensors for monitoring forest fire and dust storms, for floods mapping, monitoring and early warning, for volcanic eruption monitoring and prediction, for earthquake precursors monitoring, oil spill detection and pipeline networks monitoring, which are of particular interest for African environment and socio-economic context. Finally, it should be noted that each ALICE-like index generated by the application of the RST approach share the following main characteristics:

a) it is completely determined on the basis of satellite data on hand, i.e. no ancillary data (e.g. ground observations, model outputs, etc.) are required, and its computation can be completely automated for operational real-time monitoring purposes;

b) for the same reason it is intrinsically exportable on different satellite packages and different geographic areas;

c) it not only reduces the effects of known sources of natural (e.g. topography, land-cover) and observational (e.g. solar illumination, satellite view angle) noise, but it also takes into account (by means of the denominator term) of the effects of the residual noise due to non-predictable signal variability related to local (the double “l” will be hereafter used to highlight a reference not only to a specific place $r'$ but also to a specific time $t'$) atmospheric and earth surface conditions (e.g. change in soil and atmospheric moisture);

d) for the same reason (and even in the presence of high residual noise) it is intrinsically resistant to false alarm proliferation (which means, on the other hand, that the signal to be detected must be strong enough to stand out with respect to the residual natural and observational noise).
COMPARING PARAMETRIC AND NON-PARAMETRIC CLASSIFIERS FOR REMOTE SENSING OF TREE SPECIES ACROSS A LAND USE GRADIENT IN A SAVANNA LANDSCAPE

Cho M.A.¹, Naidoo L.¹, Mathieu R¹, Asner G.P.² & Ramoelo A.¹
1. Council for Scientific and Industrial Research (CSIR), Earth Observation Unit, PO Box 395, Pretoria 0001, South Africa
2. Department of Global Ecology, Carnegie Institution for Science, CA 94305 USA

ABSTRACT

Introduction
The ability to map vegetation to the species level is of wide interest in Ecology. Species-level maps of vegetation have important applications in resource inventories, biodiversity assessment, and fire hazard assessment. The advent of high spatial resolution multispectral imagery such as Worldview-2 with additional bands when compared to conventional sensor such as SPOT has provide new opportunities for species level classification of natural vegetation. The new opportunity also places renewed demands for algorithm or methodological protocol development. Species mapping with remote sensing is based on the assumption that each species has a unique spectral signature. Spectral signatures of vegetation vary according to biochemical content, physical structure of plant tissue and canopy architecture. However, structural and phenological variability present important challenges to species differentiation at the broad landscape. Several classification techniques have been used to map vegetation communities or land cover types using remote sensing data including maximum likelihood (ML), discriminant analysis and spectral angle mapper (SAM) classifiers (Jia and Richards 1994; Lobo 1997). ML classifier is a commonly used supervised classification method with conventional multispectral data that considers both first order variations (e.g. mean values) and second order variations (e.g. covariance matrices). However, there is a limitation with the application of the ML classifier in situations of high within species variability. The objective of this study is to ascertain which classification techniques are suitable for classification of savanna tree species at across a land use gradient.

Material and methods
The study site is located between (latitude 24o51’35.31’’ to 24o54’22.73’’S, longitude 31o20’37.88’’E, and 31o33’28.40’’E), just outside the Kruger National Park, South Africa. The area is distributed across two main land use systems; the private game reserve of Sabi Sands and the communal lands. Airborne hyperspectral and LiDAR imagery was acquired for the study area using the Carnegie Airborne Observatory (CAO) Alpha system at the end of summer 2008 (Asner et al., 2007). CAO-Alpha combined three major instrument sub-systems into a single airborne package: (i) High-fidelity Imaging Spectrometer (HiFIS, programmable up to 288 bands); (ii) small-footprint LiDAR scanner; and (iii) Global Positioning System-Inertial Measurement Unit (GPS-IMU). Physical models of the ground surface (Digital Elevation Model, (DEM)) and canopy surface model (CSM) were created using REALM (Optech Inc., Vaughn, Canada) and Terrascan/Terramatch (Terrasolid Ltd., Jyväskylä, Finland) software packages. Canopy height models (CHM, pixel size of 1.12 m) were computed by subtracting the DEM from the CSM. The HiFIS data are converted to at-sensor radiances by applying radiometric corrections developed during sensor calibration in the laboratory. Apparent surface reflectance is then derived from the radiance data using an automated atmospheric correction model, ACORN 5LiBatch (Imspec LLC, Palmdale, CA). We convolved the 72-band CAO data to the 8 multispectral bands available in the WorldView-2 satellite sensor and used for the classification. The LiDAR height data was used to mask a tree image of trees greater than two metres.

The coordinates of tree crowns were extracted from the image and downloaded into a handheld GPS device (Garmin etrex – VISTA CX). With the help of the GPS device and printed true colour composite maps of the study site, the trees were located and identified in the field. Only the dominant trees have been used in this study Combretum sp, Sclerocarya birrea, Terminalia sericea, Spirostachys africana, Dichrostachys cinerea, Acacia gerrardii and Acacia nigrescens. The performances of two parametric (Maximum likelihood and Mahalanobis distance) and three nonparametric (spectral angle mapper, artificial neural networks and random forest) classifiers were assessed.

Results
Two non-parametric classifiers provided the highest accuracies, namely ANN and Random forest. RF showed the highest accuracy for the classification of the dominant tree species.

Table 1: Comparing different classifiers

<table>
<thead>
<tr>
<th>Classifier</th>
<th>Overall classification accuracy for dominant tree species (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum likelihood</td>
<td>65</td>
</tr>
<tr>
<td>Mahalanobis distance</td>
<td>68</td>
</tr>
<tr>
<td>Spectral angle mapper</td>
<td>36</td>
</tr>
<tr>
<td>Artificial neural networks</td>
<td>76</td>
</tr>
<tr>
<td>Random forest</td>
<td>78</td>
</tr>
</tbody>
</table>

Conclusions

Two non-parametric classifiers, namely; artificial neural networks and Random forest are more suitable than parametric classifiers for savanna tree species classification at the broad landscape level.

High within-species variability over large areas reduces the efficacy of parametric classifiers that depend on first and second order variability.

References


cette région regroupe de vastes plantations agricoles, 3 réserves forestières importantes, avec un couvert végétal diversifié, allant de la forêt dense en basse altitude au désert en haute altitude, en passant par la savane en moyenne altitude et d’importantes diversités animales dans son écosystème. Notre approche méthodologique est soutenue par des données expérimentales acquises pendant diverses missions de collecte de données sur le terrain. Ces missions nous ont conduits à récolter des informations et à implanter des bornes géodésiques de suivi des mouvements du massif depuis les basses altitudes (200m environ) jusqu’au sommet du pic le plus élevé (mont Fako) du massif (4 100m environ).

Une confrontation avec des données existantes, notamment des cartes lithographiques et topographiques révèle que cette nouvelle approche produit des résultats concordants. De même une étude comparative a été menée entre notre approche et certaines méthodes existant dans la littérature, notamment celles utilisant les matrices de cooccurrence et nos résultats ont présenté plus d’atouts tant sur la qualité que sur la rapidité d’exécution dans le processus de classification.

Bibliographie

A CASE STUDY ON THE POTENTIAL USE OF SUMBANDILASAT MICRO-SATELLITE IMAGERY IN LAND COVER MAPPING IN THE WESTERN CAPE – SOUTH AFRICA.

Nokuthula Wistebaar1, Paida Mangara1, Nicky Knox1 & Hugo de Lemos1
1. South National Space Agency (SANSA), Hartebeeshoek Farm No 502 JQ.

KEYWORDS: micro-satellite, land cover, SumbandilaSat.

ABSTRACT
Information regarding the characteristics and spatial distribution of land cover is critical for sustainable land use planning and management as well as global change research. The mapping of different land cover features with remotely sensed images requires good quality image data with appropriate spatial, spectral and temporal characteristics. In this study we tested the suitability of a new South African designed micro-sat (SumbandilaSat - SSAT) for mapping land cover.

SSAT is a LEO (Low Earth Orbit) observation micro-satellite which was developed by a South African company SunSpace in collaboration with the University of Stellenbosch. The satellite was commissioned by the South African Department of Science and Technology (DST). The SSAT satellite is a medium resolution multispectral sensor which was designed to have six spectral bands (blue, xanthophyll, green, red, red-edge and near infrared (NIR)), spread over two detectors. The spectral bands were chosen to optimise the image content for a wide range of applications but focused on food security. During the launch (17th of September 2009) one of the detectors were damaged resulting in acquired images having only three spectral bands (red, red-edge and NIR) at a spatial resolution of 6.25m (Mostert et al 2008). SSAT imagery was acquired from November 2009 to July 2010. The imagery used for the case study covered an area over the Western Cape in South Africa and was acquired on the 20th February 2010.

The orthorectification of the scene was carried out using 83 Ground control Points (GCP) extracted from a SPOT- 5 2.5m panchromatic imagery and a 20m digital elevation model. The imagery was projected and resampled to 6m. This case study evaluated the effectiveness of the SSAT imagery for mapping urban and water features, as well as various vegetation types. The effectiveness of the mapping is compared against the land cover map derived from a System Pour l’Observation de la Terre (SPOT) 5 10m multispectral imagery with four spectral bands (green, red, NIR and short wave infrared) acquired on the 7th March 2010.

Supervised classification was performed by integrating both the Maximum Likelihood and the Non-parametric Parallelepiped methods to maximise the classification results. Training sites were selected from the same areas found in both the SSAT and SPOT imagery based on the pre-identified land cover categories, with a criterion that they were extensive and homogeneous. Once the training sites were created, the spectral signature files were developed for both the SSAT and SPOT imagery.

The land cover maps of both the SSAT and the SPOT image were very similar. The available band combinations on the SSAT made the discrimination of the urban class and the turbid water difficult. The SSAT bands (red, red-edge and NIR) were however well suited for differentiating the various vegetation types and conditions. The SSAT has shown that it provides effective imagery for land cover classification and is particularly well suited for studies focussed on discriminating vegetation types and vegetation condition.

ESTIMATE ABOVEGROUND BIOMASS AND SOIL MOISTURE OVER A SAHELIAN REGION USING ERS (BANDE C) AND QUIKSCAT (BANDE KU) DATA.

L.T.A (Laboratoire de Télédéttection Appliquée) Université Cheikh Anta Diop Dakar, Sénégal
Laboratoire de physique et mécanique des Géomatériaux Université Marne-La-vallée, France

ABSTRACT

In West Africa, the Sahelian region is under the influence of the African monsoon (WAM), triggering a rainy season from April to September followed by a long dry season. During the rainy season, the soil moistens and the herbaceous vegetation mainly composed of annual plants achieves its cycle, wilting and drying towards the end of the rainy season. Spaceborne C band and Ku band radar data are especially well suited for the monitoring of these regions.

Indeed, due to somewhat low vegetation biomass (smaller than 1200 kg of dry matter by ha), both soil and vegetation contributions are significant in the radar signal at the end of the rainy season, while only surface scattering occurs during the dry season characterized by bare soils conditions. Past studies have demonstrated the potentialities of radar data acquired at a high temporal frequency for surface parameters estimation. Studies based either ERS scatterometer data or QuikScat have allowed the estimation of soil moisture or vegetation at regional scales.
The SeaWinds scatterometer data on the satellite Quikscat operating in Ku band (13.4 GHz) with two polarizations HH and VV, respectively, 46 and 54° incidence. These data present two advantages, namely high temporal repetitiveness (one measurement per day at least) and their high sensitivity to the presence of plants. The ERS C-band (5.3 GHz) are in VV, they are normalized to 45° incidence. Our job is to estimate aboveground biomass and soil moisture by an inversion model. For this we have coupled these two types of data to better constrain the model. This study is done on a dataset of ten years. Results are confronted to the numerous in situ data collected by the CSE.

**STUDY OF BAYESIAN NETWORK CLASSIFIERS WITH APPLICATION TO REMOTELY SENSED IMAGES**

Radja Kheddam & Aichouche Belhadj-Aissa

1. Image Processing and Radiation Laboratory, Faculty of Electronic and Computer Science, USTHB, Algiers, Algeria

**ABSTRACT**

Classification is a basic task in data analysis and pattern recognition that requires the construction and development of a classifier. Its function is to assign a class label to instances described by a set of attributes. Land-cover cartography is usually achieved through classification process which is one of the primary objectives in the analysis of remotely sensed image. Recall that the aim of satellite image classification is to assign each pixel from the analyzed scene to a particular class of interest, such as urban area, forest, water, roads, etc. The image resulting from the labeling of all pixels is henceforth referred to as “a thematic map”. Such maps are very useful in many remote sensing applications, especially those concerned with agricultural production monitoring, land change cover and environmental protection.

Conventional supervised classifiers are statistical and very often based on the Bayesian theory which has been proved as a theoretically robust foundation for satellite image classification [1], [3]. One of the most effective of these classifiers, in the sense that its performance is competitive with state of the art classifiers, is the so-called Naive Bayesian (NB) classifier described, for example, by Duda and Hart [1] and by Langley [2]. This classifier learns from training data the conditional probability of each attribute Xi given the class label C. Classification is then done by applying Bayes rule to compute the probability of C given the particular instance of X1, X2, ..., Xm and then predicting the class with the highest posterior probability. This computation is rendered feasible by making a strong independence assumption: all the attributes Ai are conditionally independent given the value of the class C. By independence we mean probabilistic independence. Performance of NB is somewhat surprising, since the above assumption is clearly unrealistic, especially for attributes of satellite multispectral image pixels. Recall that these attributes reflect the response of a spectral sensor at various neighboring wavelengths. So the pixel attributes are much correlated and should not be considered independents. Since the “Naive” independence assumption in the NB cannot be hold in many cases, researchers have wondered whether the performance will be better if we relax the strong independent assumption among feature variables. In order to tackle this problem effectively, we need an appropriate language and efficient machinery to represent and manipulate independence assertions. Both are provided by Bayesian Networks (BN) [4].

In this paper, we shall construct and develop several models of Bayesian Networks (BN) for multispectral image classification purpose. We started by the simplest one Naive Bayes (NB) followed respectively by Semi-Naive Bayes (SNB), Tree Augmented Naive Bayes (TAN), Forrest Augmented Naive Bayes (FAN), and Bayesian networks with hidden nodes (HBN). These models have been applied to classify remote sensing multispectral image acquired on June, 3rd 2001 by ETM+ sensor of Landsat-7 satellite. The image covers the north-easter part of Algiers (Algeria). For the implementation of the proposed models, we used IDL (Interactive Data language) software.

The application of the five (NB, SNB, TAN, FAN, HBN) developed Bayesian network models to classify the above ETM+ image gives the following results. We provide in the following Table 1 statistical assessment of the above obtained results. Recall that this evaluation is done using the Overall Accuracy (OA) and Kappa (K) parameters.
A Bayesian network is a graphical model that encodes probabilistic relationships among variables of interest. When used in conjunction with statistical techniques, the graphical model has several advantages for data analysis. In this paper, different Bayesian network models are studied and implemented for classification of satellite multispectral images. These models are: Naïve Bayes (NB), Semi-Naïve Bayes (SNB) which is none other than the classical Bayesian classifier based on the maximum likelihood algorithm, Tree Augmented Naive Bayes (TAN), Forrest Augmented Naive Bayes (FAN), and BN with hidden nodes (HBN). Obtained results are better compared to the result of the MLLH classical classifier. This means that the choice of dependencies between attributes contribute significantly to the discrimination of subjects on the ground. Thus, Bayesian networks appear as powerful tools in multispectral remote sensing image classification.

References

RELEVANCE OF NEW MULTISPECTRAL IMAGERY FOR ASSESSING TROPICAL FOREST DISTURBANCE: RAPIDEYE AND WORLDVIEW-2

Cho M.A.¹, Ramoelo, A.², Mutanga O.², van Deventer H.¹, Debbja P.² & Mathieu R.¹
1. Council for Scientific and Industrial Research (CSIR), Box 395, Pretoria, South Africa
2. University of KwaZulu Natal, School of Environmental Science, P.Bag X01, Pietermaritzburg, 3209, South Africa

ABSTRACT

Introduction

Tropical forest ecosystems play a major role in sustaining rural economies and livelihoods in Sub-Saharan Africa; providing services such as food, water, fuel wood, raw material, medicine and cultural services. Tropical forest degradation is characterised by clearing of the forest for pasture, agriculture or urban development (van Wyk et al., 1996). In most cases, the forest is fragmented into patches of various sizes and shapes; most often surrounded by a matrix of different vegetation and/or land use types e.g. small subsistence farms, pasture
lands and mono-crop plantations. Spatially explicit information on tropical forest composition and function at a scale that could permit village-to-village or patch-to-patch assessment of resources are rare. The high cost and limited availability of spaceborne hyperspectral imagery has stymied the routine application of this sort of remote sensing for tropical forest assessment at a regional scale. New high spatial resolution multispectral spaceborne sensors such as RapidEye and WorldView-2 have been launched with new wavebands in the red-edge region, e.g. 710 nm for RapidEye and 725 nm for WorldView-2, which can improve the assessment of forest composition and function. The objective of this study was to assess the utility RapidEye and WorldView-2 imageries for assessing tropical forest composition and function (aboveground nitrogen stores) in a disturbed landscape.

**Methods and materials**

The study site is situated in the northern part of KwaZulu-Natal South Africa. A total of 29% of the forest in this site has been lost to settlement and subsistence farming between 1992 and 2005 (Ndlovu 2011). RapidEye image of the study site was acquired in March 2011, coincidental with field data collection of leaf samples for nitrogen content analysis in 69 plots consisting of tree or grass canopies. The sensor consists of five spectral bands (Blue: 440-510 nm; Green: 520-590 nm; Red: 630-685 nm; Red Edge: 690-730 nm; NIR: 760-850 nm). Atmospheric correction was conducted using ATCOR-2, flat terrain model. Two archive WorldView-2 images (2 m spatial resolution) acquired in April and December of 2010 were also used in the study. WorldView-2 consists of multispectral bands centred at 425 nm, 480 nm, 545 nm, 605 nm, 660 nm, 725 nm, 835 nm and 950 nm. Additional field data was collected for land cover classification of the study area in July 2011. A true colour composite image of the WorldView-2 image was used to select training data for the classification of the RapidEye image into the various land use classes using Maximum likelihood classifier. GPS locations of different land cover types (intact forest, degraded forest, grassland/subsistence farms, eucalyptus farms, sugarcane farms) were recorded in the field and used to validate the classification results. Various red-edge indices were derived from the RapidEye image, including the MERIS terrestrial chlorophyll index (MTCI) and the red-edge normalised difference index. The index data for the various 69 nitrogen plots were extracted to bootstrapped regression relationship with the leaf nitrogen data.

**Results**

An overall classification accuracy of 85% was obtained for the LULC classification (Figure 1). The producer accuracy for the natural forest was 96%, meaning an omission error of 4%.

Amongst the red-edge indices investigated, the MTCI yielded the highest linear relationship with leaf nitrogen \( (R^2 = 0.52) \) and the lowest prediction error on the test data \( (SEP = 0.66\% \text{ i.e. } 30\% \text{ of mean } N) \). The regression model was inverted on the image to produce a leaf nitrogen concentration map (Figure 2). Amongst the different land cover classes, the intact forest patches and eucalyptus farms showed the highest leaf nitrogen stores in the area and the grassland patches showed the lowest (Figure 2C).
Conclusion

The availability of the new multispectral image moves remote sensing a step closer to operational monitoring of disturbed tropical forest composition and functions in Sub-Saharan Africa.

References


Le but de cette étude est donc de coupler la télédétection avec un modèle de fonte afin (1) de mieux comprendre les processus qui la régissent et (2) de caractériser le contenu en eau du couvert neigeux. Les résultats obtenus indiquent que les images FORMOSAT2 permettent une meilleure estimation du couvert neigeux à l’échelle du bassin versant de Rheraya. En plus des mesures de terrain, les produits neige FORMOSAT2 peuvent constituer une référence pour calibrer et valider la modélisation spatialisée de la fonte des neiges. Le modèle de fonte utilisé a été initié à l’aide des données mesurées sur une station de Club Alpin Français à 2600 mètres d’altitude. Les équivalents en eaux (SWE) spatialisés sont ensuite validés à l’aide des mesures au niveau de la station d’Oukaimden (3200m) et avec d’autre points de mesure in situ. À ce niveau, les simulations des SWE indiquent une grande cohérence avec les mesures (Fig.1).

AN OBJECT BASED GIS-T DATA MODEL FOR ROAD INFRASTRUCTURE MAINTENANCE IN UGANDA

Mazzi Lydia Kayondo, Ndandiko¹, Gerhard Bax² & Sandy Stevens Tickodri-Togboa¹
1. College of Engineering Design Art and Technology, Department of Geomatics and Land Management, Makerere University, Uganda
2. Campus Karlshamn, School of Planning and Media Design, Department of Technology and Aesthetics, Blekinge Institute of Technology, Sweden

KEYWORDS: GITs, GIS-T, Road Maintenance, Data Model, Uganda.

ABSTRACT

There are several cases of poor transport services in Uganda that are caused by the bad state of roads. Road maintenance has proved ad hoc until recently when the need for preventive maintenance is being appreciated and plans of making it a priority are in place. Since roads are geographically located, the use of Geographical Information Technologies (GITs) in collecting, managing and analysing road condition is paramount. And yet, these technologies are underutilized for road maintenance. This paper derives from research aimed at accentuating the use of GITs for Road Infrastructure Maintenance (RIM) in Uganda. The research addressed three objectives, 1. To access the gaps and limitations in GIT use for RIM, 2. To develop a methodological framework for enhancing the use of GITs in RIM and 3. To develop a GIS-T data model for RIM in Uganda. In line with the 3rd objective, the paper specifically presents an object relational based data model for RIM. This
was accomplished through identification of road maintenance data requirements, review of organisational reports, workshop proceedings, organisational terms of reference for various projects, understanding and consideration of the Information Quality Levels (IQL) and a review of existing data models and standards in transportation. This resulted into a conceptual and logical data model for RIM in Uganda based on concepts of dynamic segmentation (dynseg) and linear referencing. The conceptual model depicted using Entity Relationship Diagrams (ERD) in figure 1 identifies with 3 entities: the road’s network and the point and line events that exist on it.

Besides logically documenting the various classes from the conceptual data model, the ESRI provided template for logical data modelling was used. The logical model was based on 5 business rules guided by the mandate and objectives of the organisations involved in RIM. These rules included;

1. Emphasis of the model on the events that occur on the transportation system. The geographic datum, links and nodes that form the base network are only inferred.

2. The point and linear events on the road as the transportation feature are located using a linear location referencing system based on a cumulative distance offset, referred to as chainage, from the beginning point of the road section.

3. Only one linear referencing system is used to relate point and linear events to the road.

4. All events must be related to the road; i.e., exist on, at, or adjacent to the road.

5. Because of the complexity in implementing many to many (\(\ast\ldots\ast\)) relationships, they were avoided in the model.

The model separately emphasizes objects having spatial reference, objects without spatial reference and the relationships between them. The objects with spatial references are the feature classes with defined geometry. From the proposed model, they include; the Road, Node and Link. Objects with non-spatial reference are those defining the point and line event tables. It identifies with a total of 19 classes namely; Road, Node, Link, Jurisdiction, MaintenanceRecord, Line On Going Activities, Unpaved Road Condition, Paved Road condition, Traffic Volume, Bridge, Culvert, Photo dataset, Video dataset, Road Surface Type, Road Sign, Black Spot, Road Office, point On Going Activities and location Referance Point Feature. The road is the route class of the model on which the linear and point event objects are located. The MaintenanceRecord, Road office and Jurisdiction...
are uniquely identified with the road. The Unpaved and Paved road condition classes are subclasses of the Road Surface Type. Each of the classes has a couple of named attributes with assigned data types.

The study concludes that understanding of the transportation network of the country is essential to adoption of the proposed model. The choice of the GIS software for the physical model implementation with a full set of dynseg tools is fundamental. The idea of modelling data is a contribution to standardisation of geographic datasets for the sector.

**EVALUATION DES IMAGES RSO POLARIMETRIQUES PALSAR ET RADARSAT-2 PAR UNE APPROCHE ORIENTEE OBJET SUR LA PLAINE COTIERE DE KOUROU (GUYANE FRANCAISE)**

Niamien D.¹, Lardeux C.², Frison Pl.¹, Riera B² & Rudant Jp.¹

1. University of Paris-Est marne La Vallée, Laboratoire GTMC, 5, boulevard Descartes, 77 454 Marne la Vallée Cedex 2, France.
2. ONF-International, 2, avenue de Saint-Mandé 75 570 Paris Cedex 12. France

**MOTS-CLES**: classification orientée objet, polarimétrie, RSO, plaine côtière, occupation du sol, résolutions spatiales, bande de fréquence.

**RESUME**

Les premiers RSO satellitaires mis en orbite dans les années 90 (ERS, JERS, Radarsat1) fonctionnaient selon un mode mono fréquence, mono polarisation; la même polarisation linéaire étant utilisée en émission et en réception. Ils ne permettaient donc de mesurer pour chaque cellule de résolution qu’un couple (Amplitude, phase), codé numériquement sous forme de nombre complexe, correspondant au champ électrique de la polarisation utilisée. Les systèmes mono polarisation ne fournissaient donc qu’une information partielle sur l’interaction entre l’onde et les surfaces observées. Celle-ci peut être complètement décrite à partir d’une description complète de la polarisation de l’onde rétrodiffusée par la cible, quelle que soit la polarisation de l’onde incidente. Cette description complète peut être faite depuis 2007 avec la mise en orbite des capteurs RSO pleinement polarimétriques (TerraSAR-X, RADARSAT-2, PALSAR) opérant respectivement en bandes X, C, L avec de résolutions spatiales allant de 1 m à 30 m.

L’objectif de cette étude est d’évaluer l’approche de la classification orientée objet sur les images RSO polarimétriques sur la plaine côtière de Kourou en Guyane française pour la cartographie de l’occupation du sol.

Nous présenterons dans une première partie les principales méthodes de traitement des images (RSO) polarimétriques et dans une seconde partie la méthode de classification orientée objet sur les indices polarimétriques. Nous utiliserons dans cette étude les données issues des capteurs PALSAR et RadarSAT-2 acquises sur la plaine côtière de Kourou avec des résolutions spatiales au sol respectives 9 à 30 m.

Nous notons une performance globale de la classification orientée-objet d’environ 90 % sur les différents types d’occupations dans la plaine côtière de Kourou.

La méthode de classification orientée-objet sur les données RSO polarimétriques permettra de réaliser la mise à jour cartographique dans les zones tropicales où les images optiques sont dans la majeure partie inexploitable à cause de la présence des nuages.

**References**


A COMPARISON OF SUPPORT VECTOR MACHINE AND RANDOM FOREST CLASSIFIERS: AN OBJECT-BASED IMAGE ANALYSIS OF LAND COVER CLASSIFICATION IN A HETEROGENEOUS COASTAL ZONE IN SOUTH AFRICA USING WORLDVIEW-2 IMAGERY

Elhadi Adam 1,2, Onisimo Mutanga1 & Riyad Ismail1
1. University of KwaZulu-Natal, Discipline of Geography, P. Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
2. Elfashir University, Geography Department, P. Bag 125, Elfashir, Sudan

ABSTRACT

Land cover mapping has increasingly been identified as one of the vital data components for many aspects of local and global changes and environmental applications. Remote sensing has been the most commonly data source used for determining land cover thematic mapping and providing valuable information about the extension, changes, and risk analysis of landcover at various spatial, spectral and temporal resolutions. The classification of land cover/use from remotely sensed imagery can be divided into two general image analysis methods; pixel-based classification and object-based classification. Multispectral remotely sensed data and traditional pixel-based classification has long been the mainstay for classifying landcover/use. However, it was recognized that traditional pixel-based image analysis is limited due to many problems such as; image pixels are not true geographical objects and pixel topology is limited, pixel-based image analysis overlooks the spatial photo-interpretive elements such as texture, context and shape. Moreover, in the high spatial resolution imagery, the variability implicit within the class sometime confuses the pixel-based classifiers and results in lower accuracy. Therefore, the land cover maps are often judged to be of insufficient quality for operational applications due to the disagreements between the reference data set and predicted classes derived from the remotely sensed data.

The advent of new generation satellites with moderate resolution is seen as a trade-off between the advantages of multispectral resolution satellite data and hyperspectral data. WorldView-2 is one such sensor which contains a reasonable number of spectral bands that are configured in unique portions of the electromagnetic spectrum, including the red edge. This study explored the possibility of object-based image analysis approach for mapping land cover/use in a heterogeneous coastal zone using WorldView-2 imagery. WorldView-2 image comprised eight multispectral bands with spatial resolution of 2 m. The spectral ranges of the eight bands are 400-450 nm (B1-coastal), 450-510 nm (B2-blue), 510-581 nm (B3-green), 585-625 nm (B4-yellow), 630-690 nm (B5-red), 705-745 nm (B6-red edge), 770-895 nm (B7-near infrared-1), and 860-1040 nm (B8-near infrared-2) (Fig 1). Two relatively modern and robust supervised machine learning algorithms (random forest (RF) and support vector machines (SVM) ) were also compared. Image segmentation was performed (Fig 1A), and eleven broad land cover classes were identified in a heterogeneous coastal area in KwaZulu-Natal-South Africa. Subsequently, we assessed the performance of object-based image analysis method and each of the selected machine learning algorithms in mapping these land cover classes. The validation of the developed land-cover/use maps form RF and SVM were performed through error matrix statistics using independent test dataset generated from a field work data and an aerial photography. Results showed that both the machine learning classifiers in combination with object-based approach are useful in mapping landcover/use in heterogeneous coastal areas. However, SVM achieved the best overall accuracy (86%) and kappa statistic (0.84) than RF which produced an overall accuracy of 80% and kappa value of 0.77 (Fig 1). Overall, the study underline the utility of WorldView-2 imagery and the combination of object-based image analysis and machine learning classifiers in mapping land-cover/use in high heterogeneous coastal areas - a previously challenging task with broad band satellite sensors and traditional pixel-based image classification.
Figure 1: WorldView-2 true image, image segmentation using the multi-resolution segmentation approach and the comparison of land-cover maps developed from support vector machine and random forest classifiers.

ELABORATION DE BANCS DE FILTRES DE TEXTURES D’IMAGES ROS À PARTIR DU FILTRAGE DE GABOR ET DE LA MODÉLISATION EN GAUSSIENNES GÉNÉRALISÉES

Marrakchi Olfà 1,2 & Saidani Olfà 1
1. Institut National des Sciences Appliquées et de Technologie (INSAT), Centre Urbain Nord, BP 676, 2080, Tunis, Tunisie
2. Laboratoire des Systèmes et de Traitement des Signaux, Ecole Nationale d’Ingénieurs de Tunis (ENIT), BP 37 Belvédère 1002, Tunisie

RESUME
Dans cet article nous présentons deux méthodes permettant d’élaborer des bancs de filtres des textures d’une image radar ROS aéroportée de résolution 4,6 m. Les textures de cette image sont fortement corrélées et sont formées de mélange de motifs à disposition aléatoire. L’élaboration des bancs de filtres est issue soit d’un filtrage par les filtres de Gabor ou soit suite à la modélisation en gaussiennes généralisées (MGG) des variances locales des images de sous bandes de détails obtenues par la transformée en ondelettes (TO). Par la méthode des filtres de Gabor, et pour chaque texture, un ensemble de filtres a été élaboré permettant de l’identifier et de la rehausser par filtrage par rapport aux autres textures de l’image. Le banc de filtre est représenté par une combinaison des filtres des différentes textures. Le banc de filtre retenu est celui qui permet d’identifier toutes les textures de l’image avec un taux d’identification assez élevé. Les bancs de filtres élaborés par la méthode de la TO sont formés par les couples de filtres (passe bas, passe haut) déterminés suite à la MGG. Le banc de filtre
de la texture retenu est celui qui permet d’identifier toutes les textures de l’image pour des taux assez élevés. Les différents bancs élaborés nous ont permis d’atteindre des taux d’identification des textures supérieurs à 80%.

Données utilisées
La base de textures utilisée est extraite d’une image acquise par un radar à ouverture synthétique (ROS) aéroportée fonctionnant en bande C et en polarisation horizontale de résolution de 4,6 mètres. Une étude thématique sur la zone imagée nous a permis d’identifier les différentes textures existantes dans l’image. Les échantillons de textures sont différents par leur indice d’hétérogénéité due au mélange texturale (Tab.1).

Tableau 1 : Fenêtres de textures de l’image ROS

<table>
<thead>
<tr>
<th>Nombre m²</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>289,8</td>
<td>oliviers, sol nu, vegetation</td>
</tr>
<tr>
<td>124,2</td>
<td>bâtis, sol nu, vegetation</td>
</tr>
<tr>
<td>96,6</td>
<td>sol nu, végétation</td>
</tr>
<tr>
<td>151,8</td>
<td>sol nu, végétation</td>
</tr>
</tbody>
</table>

Méthodologie d’élaboration de bancs de filtres de Gabor
Pour chaque texture est déterminé les filtres de gabor qui permettent de les identifier selon les variables \( \theta \), \( \sigma \) et \( f \) représentant respectivement l’angle d’orientation, l’écart-type et la fréquence centrale du filtre en question. Des signatures texturales en termes d’énergie et d’écart-types sont déterminées sur les zones texturales des séquences filtrées par les filtres élaborés relatif à chaque texture. Le banc de filtres optimal est celui, formé par la combinaison des filtres de chacune des textures, permettant d’identifier les différentes textures de l’image et permettant d’avoir un meilleur taux d’identification des textures sur l’image classifiée (Tab.2). La classification de l’image est réalisée selon le critère de minimisation de l’erreur quadratique moyenne entre les statistiques locales calculées dans des fenêtres de balayage, \( k \), des images filtrées et les signatures des textures élaborées.

Méthodologie d’élaboration de bancs de filtres par TO
L’élaboration de bancs de filtres par TO est réalisée selon des étapes. Les images des sous bandes des détails horizontaux, verticaux et diagonaux obtenus par TO « diadique » sur \( L \) niveaux de décomposition de l’image radar ROS permettent de déterminer des modèles de gaussiennes généralisées des variances locales. Les modèles de gaussiennes généralisées attribuées aux textures de l’image représentent les fonctions d’échelles de la TO. Les fonctions d’échelles et d’ondelettes permettent de déduire les coefficients des filtres (passe haut, passe bas) associées pour chacune des textures. Le principe de la TO est ensuite réappliqué sur l’image ROS mais en utilisant les bancs de filtres élaborés. Afin de pouvoir évaluer ces bancs de filtres nous avons déterminé les vecteurs signatures texturales (énergie, norme L1) des textures à partir des images des sous bandes obtenues après application des filtres élaborés. Ces signatures ont servis à la classification des textures de l’image ROS et cela en utilisant le critère de minimisation de l’erreur quadratique moyenne entre les statistiques locales calculées dans des fenêtres de balayage, \( k \), des images des sous bandes et les signatures des textures élaborées. Les filtres retenus sont ceux qui ont permis d’obtenir les meilleurs taux d’identification des textures (Tab.2).

Résultats de classification

<table>
<thead>
<tr>
<th>Méthode</th>
<th>( k )</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabor</td>
<td>9</td>
<td>99.69</td>
<td>98.62</td>
<td>100</td>
<td>99.58</td>
</tr>
<tr>
<td>TO</td>
<td>11</td>
<td>88.09</td>
<td>82.45</td>
<td>100</td>
<td>94.72</td>
</tr>
</tbody>
</table>

Conclusion
CARACTERISATION DE LA SALINITE DES SOLS À L’AIDE DE LA POLARIMETRIE RADAR ET LES APPROCHES DE CLASSIFICATION ORIENTEE-OBJET : CAS DE LA TUNISIE ET DU MAROC

R. Lhissou 1,2, M. Barbouchi 1,3, K. Chokmani 1, A. El harti 2, N. Benaisa 3 & R. Abdelfattah 4
1. Institut National de la Recherche Scientifique - Centre Eau Terre Environnement, Université de Québec, 490 rue de la couronne, Québec, Canada G1K 9A9
2. Laboratoire de télédifférentiation et des SIG appliqués aux géosciences et à l’environnement, Faculté des sciences et techniques, Université Sultan Moulay Slimane, B.P : 523, Béni-Mellal, Maroc.
3. Institut National Agronomique de Tunisie, 43 avenue Charles Nicolle, 1082, Tunisie
4. Ecole Supérieure des Communications de Tunis, Cité Technologique des Communications, Rte de Raoued Km 3.5, Ariana, 2083, Tunisie

RESUME
La salinité des sols représente un risque environnemental important qui affecte près de 7% de la surface de la terre (Gupta et Abrol, 1990). Deux sites d’étude à climat arides à semi-arides sont sélectionnés ; plaine de Tadla (Maroc central) et la région du Mehdia (Tunisie centrale), ils sont confrontés à une surexploitation des ressources en eaux renouvelables et à une baisse chronique du niveau des nappes phréatiques. Par conséquent, les problèmes de salinisation des sols s’y posent avec acuité. La salinisation entraîne des effets néfastes sur le sol, Elle affecte la production agricole, les infrastructures, les ressources en eau, ainsi que la biodiversité (Metternicht et Zinck, 2002). Elle est un phénomène dynamique, il devient par conséquent impératif de se doter d’outils de suivi efficaces permettant d’en saisir l’intensité, l’étendue et la répartition spatiale. Les méthodes conventionnelles de suivi de la salinité des sols par des mesures directes in situ s’avèrent être très exigeantes en temps et en moyens tout en étant très limitée en termes de couverture spatiale. Plusieurs travaux ont décrit l’utilité de la télédifférentiation pour la cartographie de la salinité (Mougenot et al., 1993; Metternicht et Zinck, 2003; Farifteh et al., 2006.). Ainsi, l’imagerie spatiale et plus particulièrement la télédifférentiation radar permet la cartographie et le suivi continu de la progression de cette salinisation et ceci par sa couverture synoptique et grâce à la sensibilité du signal radar aux paramètres du sol au niveau des premiers cinq centimètres de la couche superficielle, à savoir la constante diélectrique qui est en lien direct avec la teneur en sel du sol.

Cette étude met au point le potentiel de la polarimétrie radar à synthèse d’ouverture (RSO) pour la caractérisation de la salinité des sols et de son évolution spatiotemporel. Les données RSO en polarisation complète proviennent du capteur RADARSAT-2 à raison de 9 acquisitions au dessus de chaque site à l’étude pendant trois périodes. Trois campagnes de terrain sont effectuées sur chaque site, simultanément aux périodes d’acquisition des images RSO, les mesures de terrain sont interpolées suite à une analyse géostatistique pour constituer des cartes de références de la teneur en sel qui serviront à l’étalonnage et la validation des approches de classification développées. D’abord les données RSO sont pré-traitées radiométriquement pour réduire le chatoiement par filtrage en utilisant J.S. Lee Sigma filter (Lee, 1983), puis elles sont orthorectifiées à l’aide d’un MNT (Modèle Numérique de Terrain) sous le logiciel PCI Geomatica 10.3. La méthode suivie a abordé trois grands axes dont le premier est d’étudier l’apport de la décomposition polarimétrique des données RSO multipolarisées pour la reconnaissance des différents teneurs de salinité des sols, la décomposition polarimétrique sert à calculer les paramètres polarimétriques relatifs aux mécanismes physiques de la rétrodiffusion des objets observés, Les observations du terrain et les mesures radiométriques indiquent que les facteurs principaux affectant le comportement de la surface sont la quantité et la minéralogie des sels, la teneur en humidité, la couleur, et la rugosité de la surface (Mougenot et al., 1993). Les trois
paramètres polarimétriques, H, A, et α, sont étroitement liés à la structure et aux propriétés géophysiques de la surface observée (Ferro-Famil et Pottier, 2001). Dans notre étude, sous le programme PolSARpro v4.2, une vingtaine de décompositions cohérentes et incohérentes a été calculée pour être mise en rapport avec la conductivité électrique mesurée sur le terrain. Pour cela des analyses statistiques ont été utilisées pour caractériser la relation entre la conductivité électrique des sols et le signal radar. Le deuxième axe est d'évaluer les méthodes de classification à savoir la classification orientée-objet, les décompositions polarimétriques ayant une forte corrélation avec les mesures de terrain font l’objet d’une classification orientée-objet implémenté dans le logiciel Definiens developé 8 et d’une classification supervisée Wishart basée sur la matrice de cohérence et proposée par Cloude et Pottier (1997). Le troisième axe est de développer une nouvelle approche permettant une intégration adéquate des paramètres polarimétriques, des données de terrain et d’une méthode de classification pour la cartographie de la salinité des sols.

SUPER-RESOLUTION POST-PROCESSING FOR SATELLITES WITH YAW-STEERING CAPABILITY, SUCH AS NIGERIASAT-2

Riaan van den Dool & Stefan van der Walt

ABSTRACT
We describe a method for improving satellite image resolution, for small areas of interest where the sensor design resolution cannot represent detail well enough for some purpose. Our method may be used for satellites with yaw-steering capability, such as NigeriaSat-2. We have shown that according to the Modulation Transfer Function (MTF) plots, the effective resolution that we obtained by simulated yaw-steering of a satellite was 0.42 times that of the normal effective resolution. This roughly equates to acquiring a 2.1m resolution image with a sensor designed to acquire 5m resolution images.

REGRESSION ANALYSIS OF LONG-TERM SERIES OF NDVI, NDWI AND LST IN SUB-SAHARAN AFRICA.

Amos T. Kabo-bah1, Donald T. Rwasoka2, Webster Gumindoga3, Chenai E. Madamombe4 & Kamila L. Kabo-bah5
1. Green WaterHut, Box UP913, KNUST, Ghana
2. Upper Manyame Subcatchment Council, Box 1892, Harare, Zimbabwe
3. University of Zimbabwe, Dept of Civil Engineering, Box MP 167, Harare, Zimbabwe
4. Digby Wells Environmental, Fern Isle, Section 5e, 359 Pretoria Avenue Randburg, 2125, Republic of South Africa
5. School of Geography, Nanjing Normal University, No1 Wenyuan Road, Nanjing, China

KEYWORDS: LST, NDWI, NDVI, satellite data, NOAA-AVHRR, hydrology, Africa.

ABSTRACT
There has been a growing availability of earth observation data for climate and ecohydrological studies particularly in Sub Saharan Africa for the past decade. Despite the increasing EO data availability, not much work has been done. Some of the important parameters derived from the earth observation data are the Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) and Land Surface Temperature (LST). NDVI is generally easy to obtain for most study areas because of the varied possibility of using different images from different satellites. This situation is however not true for other datasets such as NDWI and LST. NDWI is sensitive to changes in liquid water content of vegetation canopies and is less sensitive to atmospheric scattering effects than NDVI which gives indication of the green biomass in vegetation. The ability therefore to develop workable algorithms to establish relationship of NDWI and LST to NDVI promises to contribute to (eco)hydrology and climatology studies especially in the Sub-Saharan Africa region. This is particularly important for the region because, data resources and technical expertise are still limited. Therefore, the paper developed workable empirical algorithms using regression techniques with NOAA-AVHRR
data obtained between 1998-2011. Though, similar algorithms have been developed in parts of North America, there are currently no clear studies of such a nature for the Sub-Saharan Africa. Therefore, this study fills a significant gap by providing these empirical formulae for sub Saharan Africa regions that lack the requisite satellite data for deriving these important variables.

**Justification**

Earth observation data availability has been growing over the world wide web, however enough research has been conducted by the scientific communities in Africa among other areas for important derivations and calculations of environmental and eco-hydrological indices. Notwithstanding, just as enormous work has been done in Europe and the Americas on the use of satellite data to derive various important environmental and hydrologic indices, the same is not true for Sub-Saharan Africa. These indices developed in other countries might not work exactly for Africa region because of the fact that regional climatic differences and different assumptions due to environmental characteristics. It is noted that in some parts of North America, the study of the relationship between NDVI and LST were conducted. This however did not include NDWI which is also very key component for analyzing vegetation cover characteristics. Also, compared to Africa, such studies are either not limited and one is not clear if such studies truly exists now. The regression based equations developed in this work are vital for understanding hydrological, ecohydrological and ecological processes in sub-saharan Africa. These algorithms have a great influence on future research in Sub-Saharan Africa in the study especially for ungauged catchments.

**DECISION TREE CLASSIFICATION OF LAND COVER OF THE TAPAJOS NATIONAL FOREST REGION, BRAZILIAN AMazon.**

Luciane Yumie Sato¹, Yosio Edemir Shimabukuro¹ & Tatiana Mora Kuplich²

1. Instituto Nacional de Pesquisas Espaciais – INPE, Av. dos Astronautas, CEP12227-010 - São José dos Campos - SP, Brazil
2. Instituto Nacional de Pesquisas Espaciais– INPE, Southern Regional Center, Av. Roraima 1000, CEP 97105-970 - Santa Maria – RS, Brazil

**ABSTRACT**

The data mining for decision trees is a technique widely used for image classification, which allows the integration of different source of information, providing gain increased accuracy in image classification (Hansen et al., 2008; Gong et al., 2011). The decision tree receives a vector of attribute values as input and results in an output value of a decision: yes or no (Breiman et al., 1984). A decision tree is structured in a hierarchical top-down, basically formed by internal nodes and leaves that are connected by branches (Aitkenhead, 2008).

In this context, this work has as main objective to map the land cover in the portion of the São Jorge community located in the Tapajos National Forest (TNF) region, located in the Pará state, Brazilian Amazon, including classes of degraded forest and forest regeneration. For this, we used the decision tree technique applied to an imageLandsat-5/TM acquired in 2009 and some derived products for the classification of the study area. The first derived data set was the three fraction images (soil, shade and vegetation) obtained by the Linear Spectral Mixture Model (MLME). The second derived data set consists of three vegetation indices: Normalized Difference Vegetation Index (NDVI), Normalized Water Index (NDWI), and Soil-Adjusted Vegetation Index (SAVI).

For the creation of the decision tree was used the algorithm SimpleCart, implemented in the system Waikato Environment for Knowledge Analysis (WEKA). The algorithm implementation Classification and Regression Trees (CART) was proposed by Breiman et al.(1984). The separation of the data over the nodes of the decision tree occurs through calculation of entropy or impurity of the input values (Vasconcellos et al., 2011).

In the validation of this classification, approximately 81.2% of the pixels were classified correctly by the decision tree. The highest classification errors occurred between the classes: Pasture and Regeneration, Regeneration and Forest, Forest and Degraded Forest, and Forest of Degraded and Regeneration. These errors maybe associated with the spectral behavior very close between each pair of classes, making it difficult to separate through the decision tree. The Cloud and Cloud Shadows classes were well classified since very few pixels were incorrectly classified. For Water class, there was no classification, since the Water class can be associated with quite different spectral behavior compared to other targets of the surface under analysis. The Kappa index obtained in this work was approximately 0.79. Figure 1 shows the land cover classification of the study area, through the decision tree generated by WEKA system. The results obtained in this study allowed us
to evaluate the efficiency of the use of decision tree and the integration of different products for land cover mapping in a region of the TNF region. The decision tree techniques achieved reasonable results.

![Image](image_url)

**Figure 1:** Result of the classification.

### References


---

**EXTRACTION DES NEO-CANAUX A PARTIR DES IMAGES DE TELEDETECTION VUE GLOBALE ET APPLICATIONS SOUS MONTEVERDI.**

J. Mechbouh¹, A. Emran² & O. El kharki³

1. Craste-If, Rabat
2. Institut Scientifique, Rabat
3. Département Informatique, ENCG, PB 37/S, Cité Hay Salam, Agadir, Maroc.

**MOTS-CLES:** images satellites, indice de végétation, indice du sol, indice d’eau, indice de bâti, logiciel open source Monteverdi.

**RESUME**

Dans les images satellites, chaque pixel est accompagné d’un vecteur de valeurs de réfléctance, appartenant à plusieurs canaux (bandes) du spectre électromagnétique. La nature numérique des données de télédétection se prête particulièrement bien à des opérations entre canaux. Le principe de ces opérations est d’effectuer, pour chaque pixel, des opérations mathématiques plus ou moins complexes faisant intervenir les valeurs numériques observées pour ce pixel dans les différentes bandes spectrales, afin de construire des néo-canaux. En télédétection, les indices font parties des méthodes de traitement que l’on appelle les transformations multispectrales. Ils consistent à convertir les luminances mesurées au niveau du capteur satellitaire en
grandeurs ayant une signification dans le domaine de l'environnement. Basés sur le caractère multispectral des données satellitaires.

Plusieurs indices ont été développés spécifiquement pour l'analyse des données de télédétection tels que:
- Les indices de végétation
- Les indices des sols
- Les indices d'eau
- Les indices des bâtis.

Ces indices sont susceptibles d'exprimer une ou plusieurs caractéristiques physique ou biophysiques de la couverture végétale, du sol, d'eau et du bâti.

Ce papier présente l'état de l'art sur ces indices avec des applications en utilisant le logiciel open source Monteverdi.

**APPORT DES IMAGES SYNTHETIQUES ENNUAGEMENT POUR LA CLASSIFICATION DES NUAGES ET ELABORATION DES CARTES SOLAIRES.**

Nour El Islam Bachari¹, Abdelhak Razagui² & Kada Bouchouicha³

1. Department of Environment, Faculty Biology, University of Sciences and Technology Houari Boumediene Algeria, B.P 32 El’Alia 16111, Babezzouer Alger

2. Department of physics, Faculty Sciences, University of Sciences and Technology Oran Algeria, B.P 1505 El’M’Nouar Oran 3100,

3. Unite of Research in renewable energies in Saharan Medium (URER-MS). Algeria, Adrar

**KEYWORDS:** Météosat, MSG, Ennuagement, Classification, Carte solaires

**ABSTRACT**

L’Algérie est un pays de production de gaz et de pétrole mais aussi est considérée parmi les pays les plus ensoleillés dans le monde. La politique Algérienne en matière énergétique est la production d'énergie électrique à base des usines hybride solaire-gaz. Pour cette raison les cartes solaires à une échelle temporelle fine deviennent une nécessité pour le choix des sites les mieux exposées au soleil avec une faible perturbation par les nuages. Le satellite météosat effectue une observation synoptique multispectrale de tout le disque terrestre incluant l'Europe et l'Afrique. L'analyse diachronique nous permet de créer des images de référence image ciel clair et image ciel nuageuse. Les images brutes sont transformées en image ennuagement par une combinaison entre ces images et les images de référence. L'analyse des différentes séquences et pour différentes régions nous a montré que l'ancienne technique présente des erreurs et par conséquent un nouvel algorithme est établi. Les images ennuagement présentent sous forme des matrices creuses et homogène ce qui facilite leur compression. L'enuagement est une quantification de la couverture d'un pixel par les nuages. Un Algorithme de classification est développé qui permet la transformation d’enuagement en classes des nuages. Cet algorithme se base sur le concept d’un modèle relationnel ou un ensemble des noyaux des différents nuages sont déterminées par observation et expérimentation. Les noyaux sont utilisés pour attirer les pixels à six dimensions et aboutir à une image synthétique qui décrit les différentes classes. Les images ennuagement font l’objet d’un modèle physique pour obtenir les différentes composantes solaires. Pour valider le modèle développé nous avons corrélés les données acquises au sol par les stations d’Oran et de Tamenrasset. Le coefficient de corrélation expliqué est d’ordre appreciable il est compris entre 0,8 et 0,95. Le traitement peut se faire pour un pixel ce qui permet de créer des stations radiométriques à base d'images satellites. Les couches d'information solaires, la nature du sol, les masses nuageuses sont des couches de base pour élaborer un système d'information solaire et la recherche des zones les plus adéquates pour une implémentation de station solaire.
DEVELOPPEMENT D'UNE METHODOLOGIE POUR LA TRANSFORMATION DES IMAGES TRES HAUTE RESOLUTION SPATIALE A COMPOSITION COLORE IKONS EN CARTES OBJETS GEOGRAPHIQUES.

Fadhli Fatima¹ & Bachari Nour el islam²
1. Department of physics, Faculty Sciences, University of Sciences and Technology Oran Algeria, B.P 1505 El’M’Nouar Oran 3100
2. Department of Environment, Faculty Biology, University of Sciences and Technology Houari Boumediene Algeria, B.P 32 El’Alia 16111,Babezziouer Alger

KEY WORDS: Images satellites THRS, morphologie mathématique, croissance de région, logique floue, règles de décision.

ABSTRACT
L’objectif principal de cet article concerne l’extraction des informations géographiques dans des images satellitaires à très haute résolution spatiale en composition colorée. Afin d’aboutir à cet objectif nous définissons une approche proposée pour l’extraction du réseau routier sur des images IKONOS en couleurs vraies, en se basant sur des observations formulées sous forme de règle de décision. Par la suite nous définissons un processus pour l’extraction de surface d’eau et de bâties, qui se base sur un prétraitement morphologique partiel de l’image, une segmentation par un algorithme proposé et l’extraction de l’information géographique par intégration de requêtes sous forme de règles de décision à une procédure d’extraction. L’algorithme proposé combine entre le modèle de segmentation par morphologie floue et la segmentation par détection des contours. L’application est développé en se basant sur l’initiation des germes radiométriques dans notre cas le choix des germes est une zone homogène de la mer. La compilation séquentielle du modèle développé nécessite le bon choix des seuils pour la décision et la classification. Toute la problématique réside sur le choix des seuils qui se base sur l’expérimentation et les essais. Une étude comparative entre des images IKONOS à très haute résolution spatiale, et des images LANDSAT et SPOT à moyenne résolution nous a montré que l’algorithme proposé est valable sur la démarche mais il faut développer pour chaque satellites des seuils spécifiques.

ASSIMILATION INFRARED MSG IMAGE USED RTTOV CODE

Abdelhak Razagui¹, Kada Bouchouicha² & Nour El Islam Bachari³
1. Department of physics, Faculty Sciences, University of Sciences and Technology Oran Algeria, B.P 1505 El’M’Nouar Oran 3100,
2. Unite of Research in renewable energies in Saharan Medium (URER-MS). Algeria, Adrar,
3. Department of Environment, Faculty Biology, University of Sciences and Technology Houari Boumediene Algeria, B.P 32 El’Alia 16111,Babezziouer Alger

KEY WORDS: ALADIN, simulation, Radiative Transfer Model, RTTOV, MSG2, SEVIRI.

ABSTRACT
Simulated satellite images are a good indicator for the state of the atmosphere described by the fields predicted by the numerical weather prediction (NWP) model. Therefore in the order to control the NWP model used in Algerian meteorological operational service especially over the deserting region, Meteosat Second Generation (MSG) simulated image of brightness temperature (BT) are generated from the ALADIN NWP model forecasting fields using the radiatif transfert model RTTOV9. As reference data, MSG images are used to compute some deterministic and probabilistic statistical parameter. This version of RTTOV model assimilates cumuliform clouds, stratiform clouds and the ones of the upper levels as cirrus. For the simulation of these clouds, we have implemented a fast cloud type identification and cloud structure algorithm based on the vertical profile of the cloud liquid water (CLW), cloud solid water (CSW) and some surface fields forecasted by ALADIN model at all the forty three (43) levels of the RTTOV model. So the good reproduction of the BT image by the model is
verified by computing a deterministic and probabilistic scores using as reference scores the persistence forecast. The statistical comparison show that the ALADIN model makes less a good detection for uniform cloud than the broken or the convective cloud. The BSS_NO sores show that the double penalty effect is removed for about 10% and a small part of the model skill quality is due to the misplaced of the event forecast by the model.

STUDYING THE ORIENTATIONS OF LUXOR ANCIENT EGYPTIAN TEMPLES USING VHR QUICKBIRD IMAGES.

Shaltout Moslem¹ & Ramzi Ahmed²
1. National Research Institute of Astronomy and Geophysics (NRIAG) and (2) National Authority for Remote Sensing and Space Sciences (NARSS), Cairo, Egypt.

KEYWORDS: Orientations, Ancient Sites, Quickbird Images, Archaeology, Traditional Methods

ABSTRACT
Ancient Egyptians change the orientation of their temples from true East (during the OK) to the Winter Solstice (during the NK, because of the cultic change from a rather pure solar to a mixed solar religion (Rēa Amūn-Rēa). The traditional methods for measuring the Orientations and alignment the axis of ancient Egyptian constructions like field survey are usually time consuming and costly. Remote sensing techniques are becoming powerful tools for archaeologists in their discovery and exploration ancient sites. Many researchers have considered very high resolution sensors, especially IKONOS with 1.0m resolution, QuickBird with 0.61m resolution and Geoeye-1 with 0.50m resolutions as possible substitutes of the classical aerial photos used for multi purposes such as cartographic at large scales. Research objectives is to establish a practical methodology for calculation the orientation of the main axis of the ancient Egyptian temple based on very high resolution QuickBird images as alternative for traditional methods. Five sites have been selected to perform our research lies in Luxor city, Egypt: Luxor, Karnak, Hatshepsut, Ramesseum temples and Madinat Habu. Analysis the obtained results have been done to explain the type of orientation of Luxor temples. Previous archaeologist’s studies classified the orientation of ancient Egyptians constructions into astronomical orientation (solar, moon and stars) or topographical orientation (Nile direction and hills) or both. A comparative study has been done between the results obtained from traditional methods (field survey and Google earth mages) and from very high resolution QuickBird satellite images. One can concluded that using VHR satellite images in calculation the azimuth of ancient sites is the accurate method.

EVALUATION DE LA VULNERABILITE A L’ÉROSION DES SOLS DANS LA COMMUNE V DE NIAMEY A L’OUEST DU NIGER : APPROCHE SIG.

Hassane Tahirou Amadou & Joseph OLOUKOI
Regional Centre for Training in Aerospace Surveys (RECTAS)
Obafemi Awolowo University Campus, Science and Technology Park, Off Road 1, Ile-Ife Nigeria

MOTS CLEFS : SIG, sensibilité à l’érosion, risque d’érosion des sols.

RESUME
L’objectif principal de cette étude est l’évaluation de la vulnérabilité à l’érosion des sols dans la commune v de Niamey à l’ouest du Niger. L’évaluation de cette vulnérabilité a été faite par la production d’une carte du niveau de risque d’érosion.
Les données dérivées de l’image SRTM, sont traitées dans Arc Map pour la caractérisation du relief et la pente du terrain. La carte d’érosivité des sols a été obtenue par l’analyse des couches pédologiques. Quand au facteur d’érosivité des pluies il a été considéré comme constante dans toute la zone. Ces cartes thématiques ainsi obtenues ont été croisées pour obtenir la carte de sensibilité à l’érosion des sols. Cette carte montre trois niveau de sensibilité : faible (40,5%) de la superficie, moyenne (59%) et forte (0,5%). La classification supervisée

ASSESSMENT OF SEA SURFACE TEMPERATURE AND CHLOROPHYLL-A CONCENTRATION VARIABILITY IN COASTAL WATERS OF SOUTHERN MOZAMBIQUE USING REMOTE SENSING DATA

Dove Verónica¹; Nordez Sónia² & Lobo João³
1. Eduardo Mondlane University, Department of Physics, P.O. Box 257, Maputo-Mozambique
2. Fisheries Research Institute, Maputo, Department of Aquatic Environment, P.O. Box 4603, Maputo-Mozambique
3. National Institute of Hydrograph and Navigation, P.O. Box 2089, Maputo-Mozambique

KEYWORDS: Chorophyll-a, sea surface temperature, southern Mozambique, remote sensing, GIOVANNI, MODIS AQUA.

ABSTRACT
The knowledge and monitoring of oceanographic parameters affecting the biophysical processes which determine the productivity of the coastal and marine waters of Mozambique are still unsatisfactory, taking into account that the country has a coastline of about 2,700 km long characterized by a wide range of ecosystems of great importance for the development of socio-economic activities. The use and dissemination of techniques for ease manipulation of remote sensing data sets, freely available at the INTERNET, represent a valuable opportunity to fill the gaps in the existing in-situ data sets. The objective of this study was to investigate the temporal and spatial variability of the chlorophyll-a concentration (Chl-a) and the sea surface temperature (SST) in the southern Mozambique during the period July 2002 - July 2010. Level 3 data (monthly means and time series) from Sea-viewing Wide Fidel-of-view Sensor (Seawifs) and from the Moderate Resolution Imaging Spectroradiometer, MODIS AQUA were extracted using the web based Goddard Interactive Online Visualization and Analysis Interface, GIOVANNI. Additionally, in-situ data measured during four cruises on-board the South African Fisheries Research Vessel ALGOA were used for validation purposes.

CLASSIFICATION OF OIL SPILL USING AIRBORNE HYPERSPECTRAL IMAGE: A PERFORMANCE COMPARISON OF CONVENTIONAL APPROACHES

Oluwatoba Omotilewa¹ & Linda Hayden²
1. School of Civil Engineering, Purdue University, West Lafayette, IN, USA
2. Center of Excellence in Remote Sensing Education and Research, Elizabeth City State University, Elizabeth City, NC, USA

ABSTRACT
Oil spills are accidental or intentional discharge of oil or petroleum products into coastal environments. Spills do happen on land, but are often carried to the sea through water run-offs. Most of the large oil spills are caused by tanker groundings, break-ups like the Prestige oil tanker disaster in Spain, and collisions; pipeline vandalism like the Nigerian Delta; and accidents on offshore drilling operations like the Deepwater Horizon oil spill in the Gulf of Mexico (GoM), USA. The use of satellite and airborne remote sensing in detecting and mapping of such spills cannot be over emphasized (Klemas, 2009, 2010, and 2011; Fingas and Brown, 2000; Breeke and Solberg, 2005). Hyperspectral remote sensing –sensing in hundreds of narrow continuous spectrum
bands – through hyperspectral images (HSI) have been used to accurately detect subtle spectral details which hitherto were masked in broad band multispectral images (Harken and Suguraman, 2005; Ustin et al., 2004; Goetz 2007). In order to protect coastal ecology and environment, and aid remediation work, rapid and accurate determination of oil spill is paramount (Salem et al., 2005).

In almost all oil producing countries of the sub-Saharan Africa, oil pollution is always a big environmental problem. In the Nigerian Delta alone, about 4647 incidents of oil spill did occur between 1976 and 1996 spilling about 2.4 million barrels of oil into the environment. This pollution has resulted into severe ecological damage, and adverse economic impacts on coastal communities. For instance, over 70,000 km² of mangrove forest in the Nigerian Delta (which is the third largest mangrove forest in the world) have been depleted due to oil pollution (Nwilo and Badejo, 2005). When oil is spilled, and there is no proper identification or mapping of the extent covered, remediation work becomes difficult and sketchy. Consequently, the oil is left unrecovered from the coastal environment, and the devastating effect is always substantial.

In the course of this study, we examine the performance of mapping oil spill in coastal environment from HSI using conventional approaches. This is done with the objective of improving the classification accuracy. The Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) HSI collected over the GoM in 2010, off the coast of Louisiana, is used. Isodata unsupervised technique, and supervised classification techniques such as Maximum Likelihood (ML), Spectral Angle Mapper (SAM), and other classifiers are considered. The mapping accuracies from each classifier are reported in the form of confusion matrices and kappa coefficients. The ML appears to give the best result when a 2D scatter plot technique was used to train the classifiers.

We conclude that with the recent developments in satellite hyperspectral remote sensing, such as the Hyperion EO-1 and others to follow, access to HSI along the coast of Africa’s oil producing states will become easily accessible to researchers and decision makers. This will be helpful in making swift effort to monitor oil spill movements and trajectory through multitemporal hyperspectral classification, which will reduce the economic and biodiversity losses across sub Saharan Africa.

References
INTEGRATIVE USE OF SAR AND OPTICAL DATA FOR FOREST MAPPING IN THE CONGO BASIN

M. Hirschmugl¹, R. Perko¹, C. Hörmann¹ & U. Schmitt¹
1. Joanneum Research, Institute for Information and Communication Technologies, Austria

ABSTRACT
This study presents an innovative processing chain and various test results for using both SAR (PALSAR) and optical (such as AVNIR, LANDSAT) data in an integrative way for forest mapping in the Congo Basin. The main reason for including SAR data in the processing chain is that even with several optical sensors available, there are often still gaps in the coverage of interpretable data for application in tropical areas, as cloud cover is usually high. SAR, as an active sensor capable of all-weather and day-and-night image acquisition, is thus a valuable information source to fill these gaps.

In order to do so, the optical and SAR data has to be geometrically congruent to avoid errors in the output. Due to the different sensor geometry, such congruence is not easily achieved. Typically, tie points are visually selected in the two images, which is a difficult and time-consuming task, especially in areas with large homogeneous forest cover. In order to reduce this manual effort, an automatic, robust and reliable image matching method is needed to find corresponding points. A multi-modal matching technique was developed, which relates different visible spectra, but also e.g. NIR and thermal imaging, to SAR data. Appropriate preprocessing of the data is necessary on the one hand, and SAR specific imaging effects have to be taken into account on the other. The developed fully automatic image matching procedure (Perko et al., 2011) using the mutual information method (based on Pluim et al., 2003) leads to improved geometric congruence between optical and SAR data, which in result allows easier and more accurate gap filling with SAR data.

The second step after geometric congruence is achieved is the preprocessing of the SAR data. Several preprocessing steps have been tested and compared. These steps include: (i) the use of decibel versus digital number; (ii) the use of different multi-looking resolutions and (iii) the use of different speckle filters and filter sizes. From these comprehensive testing involving altogether more than hundred different options, the optimal preprocessing was found to be: use digital number, a multi-looking resolution of 45 m and a multi-resolution speckle filter. Classification was then tested on three different polarizations available from PALSAR: Fine Beam Single Polarization (FBS: HH), Fine Beam Dual Polarization (FBD: HH, HV); and Polarimetric SAR (PLR: HH, HV, VH, VV). The best compromise between coverage and classification accuracy was achieved using FBD data.

In a final step, a fully automated tool for classifying the pre-processed PALSAR data is presented. With the use of a so-called ‘classification-based trainer’, the optical image is used to train the SAR image for filling the gaps. The results for an artificial gap showed, that non-forest was slightly overestimated (36.5 vs. 35.7%) compared to the classification based on the optical image. The method was tested on real cloud and cloud shadow gaps and proved to give useful classification results.

AGRONOMIC EFFECTIVENESS OF MINJINGU PHOSPHATE ROCK IN ACIDIC SOILS OF MOLO COUNTY, KENYA.

Joyce J. Lelei² & Richard N. Onwonga²
1. Department of Crops, Horticulture and Soils, Egerton University. P.O. Box 536, Egerton.

KEYWORDS: Maize hybrids 614 and 513, Relative Agronomic Efficiency, Triple super phosphate

ABSTRACT
The agronomic effectiveness of Minjingu rock phosphates (MPR) as substitutes for the conventional phosphorus (P) fertilizer sources in the production of maize was evaluated for two years using triple superphosphate (TSP) as reference. The experiment was set up on an acid mollic Andosol at the Kenya Agricultural
Research Institute Molo. The experimental layout was a randomized complete block design with a split plot arrangement replicated thrice. Two maize hybrids, H513 and 614 were used as test crops and constituted the main plots. The split plots were an absolute control and 60kgPha \(^1\) each of TSP and MPR. The two year mean value of relative agronomic efficiency (RAE \%) of MPR was 60 and 83\% for maize hybrid 513 and H614, respectively. MPR proved to be as effective as TSP and is recommended as an alternative cheaper P source for the acid soils of Molo County.

**TURBO FILTER APPLIED TO THE POLARIMETRIC RADAR SAR IMAGES**

*Souhila Boutarfa*, Youcef Smara & Lynda Bouchemakh  
1. University of Sciences and Technology Houari Boumediene (USTHB).  
2. Faculty of Electronics and Computer Science. Laboratory of Image Processing and radiation. BP 32, El-Alia, Bab-Ezzouar, 16111, Algiers, Algeria.

**KEY WORDS:** POLSAR images, speckle filtering, Turbo filter, refined Lee filter, wavelet filtering, SWT

**ABSTRACT**

POLSAR radar images are affected by a granular multiplicative noise called speckle. This noise degrades the quality of these images and makes it difficult to interpret. That is why a polarimetric filtering is necessary. In this paper, our goal is to study a new method of speckle filtering in POLSAR radar images, not only in intensity but also in complex images. This method called Turbo combines two complementary filters: the refined Lee filtering based on the estimation of the minimum mean square error MMSE and the wavelet filtering by using the stationary wavelet transform SWT. One filter can boost up the results of the other. We propose to optimize this method by adding a parameter in the calculation of the threshold in the wavelet filtering using multi-scale edge detection and sum of squared coefficients SSC technique for the wavelet coefficients improvement, this parameter will control the filtering effect and get a good compromise between smoothing homogeneous areas and preserving linear structures. The advantage of this algorithm is to use the advantages of both filters and to obtain images with well reduced speckle. Visual and statistical evaluation and a comparative study are performed to validate the studied methods according to the following criteria: best filtering in terms of smoothing homogeneous areas, preserving edges and conservation of the polarimetric information.

**CARTOGRAPHIE DE LA TURBIDITE ET DE LA CHLOROPHYLLE A PARTIR DES DONNEES SATELLITAIRE MODIS AQUA DANS LE GOLFE DE GABES**

*Rim Katlane* \(^1\) & Fouad Zargouni \(^1\)  
1. Université Tunis el Manar, Faculté des Science de Tunis, Département Géologie, Unité Géomatique, Géologie Structurale et Appliquée, 2092, El Manar II, Tunis, Tunisie

**MOTS-CLES:** Télédétection aquatique, Chlorophylle, Turbidité, Golfe de Gabès, Données MODIS.

**RESUME**

La bande littorale de la Tunisie mesure plus de 1300 km, elle est très sollicitée par l’urbanisation, les activités industrielles et de service d’où la nécessité de la surveiller, de gérer et de réhabiliter les zones côtières. En particulier le golfe de Gabès où l’activité industrielle a débuté depuis les années 70. La pêche intensive, les déchets anthropiques et naturels ont contribué à la dégradation de la biodiversité de l’écosystème du golfe. La démarche adoptée s’appuie sur l’analyse spatio-temporelle des données Moderate Resolution Imaging Spectrometer MODIS AQUA niveau 1 et 2 pour l’année 2009. La génération des cartes journalières de la concentration de la chlorophylle a été effectuer à l’aide de deux algorithmes OC3 et OC5. En revanche la turbidité a été cartographiée en utilisant un algorithme semi-analytique TU. Les cartes ainsi obtenues issue des
ESTIMATION DU RENDEMENT ET DE LA DYNAMIQUE DE CÉRÉALES EN ZONES SEMI ARIDE PAR TELEDETECTION ET LE MODÈLE DE CROISSANCE SAFY

Aicha Chahbi\textsuperscript{1,2}, Mehrez Zribi\textsuperscript{1}, Zohra Lili-Chabaane\textsuperscript{2}, M. Shabou\textsuperscript{1,2}, Benoit Duchemin\textsuperscript{1}, Bernard Mougenot\textsuperscript{1} & Gille Boulet\textsuperscript{1}

1. CESBIO, 18 avenue. Edouard Belin, bpi 2801, 31401 Toulouse cedex 9, France
2. INAT, 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène, Tunisie

MOTS-CLES: Céréale, NDVI, rendement, télédétection, SAFY.

RESUME

En zones semi-arides et particulièrement dans les zones semi aride, le suivie du couvert végétale est un enjeu majeur. Ainsi suivre la capacité de production des plantes et plus particulièrement des céréales est nécessaire. La télédétection est un outil très intéressant pour donner une information sur le développement du couvert végétal. Dans ce contexte, notre objectif est d’analyser les caractéristiques des céréales pluviales et irriguées. Ainsi, on a eu recours à trois axes de recherche : le premier est basé sur l’étude de la relation entre l’indice normalisé de végétation NDVI déterminer à partir des images satellitaires et l’indice foliaire LAI mesuré in situ. Le deuxième axe est basé sur l’estimation du rendement de céréales à partir de l’indice normalisé de végétation NDVI. Le troisième axe est basé sur l’application d’un modèle de croissance SAFY «Simple Algorithm For Yield Estimate » développé pour simuler la dynamique de l’indice foliaire LAI.

Le deuxième axe de recherche concerne l’estimation du rendement de céréales conduits en sec et en irrigué. L'approche a été testée sur 27 parcelles test. En se basant sur les mesures du rendement de céréales des parcelles test, on a établi une relation entre le NDVI et le rendement en grain et en paille pour différentes dates. Les résultats montrent qu’une prévision précoce est possible à partir de mi-mars à mi-avril. Le NDVI est bien corrélé avec le poids moyen du grain ($R^2 = 0,6$) et avec le poids moyen des pailles ($R^2 = 0,65$).

Pour le troisième axe, nous avons utilisé le modèle SAFY. Dans ce modèle, la dynamique de la végétation est appréhendée par la théorie des efficiencies de Monteith pour la photosynthèse et la production de biomasse. En se basant sur des mesures ponctuelles du LAI le long du cycle végétatif de céréale, le modèle simule les évolutions de l’indice foliaire vert.

L’approche validée sur les parcelles test, offre l’avantage d’être très simple, sans avoir besoin de données sur les pratiques agricoles (semis, irrigation et fertilisation).
CARACTERISATION DES TRAJECTOIRES DE FRACTURES DANS LE PROSPECT GEOThERMIQUE D’ITASY, CENTRE DE MADAGASCAR : IMPLICATION DANS L’ESTIMATION DES RISQUES LIES AU SEISME INDUIT PAR LES FAILLES ACTIVES.

Lala Andrianaivo¹ & Voahanginirina J. Ramasiarinoro²
1. Ecole Supérieure Polytechnique, Université d’Antananarivo, BP 1500, Antananarivo 101
2. Faculté des Sciences, Université d’ Antananarivo, BP 906, Antananarivo 101, Madagascar

RESUME
Problématique
Dans l’objectif de trouver de l’énergie renouvelable non polluante sans émission de gaz à effet de serre, les études antérieures mettent une continuité en vue d’une connaissance beaucoup plus approfondie tout d’abord sur les ressources géothermiques elles mêmes, ensuite sur leur prospection et enfin sur leur exploitation. Cependant, la distribution de sources chaudes, les sources de chaleur et la nature des réservoirs géothermiques sont contrôlés par les structures géologiques.

On sait que le prospect géothermique d’Itasy est situé dans une zone tectoniquement active *1+ *4+. On connait également depuis longtemps que le séisme est fréquent dans cette région du centre Est de Madagascar [3] [4]. De nombreux travaux ont montré une liaison probable entre sources thermes, volcanisme quaternaire récent, faille active et tremblement de terre dans la région d’Itasy [1] [2]. La question de l’impact socio-économique négatif des séismes sur les activités humaines reste toujours d’actualité. Dans tout projet de construction, ce type de risque naturel est toujours présent et les problèmes y afférents (dégâts) sont ainsi à craindre.

L’implantation de centrale géothermique dans le prospect d’Itasy est dans ce cas suspecte et suppose une étude minutieuse du prospect. Les études de prévention concernent principalement une analyse structurale détaillée du prospect, dans le but de mieux caractériser les principales zones de failles potentiellement actives pouvant induire des séismes. La connaissance exacte des zones potentielles à risque servira de base dans le choix du site d’implantation de forages d’exploitation et de construction de l’infrastructure.

Données de base et méthodologie suivie

Dans un premier temps, la technique est basée sur la fusion de données spatialisées afin d’optimiser la détection de linéaments structuraux. Dans un second temps, il suffit de confronter les résultats obtenus (cartes des linéaments structuraux) à la réalité du terrain (carte tectonique) en vue de déterminer les principaux accidents tectoniques majeurs (failles, fractures). Associé à ces traitements, l’utilisation du Système d’Information Géographique (SIG) comme outil d’exploitation des données permettra d’affiner l’analyse et détecter les structures cassantes majeures.

Cette étude est le résultat des travaux effectués depuis la recherche de documentation existante, la réinterprétation des données antérieures, le traitement et l’analyse spectrale d’images satellites, l’analyse structurale, l’analyse statistique et l’exploitation des données. Elle utilise une approche multiscale (télédétection, travaux de terrain, travaux de laboratoire, théorie, SIG) de l’objet faille active. Cette recherche est donc pluridisciplinaire et fait ainsi appel à diverses méthodes comme la géomatique, la géologie structurale, la morphotectonique, la cartographie, l’hydrogéologie et l’hydrologie.

Résultats et conclusion
Les résultats provenant de la télédétection radar et optique (cartes des trajectoires de fractures) comparés avec les données géosciences (cartes des failles) provenant de nos propres investigations de terrain concordent. La carte de synthèse ainsi obtenue montre un système de fractures de direction globale subméridienne.

L’activité géothermique est probablement en relation avec la phase volcanique pléistocène formant les terrains volcaniques d’Itasy. Des mouvements tectoniques ont induit un système de failles profondes de direction N-S à NNE-SSW. Ce sont des failles de décrochement et des failles normales qui peuvent jouer le rôle de drain pour les sources chaudes en profondeur [1]. L’extension intra-plaque d’âge récent à actuel et de directions E-W à
ENE-WSW suggère ainsi que la région d’Itasy est encore tectoniquement active. Ces failles actives peuvent ainsi induire des séismes qui constituent une menace naturelle.

La carte de synthèse met également en évidence l’existence d’une faille majeure de direction subméridienne passant par le marais d’Ifanja et par le centre du bassin (bassin de décrochement). Il s’agit d’une faille de décrochement probablement à jeu senestre et longue d’environ vingt cinq kilomètres.

La connaissance exacte de la principale faille active permet d’orienter les travaux futurs. Pour cela, une ultime série d’études sur cette zone localisée est indispensable afin de mieux modéliser le système géothermal et surtout de réduire les risques dans le projet en améliorant la connaissance du milieu par des études de surface et par des études géophysiques affinées avant d’engager des travaux onéreux de développement et d’exploitation sans être sûr que la zone choisie soit adéquate.

Bibliographie


GLOBAL MEAN VALUES IN LINEAR SPECTRAL UNMIXING: DOUBLE FALLACY! #102

Thomas Ngigi¹, Edward Waithaka¹, Moses Gachari¹ & Ryutaro Tateishi²

1. Department of Geomatic Engineering and Geospatial Information Systems, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200, Nairobi, Kenya; Kimathi University College of Technology, P.O Box 657, 10100- Nyeri, Kenya.

ABSTRACT

Almost all conventional linear spectral unmixing techniques are based on the principle of least squares. The global mean digital number (DN) of an endmember is taken as the representative (i.e. contributory) DN for the end-member. This paper sets out to prove that the notion is a fallacy, and will always lead to negative percentages, super-positive percentages and non-100% sum of percentages if the unmixed pixel is not composed of, to within some tolerance, the global mean DNs only. Three sets of spectral end-members (two, three and four spectral end-members) are generated from Landsat ETM+ data. Practical percentages (between 0% and 100% and totalling 100%) of the end-members are returned by pixels in which the local mean DNs of the spectral end-members do not differ from the global mean DNs by, on average, 4.

SUITABILITY OF MARKOV RANDOM FIELD-BASED METHOD FOR SUPER-RESOLUTION LAND COVER MAPPING.

Rahel Hailu Kassaye

Ministry of Urban Development & Construction, P.O.Box 3221, Addis Ababa, Ethiopia.

KEYWORDS: Neighborhood size, Class separability, Smoothing parameter, annealing parameters, Scale factor, Super-resolution mapping, Markov random file.
ABSTRACT
The use of remote sensing data for land cover mapping undoubtedly requires a range of tools to acquire information accurately. The introduction of sub-pixel classification brings a major improvement in handling the problem imposed by the occurrence of mixed pixels. Although the sub-pixel classification approach is more informative than pixel-based techniques, the exact location of the class proportion cannot be estimated. Super-resolution mapping (SRM) works by dividing the coarse pixel into sub-pixels and assigning the class proportion estimated by sub-pixel classification to each corresponding sub-pixel then the class labeling is optimized based on the principle of spatial dependency. Among the existing SRM techniques, Markov random field (MRF)-based SRM is one of the most recently introduced techniques. However, its suitability was not assessed in a systematic way. Therefore, this study attempts to assess the suitability of this technique for super-resolution land cover mapping.

The data sets used during this study were synthetic image and remote sensing data. The aim of using synthetic data in this study enabled to evaluate the performance of the method properly because it represents simple geometric features, it lacks co-registration errors between low and high resolution images and exact proportions of endmembers can be estimated. The spatial contextual smoothness constraint and spectral information were modelled with prior energy and the likelihood energy function respectively. These two energy functions were balanced with a smoothing parameter. The maximum a posterior estimate maximizes labeling probability which is equivalent to minimizing the global energy. To find this minimum global energy an iterative searching process was required and this was performed using simulated annealing algorithm. The outcome of the MRF-based SRM algorithm was evaluated by comparing to the fine resolution ground truth map.

Parameterization was done using the synthetic data sets and the effect of several factors on the quality of SRM was observed. The main findings in this study are: increasing the neighborhood size while increasing scale factor enables to keep the Markovian property and the variability of optimal smoothing parameter in relation to the class separability. The appropriate setting of the optimal smoothing parameter can give a reasonable accuracy even for classes with low separability. The experimental result from both data sets proof the suitability of the method for super-resolution land cover mapping. The result obtained from this study can be used as a guideline for further application of the method.

ESTIMATION OF LEAF AREA INDEX OF THE TROPICAL RAINFOREST OF ZAHAMENA BY SPOT IMAGE.
Ranaivoarimanana, S. 1, Rakotondraompiana, S. 1, Rakotoniaina, S. 1, Faramalala, M. H. 2 & Edmond, R. 2
1. Institut & Observatoire de Géophysique d’Antananarivo. Université d’Antananarivo, Madagascar
2. Département de Biologie et Ecologie Végétales, Faculté des Sciences. Université d’Antananarivo, Madagascar

KEYWORDS: LAI, correlation, filtering, vegetation indices, PCA, regression, residual.

ABSTRACT
Introduction
The leaf area index (LAI) is a variable that takes account of the penetration of light through a vegetative cover. It helps in many processes such as radiation interception, photosynthesis and evapotranspiration. We discuss in this paper an approach for estimating LAI from a remotely-sensed image.

Materials and methods
a) Study site
The study site is the protected area of Zahamena. It geographic coordinates are between 17°30’ and 17°43’ South latitude and 48°41’ and 49°03’ East longitude. It is characterized by a moist evergreen forest of medium altitude.
b) Field works
Five plots were installed in the study area: crest, upper slope, on slope, low slope and plane area. LAI measurements were made with the LAIL sensor (Cournac et al., 2002).

c) Remote sensing data
The SPOT-5 multispectral image used in this study has 10 m of spatial resolution. It was acquired in September 2008. The spectral parameters of the image retained are the XS bands and vegetation indices. Pre-treatments (brightness corrections, filtering) were performed on LAI data before processing them and the spectral variables with statistical analysis such as PCA (Principal Component Analysis), regression, and residuals.

Results
Regression analyses of the spectral variables and the LAI have shown that the LAI evolves exponentially with a spectral variable. The best relationship was obtained with the vegetation index PVI (Perpendicular Vegetation Index). The equation corresponding to this type of regression is given by the following relation:

\[ LAI = 6.199 \exp(0.014 \times PVI) \]  

The combination of three spectral variables: RATIO, CNDVI (Corrected Normalized Difference Vegetation Index) and RSR (Reduced Simple Ratio) in the regression has given a good result compared to the first. This has yielded a relationship between these variables and LAI as

\[ LAI = -22.3 + 15.3 \times RATIO - 108.6 \times CNDVI + 18.6 \times RSR \]  

Discussions
Comparison of residuals obtained from the regression of the relation [2] with those found elsewhere (Peterson et al., 1987; Baret et Weiss, 2010) allowed us to conclude that the results we have obtained are suitable even if the corresponding coefficient of determination \( R^2 \) is still low. A map of LAI was developed from the relationship [2].

Conclusion
The estimation of LAI in tropical environments is not an easy operation. The used of other types of data such as RADAR, LIDAR are other interesting approaches for estimating LAI.

Reference


EVALUATION DU POTENTIEL DE L’ALGORITHME FLAASH POUR LES CORRECTIONS ATMOSPHERIQUES D’UNE IMAGE TM.

Abderrazak El Harti¹, Hamza Droussi¹, Soufiane Maimouni¹, Rachid Lhissou³, El Mostafa Bachaoui¹ & Abderrahmen El Ghmari¹

1. Equipe de télédétection et SIG appliqués aux géosciences et à l’environnement, Faculté des Sciences et Techniques, Béni Mellal, BP. 523, Maroc

ABSTRACT
La dégradation du signale est une contrainte dans l’utilisation de l’imagerie satellitaire pour les études de la surface terrestre. Cette dégradation est causée par les effets de l’absorption et de la diffusion. Pour avoir des images de réflectance au sol et pour l’extraction de paramètres quantitatifs à partir des données de télédétection, l’élimination des effets de l’atmosphère est fondamentale. Pour ce faire, plusieurs approches ont été utilisées pour la correction radiométrique des images multispectrales et hyperspectrales ; la plus utilisée est celle basée sur les modèles de transfert radiatif.
La présente étude évalue le potentiel de l’algorithme FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes) pour la réduction des effets atmosphériques d’une image du capteur TM (Thematic Mapper) du satellite Landsat-5 dans un environnement semi-aride. Le Compte Numérique de l’image brute est transformé en luminance apparente puis en réflectance au sol en utilisant l’algorithme FLAASH. Pour l’évaluation des corrections radiométriques réalisées, des mesures spectrales au laboratoire sont effectuées à l’aide d’un spectroradiomètres de type ASD entre 400 nm et 2500 nm. La comparaison des mesures spectrales au laboratoire à celles extraites de l’image corrigée montre une bonne corrélation entre les des deux types de signatures spectrales. Les variations moyennes des réflectances entre celles mesurées au laboratoire et celles extraites de l’image corrigée sont de 2,1% pour la bande 1, 2% pour la bande 2, 2,4% pour la bande 3, 3,3% pour la bande 4, 4,3% pour la bande 5 et 4,8% pour la bande 7.

UNE NOUVELLE APPROCHE AUTOMATIQUE D’ÉCHANTILLONNAGE POUR LA CLASSIFICATION DIRIGEE DES IMAGES DE TELEDETECTION MULTI-SOURCES ET MULTIDATES.

O. El kharki1, d. Ducrot2, & j. Mechbouh3
1. Département Informatique, ENCG, PB 37/S, Cité Hay Salam, Agadir, Maroc
2. CESBIO, Toulouse, France
3. Craste-If, Rabat, Maroc

MOTS-CLES : Échantillonnage, segmentation, base de données géoréférencée et cartographie automatique.

RESUME
La classification dirigée nécessite l’intervention de l’expert qui doit définir les thèmes qu’il juge importants et caractéristiques du milieu étudié. L’occupation du sol varie d’une année à l’autre du fait des rotations de cultures et de divers changements de gestion des parcelles agricoles ou forestière. Il est indispensable de se rendre sur le terrain pour le choix d’échantillons d’apprentissage et de vérification de l’occupation du sol, ce qui donne lieu, souvent, à plusieurs sorties sur le terrain.

Les techniques d’apprentissage classiques reposent en général sur l’utilisation des cartes topographiques, des photos aériennes et des logiciels de traitement d’image comme ENVI, IDRISI, Erdas Imagine, Monteverdi, ..., etc pour localiser et créer les fichiers des échantillons (ROIs). La prise des échantillons est une tâche fastidieuse et contraignante ; de celle-ci dépend en grande partie les résultats de la classification supervisée. L’inconvénient majeur de ces méthodes est que seul trois canaux sont utilisés pour la visualisation de la composition colorée indispensable pour le choix des échantillons.

Motivé par ces raisons, nous proposons une nouvelle méthode automatique pour créer des ROIs basée sur une base de données géoréférencée et une image segmentée. Cette dernière est le résultat de la segmentation d’une série d’images qui peuvent être multibandes et/ou multi-dates et/ou multi-sources.

Nous avons testé cette méthode avec une série d’images acquises en 2002 dans le Sud-Ouest de la France et nous avons souligné la contribution de cette méthode pour automatiser le processus de la cartographie.
ABSTRACT
Generation of reliable urban land use/cover classes is crucial for a better understanding and management of urban physical, ecological and social processes. Before the emergence of remotely sensed imagery, aerial photographs played an important role in land use/cover mapping. However, lack of multispectral information inherent in earlier aerial photographs constrained their wide application in urban mapping. In the recent past, advancement in aerial imaging has seen the emergence of multispectral aerial photographs. This offers an invaluable potential in urban land use/cover mapping.

Textural and spectral characteristics are fundamental for object identification on aerial photographs and satellite imagery. Whereas the use of spectral schemes has been popular, a number of researchers note that accuracy of land use/cover classifications based solely on this characteristic is often compromised by spectral similarities within and between land use/cover classes. Until recently, use of textural characteristics was mainly limited to visual pattern recognition and interpretation. Emerging works have however shown that spatial textural variations offer valuable information about structural configuration of objects and their neighbourhoods and can be used to resolve misclassification from spectral-based classes. Multispectral aerial photographs offer a great opportunity for spectral/textural complimentarity for better urban land use/cover accuracy. In this study we test the feasibility of of multispectral aerial photograph in a heterogeneous urban landscape.

An image of 0.5m and four bands spectral resolution sensitive to blue, green, red and near infrared bands of electromagnetic spectrum was used. A multi-resolution segmentation algorithm was applied to the aerial photograph to derive homogeneous image objects. All the four spectral bands were given an equal weighting in the segmentation. To avoid under-segmentation or over-segmentation, a testing phase was carried out to ensure ideal image objects were derived. Parameters of shape (0.4) and compactness (0.5) at a scale of 30 were allocated.

The derivations of the GLCM and GLDV textural features were done in eCognition software and a summation of all four directions (0°, 45°, 90°, 135°) done before texture calculation using commonly used texture features. Using SEaparability and THresholds (SEaTH) software, over 40 random objects per land use/cover class were selected as samples for feature analysis and threshold identification. This procedure eliminates redundant GLCM textural features, minimizes errors of commission and omission and expedites the identification of thresholds necessary for rule-based classification. The Jeffreys-Matisuta (JM) distance equation was then used to identify the optimum subset of textural features for the development of the classification rules.

Results in this study (Figure 1) showed that GLMC and GLDV Haralick textural features can be used to effectively discriminate between different urban land use/cover types on multispectral aerial photographs. The JM results showed a effective separability between different vegetation cover types. The separation of grass from dense vegetation for instance was 1.908 using GLCM Mean Green and low vegetation from grass was 1.730 using GLCM Mean NIR. As shown by a JM value of 1.935, GLCM Mean Red and GLCM Entropy effectively discriminated low vegetation from dense vegetation in all directions. These vegetation classes commonly have near similar spectral characteristics that often lead to spectral confusion. Using textural features, this separability can be considered to be more reliable than use of spectral delineation.

This study shows the feasibility of multispectral aerial photographs using rule based approach and Haralick textural classification on urban landscapes. The selection of the appropriate textural features and thresholds was done objectively using the JM distance analysis. The feature analysis executed in this study ranked GLCM Mean, GLCM Second Angular Moment, GLCM Entropy, GLDV Contrast and GLCM Homogeneity as the most effective Haralick textural features for urban land use/cover classification. In contrast, GLCM Correlation and GLCM Standard Deviation were the least effective. To improve the reliability of urban land use/cover maps, it is necessary that an integration of both parameters be considered in the classification process. Since most urban
land use/cover units are represented by a group of pixels, object oriented classification that takes cognisance of related pixel textural characteristics is an effective technique in heterogeneous urban landscapes.

![Figure 1: RGB 321 aerial photograph (a) and classified land use/cover map (b).](image)

**Figure 1:** RGB 321 aerial photograph (a) and classified land use/cover map (b).

**RELATION ENTRE LA RESOLUTION SPATIALE DES IMAGES SATELLITES ET LES METHODES DE CLASSIFICATION**

**Omar Bachir ALAMI**

Département Mathématiques, Informatique & Géomatique, EHTP

**MOTS-CLES :** Classification multispectrale, classification orienté objet, THR, résolution spatiale.

**RESUME**

La classification d’images satellite a pour objectif de produire des images thématiques, c’est-à-dire des images dont le contenu ne représente plus une mesure mais une interprétation et une catégorisation de la nature des objets associés aux pixels. En analyse d’image de télédétection, la classification utilise des algorithmes adaptés pour donner une étiquette (label) à un pixel de l’image pour traduire le type d’occupation du sol qu’il représente\(^1\).

D’un côté les capteurs des satellites d’observation de la terre sont devenus de plus en plus à très haute résolution spatiale THR (Ikonos à 1m, Quickbird à 60 cm et Worldview à 50 cm). D’un autre côté, plusieurs algorithmes en matière de classification d’images se sont développés (Classification multispectrale par maximum de vraisemblance, classification subpixel, classification orientée objet,...ect). Il s’agit au fait de deux grandes familles de classification : Classification par pixel ou par objet. La classification est souvent lié à un thème donné (classification sur le thème de l’occupation des sols, classification lithologique, forestière,...ect).

Le présent projet de recherche a pour principal objectif de mettre en relief l’effet de la résolution spatiale sur les résultats de la classification et de définir la limite entre les approches de classification orientée pixel et d’autre orientée objet en termes de résolution spatiale.

PREVISIBILITE DE LA DYNAMIQUE DU BLE PLUVIAL EN ZONE SEMI-ARIDE PAR APPROCHE GLOBALE A PARTIR DE SERIES TEMPORELLES D’INDICE DE LA VEGETATION

Mangiarotti S.1, Chassan M.1 & Drapeau L.1
1. CESBIO, UPS-CNRS-CNES-IRD, 18 av. Edouard Belin, 31401 Toulouse, France

ABSTRACT
Basée sur la théorie des systèmes dynamiques, la modélisation globale vise à obtenir des modèles réduits à partir de séries temporelles uniques. En utilisant les indices de végétation NDVI (Normalized Difference Vegetation Index) issus des capteurs AVHRR et disponibles depuis le début des années 1980, cette approche a permis de mettre en évidence un comportement déterministe sous-jacent à la dynamique du blé pluvial au Maroc et d’en tirer un modèle en équation aux dérivées ordinaires. La dynamique du modèle ainsi obtenue est de petite dimension et caractérisée par un régime chaotique de type toroidal. Associé à un schéma d’assimilation de données, ce modèle fournit un chainon intéressant pour la prévision saisonnière.

AFRICAN MAPPING INITIATIVE–DATA INTEGRATION & GEOGRAPHIC INFORMATION MODELLING

-Ireti Ajala -Managing Partner (Spatial Technologies Ltd, Lagos, Nigeria)

ABSTRACT
The spatial industry across the world is being revolutionized by changes in technology, societal trends, and the mapping community itself. This wave of change is not only reshaping the industry landscape, but providing new opportunities in Africa. Mapping has evolved from manual methods, to computer assisted cartography. Map data is now database-driven that can be accessed by a variety of devices including mobile phones, tablets, laptops, and personal digital assistants.

African map providers must adapt to these changes to remain relevant and contribute to the continental success stories. There is a need for new strategies across African Geographic Information (GI) covering:
1. Map data collection
2. Data management system
3. Map product and data engineering
4. Product management

In response to these changes, map data providers across Africa must ensure that map product development processes are consistent and efficient. The best way to ensure this is to view map features as data like other types of data e.g. telecom, financial, pharmaceutical data, etc. This view will ensure that the process of abstracting geographic features is consistent and repeatable. Data models in the context of geographic features are becoming indispensable in providing abstractions of the real world features that allows geo-data architects to reason about how geographic features are related by ignoring extraneous details while focusing on relevant ones.

Models are used in many ways such as to predict geographic feature qualities, reason about specific properties when aspects of the features are changed, and communicate key system characteristics to various stakeholders. The models may be developed as a precursor to implementing the map products.

Because many aspects of a geographic information system might be of interest, it is possible to use various modelling concepts and notations to highlight one or more particular perspectives, or views, of that system, depending on what is relevant at any point in time.

Data modelling traditionally has its origin in database management and software development; however, it is becoming increasingly apparent that a model driven approach to developing consistent map products offers huge technical and business values. The ISO 19100 series of standards as part of the ISO/TC211 project http://www.isotc211.org provides a robust domain reference model, which defines the terms geographic dataset, feature, spatial object, application schema... e.g. Conceptual model
The ISO19100 series of geographic standards also provide the conceptual framework for spatial data integration covering the strategy of Interoperability as well as the specific details of how to use models in defining geographic product specifications which cover things like template and definitions for specifying data products, encompassing identification, application schema, feature catalogue, quality and other metadata. Interoperability in this context involves the exchange of actionable geographic data between two or more geographic data store systems owned and maintained separately with the intention of integrating data from the 2 data sources.

Specifically, the interoperability strategy for data integration must address:

- A shared understanding of the exchanged of geographic data during integration
- A requisite quality of service: reliability, fidelity, and security.

The result of such integration enables a larger interconnected GI system capability that transcends the local perspective of each participating subsystem.

Paper Objectives

- This paper will articulate the framework for creating conceptual and domain models using the principles of ISO19101 and 19103 for modelling and integrating geographic products using the guide from ISO19131.
- The paper will also lay out a plan of how Africa map providers can utilise GI standards to create better GI production environments, maintenance procedures and reliable interoperable geographic products.

APPROCHE METHODOLOGIQUE POUR LA CARTOGRAPHIE DES ZONES HUMIDES :
APPLICATION AU MOYEN-ATLAS (MAROC)

Lebaut Sebastien ¹ & Labhar Mohamed ²

1. Centre d’Etudes Géographiques, EA n°1105, Université de Lorraine, France.
2. FLSH Dhar Mehraz, Université de SIDI MOHAMED BEN ABDELLAH de Fès, Maroc.


ABSTRACT

Les zones humides renferment une forte biodiversité, jouent un rôle non négligeable dans le maintien d’une bonne qualité des eaux et dans la régulation des écoulements rapides de crue. Au-delà de ces exemples elles sont un enjeu pour « une gestion équilibrée et durable de la ressource en eau » (art. L211-1 du code français de l’environnement) et constituent de fait un enjeu sociétal majeur. Néanmoins l’identification, la délimitation et la classification des zones humides est compliquée puisqu’elles peuvent être répandues dans tout le paysage et être difficilement accessibles.


L’objectif de ce travail est la cartographie multi-date des zones humides dans le Moyen-Atlas afin d’en évaluer l’évolution récente. Cette cartographie se fait sur la base d’images Landsat TM disponibles depuis le début des années 1980. La méthodologie mise en place repose sur 3 étapes majeures : identification, délimitation, caractérisation. A chaque étape, des images de situations hydrologiques différentes sont utilisées pour s’appuyer au mieux sur la phénologie des zones humides. La première étape utilise des images de situation hydrologique haute propice à mettre en évidence des surfaces d’eau libre. La seconde étape consistant en une délimitation précise des ZH repose davantage sur des périodes de fin d’hiver mettant en contraste les secteurs humides permanents ou quasi permanent. Enfin la troisième étape propose également de mettre en relief des secteurs pouvant être temporairement humide en s’appuyant sur des données de MNT.
Au final les zones humides sont cartographiées sur les 30 dernières années ; ces résultats mettent en lumière les pressions importantes que subissent ces milieux fragiles.

**APPROCHE DE CLASSIFICATION NON SUPERVISEE PAR LES RESEAUX DE NEURONES PROBABILISTES POUR ETABLIR DES CARTES D'OCCUPATION DU SOL DE LA REGION DE TENSIFT AL HAOUZ (MAROC).**

Jawad Iounousse, Ahmed Farhi, Salah Er-Raki, Ahmed El Motassadeq & Hassan Chehouani
1. Laboratoire des Procédés, Métrie et Matériaux pour l’Energie et L’Environnement, Faculté des Sciences et Techniques, Marrakech, Maroc

**MOTS CLES** : Traitement des images, Classification, Images satellitaires, indice de végétation NDVI, Réseaux de neurones probabilistes PNN, indice de validité des clusters, Automatisation.

**RESUME**
La classification est une étape très courante dans tout processus d’analyse des images satellitaires. C’est un traitement de bas niveau qui précède l’étape de mesure, de compréhension et de décision. Son objectif consiste à partitionner l’image en régions connexes et homogènes au sens d’un critère d’homogénéité. Pour pouvoir utiliser les images satellitaires pour la cartographie ou pour des analyses complémentaires, il est souvent important de traduire l’information de fréquence contenue dans les images en information thématique portant sur l’occupation du sol ou la couverture végétale. C’est dans ce contexte que nous proposons dans ce travail une technique d’automatisation de la classification basée sur les réseaux de neurones probabilistes. Notre objectif est d’extraitre les profils de végétation présents dans une région à partir d’une séquence de scènes d’images satellitaires en se basant sur l’indice de végétation NDVI.

Les Réseaux de neurones probabilistes (PNN: Probabilistic Neural Network) (Wasserman, 1993) sont souvent utilisés pour des problèmes de classification de données. Ce algorithme suppose la fixation a priori des classes cibles par l’utilisateur, ce qui n’est pas toujours possible. Le choix des classes cibles et leur nombre créent un souci d’erreur. Une méthodologie d’évaluation est requise pour déterminer le nombre optimal de clusters (k*) et les bien choisir. C’est ce qu’on appelle l’indice de validité des clusters (cluster validity index). Le processus pour le calcul de cet indice est résumé par les étapes suivantes:

**Étape 1** : Choix des classes cibles à partir d’un nombre de clusters k.
**Étape 2** : Appliquer l’algorithme PNN pour différentes valeurs de k avec k ∈ [Cmin,Cmax]. Avec Cmin et Cmax présentent respectivement le nombre minimal et maximal de classes possibles qui sont fixés au préalable par l’utilisateur.
**Étape 3** : Calculer l’indice de validité pour chaque partition obtenue à l’étape 2.
**Étape 4** : Choisir le nombre optimal k* de clusters.

Pour atteindre notre but qui est l’extraction de profils de NDVI à partir d’une série d’images (7 images LANDSAT) couvrant la saison agricole du blé (Novembre 2002-Juin 2003), nous avons procédé par deux classifications utilisant PNN. La première est spatiale pour classifier, une par une, les scènes de NDVI en se basant sur l’histogramme représentant la distribution des valeurs de NDVI. La deuxième est temporelle en s’inspirant de la méthode d’analyse hiéarchique des clusters (Ward, 1963) pour trouver les profils types de NDVI par classification de leur évolution pendant la saison agricole du blé. Les résultats obtenus sur la région irriguée de Sidi Rahal située dans la plaine du Haouz dans le centre du bassin du Tensift (Maroc central), 40 km à l’Est de la ville de Marrakech ont été très satisfaisants car tous les types de végétations (blé précoce: 29.25%, blé tardif: 6.5%, orge: 25.31%, arbres: 3.04%, arbres avec herbes: 4.76%, jachère: 13.25%, sol nu: 17.89%) présents dans la zone ont été parfaitement détectés. La figure suivante représente la carte d’occupation du sol de notre zone d’étude :
LA COMBINAISON D’INDICATEURS DE CHANGEMENT POUR LE SUIVI DE L’ÉVOLUTION DE L’OCCUPATION DU SOL A PARTIR D’IMAGERIE SATELLITALES.

Faten Katlane1 & Mohamed Saber Naceur1
1. Laboratoire de Teledetection et systeme d’informations a reference spatiales – Ecole National d’Ingenieurs de Tunis BP37, Tunis le belvedere, 1002 Tunisie

MOTS-CLES: indicateur de changement, combinaison a contrario, changement-significatif, taux de bonne identification des changements.

RESUME
L’apparition de capteurs d’observation de la terre ayant une haute résolution spatiale a permis la réalisation de beaucoup d’applications liées à l’analyse de la surface terrestre ou de l’environnement comme le suivi de la végétation, la mise à jour de la cartographie et aussi la gestion des risques.
La détection de changement peut se faire entre deux images ayant différentes dates, tandis que le suivi de l’évolution de l’occupation du sol se fait à partir d’une multitude d’images multitudes. L’application de l’approche a contrario en traitement d’images, repose sur la détection de structures non attendues, c’est-à-dire fortement improbables ou plus exactement extrêmement « rares » sous le modèle a priori (Desolneux, 2000). Ainsi, on peut détecter des « événements » sans faire d’hypothèse sur la forme de ces événements, mais

Références

LA COMBINAISON D’INDICATEURS DE CHANGEMENT POUR LE SUIVI DE L’ÉVOLUTION DE L’OCCUPATION DU SOL A PARTIR D’IMAGERIE SATELLITALES.

Faten Katlane1 & Mohamed Saber Naceur1
1. Laboratoire de Teledetection et systeme d’informations a reference spatiales – Ecole National d’Ingenieurs de Tunis BP37, Tunis le belvedere, 1002 Tunisie

MOTS-CLES: indicateur de changement, combinaison a contrario, changement-significatif, taux de bonne identification des changements.

RESUME
L’apparition de capteurs d’observation de la terre ayant une haute résolution spatiale a permis la réalisation de beaucoup d’applications liées à l’analyse de la surface terrestre ou de l’environnement comme le suivi de la végétation, la mise à jour de la cartographie et aussi la gestion des risques.
La détection de changement peut se faire entre deux images ayant différentes dates, tandis que le suivi de l’évolution de l’occupation du sol se fait à partir d’une multitude d’images multitudes. L’application de l’approche a contrario en traitement d’images, repose sur la détection de structures non attendues, c’est-à-dire fortement improbables ou plus exactement extrêmement « rares » sous le modèle a priori (Desolneux, 2000). Ainsi, on peut détecter des « événements » sans faire d’hypothèse sur la forme de ces événements, mais

Références
simplement en testant la cohérence par opposition à un modèle a priori (dit modèle naïf), ce qui justifie le qualitative de détection a contrario (Mascle, 2005).

Au cours de ce travail, nous avons appliqué l’approche a contrario pour faire le suivi de l’évolution de l’occupation du sol en combinant plusieurs indicateurs de changement.

**UTILISATION DES DONNEES MSG POUR L’ESTIMATION DE L’INDICE DE NEBULOSITE AU MAROC**

M.F. Smiej
CRTS, B. Zalagh, CRASTE-LF

**ABSTRACT**

La connaissance du taux de couverture nuageuse est importante pour plusieurs applications dans le domaine de la météorologie, l’aviation, les bilans d’énergie, en particulier l’évaluation du potentiel énergétique solaire, en tant que source d’énergie propre et renouvelable. L’article se propose de présenter une méthodologie d’estimation d’un indice de nébulosité au dessus de n’importe quel site en utilisant les images satellitaires MSG. L’algorithme utilise les réflectances dans le domaine visible et la température de brillance dans le thermique, en situant ces valeurs par rapport à références préalablement établies dans les deux régions spectrales correspondant à un ciel complètement clair et nuageux. Les indices de nébulosité dans les deux régions sont alors défini par

\[
IN_{\text{Vis}} = 100 \times \frac{(R_{\text{Vis}}^n - R_{\text{Vis}})}{(R_{\text{Vis}}^n - R_{\text{Vis}}^c)}
\]

et

\[
IN_{\text{IT}} = 100 \times \frac{(T_{\text{IT}} - T_{\text{IT}}^c)}{(T_{\text{IT}}^c - T_{\text{IT}}^n)}
\]

avec \( R_{\text{Vis}}^n, R_{\text{Vis}}^c \) et \( R_{\text{Vis}} \) sont respectivement les réflectances d’un ciel complètement nuageux, entièrement clair et celui du site à évaluer à un instant donné,

et \( T_{\text{IT}}^n, T_{\text{IT}}^c \) et \( T_{\text{IT}} \) sont respectivement les température de brillance d’un ciel complètement nuageux, entièrement clair et celle du site à évaluer à un instant donné.

La première partie décrit la méthode adoptée pour la détermination des images de références dans le visible et le thermique.

La seconde partie définit un « zonage » à l’échelle nationale définissant des zones relativement homogènes vis-à-vis du comportement spectral du couvert nuageux et neigeux. Ensuite, la définition de la combinaison optimale des deux indices sera établie, en se basant sur des images de masque nuage correspondant aux mêmes dates de l’image.

La dernière partie sera consacrée à l’application de cet indice comme un des paramètres principaux de l’estimation de l’énergie solaire directe.

**TECHNICAL APPROACHES TO ACCESSING SATELLITE DATA IN SERVIR**

Jubal Harpster
Principal—Spatial Development International, 2208 NW Market St, Seattle, WA, 98107

**ABSTRACT**

As part of the SERVIR program SpatialDev in collaboration with NASA has been working on a ‘Reference Node’ project that brings together a set of services and data in to a cloud computing platform. Key to this effort has been the development of a series of ETL (extract, transform, load) procedures that access and process Earth Observation data.

These ETL services automatically discover, download, process and update time series Earth Observation data from a number of NASA satellites.

This data is then presented through time—enabled map services that scientist, analysts and the public can access for visualization, application development or further analysis.

This presentation will demonstrate the technical approaches and Techniques used to create a robust process for accessing and delivering near real—time satellite data.
The speaker will cover the technology choices involved in the process as well as show multiple ways to access the data using both web and desktop based tools.

CLASSIFICATION AUTOMATIQUE DES IMAGES SATELLITAIRES OPTIMISEE PAR METAHEURISTIQUE

Soumia Benmostefa¹ & Fizazi Hadria¹

1. Laboratoire SIMPA, Équipe Imagerie et Décision, Université de sciences et technologies USTO, Algérie, BP 1505, 31000 Oran

ABSTRACT

Durant ces dernières années, l'évolution des moyens informatiques a permis la manipulation et le stockage de grandes quantités d'images de haute qualité et très riches en informations. Ces informations sont potentiellement utiles pour un large éventail d'applications. Parmi celles-ci nous pouvons compter les applications militaires, la prévention du crime, les systèmes d'information géographique (SIG), la télédétection et les diagnostics médicaux. Le défi majeur pour tous ces domaines est l'extraction et l'exploitation des informations afin d'en tirer le maximum.

Lorsqu'un être humain observe une image naturelle, il divise l'image en objets ou segments, puis les identifie afin de pouvoir l’interpréter. Cependant, cette interprétation visuelle atteint actuellement ses limites, vu que les images sont devenues très complexes et formées de nombreux éléments. De ce fait est né le besoin de mettre en œuvre des techniques et des méthodes automatiques permettant d'extraire le maximum d'informations possibles à partir des images. Ces méthodes s'inscrivent dans le cadre du traitement d'images. L'opération la plus importante dans ce traitement, permettant une meilleure interprétation, est la classification. Il s’agit donc d’une étape-clé et sa qualité conditionne fortement la prise de décision dans des domaines très variés.

La classification, dite aussi segmentation, consiste à localiser et à délimiter les entités présentes dans une image. Elle est souvent réalisée avant les étapes d'analyse et de prise de décision. On peut distinguer deux approches principales de classification d’images : supervisée et non supervisée. Dans l’approche supervisée, le nombre et la signification des classes sont connues au préalable (par un analyste) et sont utilisés dans l’étape d’apprentissage. Quant à l’approche non supervisée, appelée aussi classification automatique ou segmentation, elle regroupe les pixels similaires selon un certain critère d’homogénéité sans connaître à l’avance ni le nombre de régions ni leurs significations. L’approche non supervisée est plus avantageuse que l’approche supervisée, du fait qu’aucune connaissance préalable d’un analyste n’est nécessaire.

De nombreuses méthodes ont été conçues pour résoudre le problème de la classification automatique d’images. Parmi les plus populaires : K-means, ISO-DATA, Parallélépipède et le maximum de vraisemblance. Cependant ces approches classiques présentent quelques inconvénients, dont les principaux sont : leur grande sensibilité à la configuration initiale ainsi que la convergence prématurée vers un optimum local. De surcroît, plusieurs classifications d’une même image sont possibles. Par conséquent, les recherches ont adaptés le problème de classification en un problème d’optimisation. En effet, les méthodes d’optimisation présentent l’avantage de donner en sortie un nombre optimal de groupes et classifie l’image avec la meilleure partition selon une fonction objective. Ce point de vue a permis d’appliquer la catégorie la plus puissante des méthodes d’optimisation dite métaheuristique à la classification des images. La majorité des métaheuristiques s’inspirent des phénomènes biologiques et physiques de la nature, telle que l’optimisation par essaim particulaires (PSO) basée sur le comportement d’essaim d’oiseaux ou de poissons, les algorithmes génétiques dérivés de la théorie d’évolution de la nature et le recuit simulé fondé sur un processus de métallurgie.

Formellement, l'algorithme des chauves-souris considère chaque chauve-souris comme une classification possible de l'image. À chaque itération la chauve-souris se déplace selon trois équations correspondantes à la fréquence, la position et la vitesse. Chaque déplacement donne lieu à une classification possible de l'image. Cette dernière est évaluée et comparée avec les classifications obtenues par la chauve-souris elle-même, puis avec toutes les autres chauves-souris de la volée. La classification retenue est celle qui est jugée meilleure selon une fonction objective.

La nouvelle approche de classification automatique basée sur l'algorithme des chauves-souris est implémentée et appliquée au préalable sur des images synthétiques dont les régions sont distinguables à l'œil nu, cela permet de tester l'applicabilité et l'efficacité de l'approche. Puis, sur des images satellitaires, particulièrement sur une image de la région d'ORAN ouest en ALGERIE. Cette zone d'étude a été choisie pour notre maîtrise thématique de la région ainsi que pour son paysage varié pouvant présenter un intérêt pour l'évaluation de notre approche. Après une étude expérimentale et comparative, il s'est avéré que l'approche proposée s'est montrée plus performante que d'autres algorithmes dédiés à la classification selon certain critères, tels que l'absence de confusions entre les classes, le taux de classification et le temps de classification.

Finalement, notons que l'algorithme des chauves-souris, comme tout algorithme de classification, est influencé par des paramètres tels que la taille de la population, le nombre d'itérations, le critère d'arrêt, etc. Le choix de ses paramètres influence fortement sur la qualité de la classification.
MESURE EXPERIMENTALES ET ESTIMATION DU RAYONNEMENT SOLAIRE GLOBAL : CAS DE LA STATION D’ORAN (USTO)

S.Talamine & A. Hassini
1. Laboratoire d’Analyse et d’Application du Rayonnement, Département de Physique, U.S.T.Oran, B.P. 1505 El M’Naouer, Oran, Algérie
2. Institut de Maintenance et Sécurité Industrielle- Université d’Oran Es-Sénia

MOTS-CLES: Rayonnement global, SPCTRL2, MBE, MAE, RMSE.

RESUME
L’énergie radiative du soleil subit de profondes modifications en traversant l’atmosphère en raison de l’absorption et de la diffusion. À la surface de la Terre, on observe non seulement le rayonnement solaire direct mais aussi le rayonnement diffus qui provient de chaque point dans l’atmosphère. Ces deux rayonnements constituent le rayonnement global dont une partie est réfléchie par la surface et l’autre absorbée.

Dans cette étude nous allons mesurer le rayonnement global mensuel sur la surface d’une région (ici Oran en Algérie).


IMPACT DES ALEAS CLIMATIQUES ET DES PRESSIONS ANTHROPIQUES SUR LA DYNAMIQUE DES ECOSYSTEMES STEPPIQUES. CAS DES HAUTES PLAINES OCCIDENTALES ALGÉRIENNES

Lafrid Aicha, Youssi Djaifar, Kharroubi Bénali & Mederbal Khalladi
1. Centre des Techniques Spatiales d’Arzew (CTS), Oran, Algérie. BP 13, 31200, Arzew, Algérie.
2. Université des Sciences et de Technologie d’Oran (U.S.T.O)
3. Université de Mascara, Algérie.

RESUME
La région steppique algérienne subit des perturbations naturelles et anthropiques de plus en plus agressives induisant une baisse considérable du potentiel biologique aggravant ainsi la dégradation du milieu ; plus particulièrement, dans ces zones soumises à un climat aride, les sécheresses sont fréquentes et la population, qui se trouve de plus en plus dans des conditions de déficience en ressources naturelles, affronte sa pauvreté en surexploitant la steppe déjà dégradée. Par ailleurs, ces zones, sujettes de désertification, font aussi l’objet de mesures d’aménagement destinées à freiner et à inverser les processus de dégradation.

Pour cerner la dynamique des écosystèmes, afin de les réhabiliter ou de mieux les préserver, l’analyse du milieu est une étape nécessaire. Or, les méthodes classiques de diagnostic phytoécologique, qui sont nombreuses et diversifiées, ne permettent pas d’étudier de grands espaces dans un laps de temps raisonnable et ne répondent pas souvent, aux attentes du praticien du terrain.

La finalité de notre recherche est de mettre en place une approche consistant à réaliser un diagnostic spatio-temporel de l’état et de la dynamique des écosystèmes (sol et végétation) en relation avec l’impact du climat et des activités humaines "destructrices".

Ainsi, il est proposé une cartographie multitemporelle des écosystèmes en utilisant les images satellites de type Landsat (TM 1987 et ETM+ 2011) et les observations de terrain ; les données générées à partir de différents traitements des images satellites sont utilisées par la suite pour, notamment, détecter les changements spatiaux dans la région.
Les résultats obtenus ont permis de constater que, depuis 1987, la partie ouest du territoire étudié était déjà dégradée et gravement touchée par le phénomène d’ensablement. En 2011, la région est en net déclin malgré les efforts de l’Etat pour réduire les dégâts survenus sur ce milieu.

Les phénomènes de désertification observés actuellement dans la région steppique algérienne constituent la conséquence directe d’une longue surexploitation des ressources naturelles à laquelle s’ajoute l’aridité du climat fréquemment affecté par la sécheresse.

**METHODE DE SELECTION DES BANDES A BASE DE L’ANALYSE EN COMPOSANTES INDEPENDENTES APPLIQUEE AUX IMAGES HYPERSONTECRALES DE TELEDETECTION**

Chouaf Seloua\(^1\), Smara Youcef\(^2\)

1. Université des Sciences et de la Technologie Houari Boumediene (USTHB)
2. Faculté d’Électronique et d’Informatique, Laboratoire de Traitement d’Images et de Rayonnement, B.P 32, El-Alia, Bab Ezzouar, 16111, Alger, Algérie

**MOTS-CLES:** Imagerie Hyperspectrale, Sélection des Bandes, Analyse en Composantes Indépendantes, Poursuite de projections, Ajustement en bruit.

**RESUME**

L’imagerie hyperspectrale est un processus d’acquisition optique qui permet la collecte d’images sur un nombre révolutionnaire de bandes étroites et contigües couvrant une large gamme spectrale. En plus des hautes résolutions radiométriques et spatiales, les images de télédétection sont généralement prises sur des centaines de bandes couvrant les régions spectrales du visible, du proche infrarouge et de l’infrarouge en ondes courtes. Les images ainsi produites, sont caractérisées par un volume considérable qui alourdit dans la plupart des cas les taches usuelles telles que la visualisation, le stockage, la transmission et le traitement.

Pour remédier à ce problème, nous nous intéressons à la réduction de la dimensionnalité hyperspectrale qui consiste à réduire les redondances. Ceci est généralement obtenu par l’extraction des caractéristiques qui revient à projeter les données originales dans un espace de représentation de dimension moindre. Dans ce cas, l’aspect spectral des données est complètement perdu. Pour cela, nous nous proposons d’adopter une approche différente qui permet de conserver le sens informatif et spectral des bandes retenues. Nous nous sommes alors proposé de développer un algorithme de sélection qui s’appuie sur l’analyse en composantes indépendantes pour estimer l’apport informatif de chacune des bandes spectrales d’origine. Ceci nous permettra d’établir un ordonnancement renseignant sur le degré d’importance de chacune d’entre elles.

La sélection signifie la conservation d’un nombre réduit de bandes parmi les plus pertinentes grâce à un seuil fixé en fonction des objectifs à atteindre.

Nous appliquons l’analyse en composantes indépendantes sur la totalité de l’hyper-espace utilisant l’algorithme le plus rapide (connu sous la dénomination FastICA). Cette transformation génère des composantes aussi indépendantes que possible se basant sur des critères d’optimisation qui utilisent les statistiques d’ordres supérieurs à deux (kurtose, néguentropie).

Nous proposons d’estimer la matrice de transformation en considérant des orthogonalisations symétrique (globale) ou à déflation (séquentielle, qui s’approche du principe de la poursuite de projections). De plus et par crainte de produire des composantes bruitées, nous apportons un ajustement aux données originales avant d’implémenter l’algorithme de séparation.

Les tests effectués, sur des images hyperspectrales aéroportées issues des capteurs AVIRIS et Spectir, jusqu’à lors ont montré l’efficacité de la méthode pour passer de l’hyper-espace original vers un espace de dimensionnalité réduite, moins redondant et qui préserve aussi bien la représentativité des données que leur sens spectral.
DEVELOPING A LAND INFORMATION SYSTEM FOR POVERTY ALLEVIATE THROUGH GEOGRAPHICAL INFORMATION SYSTEM AND COMMUNITY REMOTE SENSING

M.O. Adepoju 1 & Taslim Alade 1
1. National Space Research and Development Agency, Nigeria

KEYWORDS: Poverty alleviation, GIS, Remote Sensing and Land Administration.

ABSTRACT
Poverty is a livelihood condition estimated to affect more than 1.2 billion people around the globe. Amongst those suffering, approximately 75 per cent are people living and working in rural areas (International Fund for Agricultural Development (IFAD, 2001). The progress of developing countries and poverty problems are exacerbated by the alarming rate of population expansion, especially in the urban slum, the exploitation and degradation of land and natural resources, health epidemics, and sustained political instability. The inability of the world’s poor to gain formal recognition of their property rights is a major stumbling block to alleviating poverty. Almost everywhere in the world the poor have one asset in common, which is the land they occupy. Unfortunately in Nigeria, very few of these people have ever received any type of legal recognition that the land they occupy is theirs, especially in situations where the ownership is informal or based on customary forms of tenure. This research utilised land information system with community remote sensing to establish a land administration framework for leading to government recognition and issuance of right of occupancy which enables owners to approach financial institutions for soft loans to aid business activities thereby increasing the economic status of the poor in the study area. Community remote sensing is a new field that combines remote sensing with citizen science, social networks, and crowd-sourcing to enhance the data obtained from traditional sources. It includes the collection, calibration, analysis, communication, or application of remotely sensed information by these community means. Effective and efficient land administration provides a central framework for a country’s capacity to deliver economic growth and sustainable development for poverty alleviation. Secure land tenure is important for economic, social and environmental development and is central to secure shelter, easy access to investment and credit opportunities. This research clearly shows the importance of space applications as the alternative path to poverty reduction in rural and urban areas in Nigeria.

A PROTOTYPE OF OPEN SOURCE TOOL FOR WATER RESOURCES MANAGEMENT IN DEVELOPING COUNTRIES

Naga Coulibaly 1, Umesh Bellur 2, Nandlal L. Sarda 2, Smita Sengupta 2 & Issiaka Savané 2
1. UFR-SGE, Univ. of Abobo-Adjamé, Abidjan, Côte d’Ivoire
2. CSE Department, IIT-Bombay, Mumbai, India

ABSTRACT
The development of almost all socio-economic sectors depends on water resources. Indeed, water resources are mobilized to satisfy various uses like domestic, agricultural, industrial, livestock, tourism, leisure etc. In developing countries, water resources are not available in sufficient quantity and quality anytime, anywhere. This situation is worsened by the pressure induced by socioeconomic and population growth. It’s therefore necessary to create the conditions for sustainable access to water for the different users. Such an approach must be supported by tools which allow management and analysis of current and historical data.

The present paper describes a spatial tool prototype for the integrated water resources management for various uses in developing countries. The tool assesses water vulnerability to pollution, water demand and soil erosion in a watershed. Design with Unified Modeling Language (UML), the tool integrates a socio-economic and environmental database for water resources assessment, management and planning at a watershed level. It is developed with Quantum GIS (QGIS) shell enhanced with GRASS functionalities. Quantum GIS performs well under very poor computing conditions; this will make this tool accessible to all water resources actors. The
CARACTERISATION GEOMORPHOLOGIQUE DU SYSTÈME LAGUNO-LACUSTRE DE BIZERTE (TUNISIE DU NORD) PAR TELEDÉTECTION RADAR ET OPTIQUE

Ibtissem Amri¹, Mohamed Chedly Rabia¹ & Jean Paul Rudant²

1. Unité de recherche Géomatique et Géosystème. Campus Universitaire de la Manouba_Tunis_
Tunisie
2. Groupe TIG (Télédétrection, Information Géographique), Université Paris-EST _ Marne la Vallée_France

MOTS CLES : radar, SAR, MNE, ASTER, SRTM, distorsion géométrique, indices spectraux, géomorphologie

RESUME
L’objectif de ce présent travail est de caractériser la géomorphologie des environs du système lacustre de Bizerte-Ichkeul (Nord de la Tunisie) en se basant, essentiellement, sur les informations tirées des images radar SAR. Ces dernières sont caractérisées par des distorsions géométriques importantes dont la correction est indispensable pour en tirer les informations recherchées.

Les paramètres altimétriques influent directement sur la qualité de la correction géométrique des images radar. Dans ce présent travail, ces paramètres sont tirés de deux sources différentes : le premier consiste en un modèle numérique d’élévation dérivé de la navette spatiale du satellite ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) et le deuxième consiste en un MNE SRTM (Shuttle Radar Topography Mission) donnée suite à une campagne radar à ouverture synthétique.

L’image radar ASAR en « amplitude » a été corrigée géométriquement en utilisant les informations altimétriques tirées des deux MNE ainsi cités. Une amélioration de la qualité géométrique de l’image en sortie est fortement sentie. Le MNE-SRTM a surtout corrigé les distorsions géométriques dues essentiellement aux pentes raides, le MNE-ASTER a, en contre partie, amélioré la qualité géométrique de l’image au niveau des terres plates et a montré de plus les détails dans l’image grâce à sa haute résolution spatiale (30m).

La complémentarité entre les deux types d’information est à l’origine de la mise en évidence des principales structures des environs du système lacustre de Bizerte-Ichkeul. L’ajout des informations texturales données par la bande « amplitude » et les paramètres spectrales tirées des images SPOT et Landsat a contribué à la caractérisation lithologique de la région cible.

Les informations morpho-lithologiques tirées des données radar et optique ont été fusionnées par la méthode ITS. Le produit final a subi par la suite une classification par maximum de vraisemblance permettant, ainsi, la caractérisation géomorphologique des environs du système lacustre de Bizerte.

GIS-SUPPORTED STUDY OF OFADA RICE VALUE CHAIN IN SW NIGERIA

Oyedepo, J.A.¹, Omotayo, A. M.¹, Elemo, K.1 & Oyedepo, E.O.¹

1. University of Agriculture, P.M.B. 2240, Abeokuta Ogun State Nigeria

KEY WORDS: Ofada rice, ProductionAreas, SW Nigeria, GIS
ABSTRACT
Mapping exercise of Ofada rice production areas was motivated by the need to develop, spatially targeted interventions that will positively impact local rice value chain in south western Nigeria. The study aimed at identifying production areas and associated constraints for development of decision support to aid geographical targeting of interventions. 254 Ofada rice farmers in 55 villages in 11 local Government areas of three Nigerian States were identified. Results show that production inputs locations were far from majority of the rice farmers. There is the need for direct intervention to improve access of farmers to all rice production inputs.

The overall geometry of the broken trajectories can be maintained for non-spherical particles by, however, doubling the geometries at each partial tract. As in Ref.3 each trajectory from the starting point, the first scattering, the second scattering and the receiver is determined by geometrical considerations and the chosen time length. The corresponding total attenuation of the path is determined by the extinction coefficients of the medium for the modes to be considered at each path step. Differently from the case of spherical particles the actual contribution to the received power depends on the azimuthal direction of the starting direction. In the procedure of Ref. 3 a double integration was needed with respect to angles of scattering and positions of first scattering point. In the considered case a further angular variable is needed, together with an angular integration with respect to the symmetry axis of the considered beam.

The paper which I would like to present would show the relevant mathematics, and possibly a series of numerical results for very simple small particles.


COMPARISON OF A NEW CLASSIFIER, THE MIX–UNMIX CLASSIFIER, WITH CONVENTIONAL HARD AND SOFT CLASSIFIERS

Thomas Ngigi¹, Edward Waithaka¹, Ryutaro Tateishi², Adel Shalaby³ & Mohamed Ghar³

1. Department of Geomatic Engineering and Geospatial Information Systems, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200, Nairobi, Kenya.
3. National Authority for Remote Sensing and Space Sciences, P.O. Box 1564 Alf Maskan, Egypt.

ABSTRACT
The number of bands must be more than the number of end-members…’ is perhaps the most ubiquitous statement in linear spectral unmixing. The Mix–Unmix Classifier overcomes this limitation. Further, the classifier creates a processing environment that allows any pixel to be unmixed without any sort of restrictions (e.g. minimum determinable fraction), impracticalities (e.g. negative fractions), or trade-offs (e.g. either positivity or unity sum). The classifier gives not only the most probable fractions of end-members, but also their most probable contributory DNs. The contributory DNs directly define the qualities, (e.g. the phenological stages) of the end-members.
The classifier is applied as a dual classification method and compared with popular conventional hard and soft classifiers in production of two to eight spectral classes/end-members from Landsat 7 ETM+ data. The classifiers considered are Spectral Angle Mapper, Binary Encoding Classifier, and Maximum Likelihood Classifier for hard classification; and IDRISI Kilimanjaro Probability Guided Option linear unmixing technique for soft classification. The Mix–Unmix Classifier performs better than the others.

VISUAL IMAGE INTERPRETATION IN MODELLING THE DYNAMICS OF A SLUM SETTLEMENT

Shoko, M.
Department of Surveying and Geomatics, Midlands State University, P.O. Box 9055, Gweru, Zimbabwe.

KEYWORDS: Slum settlement, Rule based, Growth, Agent, Environment

ABSTRACT
Informal settlements also known as slums are some of the negative effects of rapid urbanization. They emerge when hopeful migrants move in numbers to urban areas seeking better opportunities. A significant number of this human traffic end up settling in slum settlements due to lack of affordable urban housing to accommodate the unplanned numbers. Urban planners and policy makers face challenges in effective management of slum settlements as they do not fully understand their dynamics and extents. In recent years, global research interest has developed on the area of slums in an effort to understand them fully as to manage them better.

Initially most study approaches were participatory in nature resulting in time consuming ground based techniques whose results could not always be updated quickly when required. Advances in remote sensing have recently offered growing results in slum characteristics using various pixels based and of late more of object based techniques. This particular research seeks to develop a basic prototype of an agent based model that can be used as a basis of modeling growth trends within a slum settlement from inception to consolidation. It employs a set of agent rules biased towards a Marxist approach of space occupation and uses simulation as a vehicle to predict slum proliferation within a growing settlement using Khayelitsha in Cape Town, South Africa as a test case. Parameters are drawn from remotely sensed imagery as rules in the agent based model. Slum growth parameters extracted from the imagery and simulation are then for use in further studies on slum growth modeling. Such contributions aid researchers in building an information base that is useful to city planners and developers.

ACCURACY ASSESSMENT OF MULTI-SOURCE DATA SETS IN LANDCOVER ANALYSES IN SOUTHWESTERN NIGERIA

Ojo A. G.
African Regional Centre for Space Science and Technology Education, PMB 019 OAU Campus, Ile-Ife.

KEYWORDS: accuracy assessment, remotely sensed imageries, medium resolution imageries, seamed imageries land use/land cover.

ABSTRACT
The study aimed to assess the relative accuracy of feature definitions on the imageries; and examines the potentials and constraints of data seaming for complimentary usage of spatial data.

The study revealed that significant and positive correlated occurred within the visible bands in NigeriaSat-1 ($r=0.95; p \leq 0.05$) and SPOT ($r=0.98; p \leq 0.05$) while it was lower in Landsat TM imagery ($r < 0.3; p \leq 0.05$) on the other hand the objects in the Near Infrared (NIR) correlated significantly with the red band (visible band) only in SPOT ($r=0.98; r \leq 0.05$) Landsat TM imageries ($r = 0.98; r \leq 0.05$). In addition, the percentage accuracy of the classified area was highest in NigeriaSat-1 for built-up area (97.3%) and lowest in SPOT imagery (81.98%). On the other hands, while bare rocks (89%) were classified with the highest accuracy in SPOT, other land uses
such as farmland (88.1%), secondary forest regrowth (78.3 %) were more accurately classified in NigeriaSat-1 (k = 0.97; p ≤ 0.05), water today was however most accurately classified in SPOT imageries (85.5%; k = 1.0; p < 0.05).

Furthermore, the results of the accuracy assessment of the seamed set of the imageries showed that a merge of SPOT + NigeriaSat-1 correlation was however yielded higher 81.2% (k = 0.98) than other combination (i.e. Landsat TM + NigeriaSat-1 seamed was however yielded higher level accuracy for built up area (>96%) and were more defined than other landuse classes. The study showed that both SPOT and NigeriaSat-1 imageries are likely to be useful within acceptable accuracy for land use/land cover in urban area in southwestern Nigeria. The study concluded that integrating more than one medium resolution imageries could provide better accuracy than a singular image for land use/land cover study in the southern Nigeria.

NEAR REAL TIME MSG –SEVIRI SATELLITE DATA ACQUISITION AND PROCESSING SYSTEM

A.Hassini1,2, S.Talamine1 & A.H.Belbachir1
1. Laboratoire d’Analyse et d’Application du Rayonnement, Département de Physique
U.S.T.Oran, B.P. 1505 El M’Naouer, Oran, Algérie
2. Institut de Maintenance et Sécurité Industrielle- Université d’Oran Es-Sénia

KEY WORDS : development, sensors, acquisition, images, satellite, environent

ABSTRACT
The SEVIRI (Spinning Enhanced Visible and Infrared Imager) sensor on the MSG satellite provides an image every 15 minutes, so the development of an algorithm that can exploit the temporal behavior of the observations of terrestrial half-disc centered on Africa, in spite of their large pixel size, is crucial for these near-real-time applications. In this search, we realized a ground station, to receive daily the enviromental data from either HRIT (High Rate Image Transmission from METEOSAT9 geostationary satellite baptized MSG2), HRPT and APT (High Resolution Picture Transmission and Automatique Picture Transmission from NOAA19 polar satellite) real time satellite data transmissions. In the APT system, the predictions tell the operator when to have the system active. The HRPT system, however, uses the predictions to aim the dish antenna at the polar satellite as it passes overhead, so accuracy in the predictions and proper timing is essential. Some results of acquisition and treatment (by our MSGViewer and PCNOAA developped softwares) are described in this paper.

LA TECHNIQUE VRS, UN AVENIR PROMETTEUR POUR LES PROJETS DU DEVELOPPEMENT DURABLE

Moha El-Ayachi
Institut agronomique et Vétérinaire Hassan 2, Maroc

MOTS CLEES: VRS, Modélisation, ionosphère, troposphère, infrastructure, localisation.

ABSTRACT
La technique VRS (Virtual Reference Station) est apparu pour permettre une gestion Centralisée d’une multitude de stations de référence GNSS et la sélection de la référence la plus proche à une station mobile en temps réel (RTK) pour l’exploiter dans la modélisation des corrections RTK du réseau considéré avec une capacité de supporter jusqu’à 100 stations de référence. Avec le principe de la station virtuelle, la technique assure une ligne de base courte et performante à l’intérieur du réseau. Elle se base sur la mise en place d’un réseau de stations permanentes et opérant d’une façon continue. Cet article a pour objectif pour présenter des cas d’études établis par la technique VRS. Il s’agit de fournir les applications réussies pour la navigation, le contrôle des infrastructures et la modélisation des changements climatiques. En effet, Les stations VRS permettent de réduire significativement les erreurs systématiques et d’assurer des lignes de base courtes et une initialisation rapide. Son fondement augmente la productivité des
opérateurs en éliminant le besoin d’établir une station de référence locale et en fournissant un service d’alertes et d’avertissement accru par une gestion intégrée des différentes erreurs et stations. Tous les utilisateurs opèrent dans un référentiel de coordonnées commun et exploitent un seul numéro de téléphone pour tout le réseau. Le moyen de transmission est basé sur l’Internet, le GSM et le GPRS. Un autre aspect très important est assuré par le VRS et s’agit de la possibilité de modéliser les effets ionosphériques linéaires et non linéaires à un premier ordre et d’appliquer des modèles Troposphériques. Une autre fonctionnalité importante est offerte par la technique VRS qui est celle de la possibilité d’étudier les perturbations ionosphériques et les erreurs prédites dues à l’ionosphère et à la troposphère.

CORRECTION ATMOSPHERIQUE DES IMAGES LANDSAT PAR LA METHODE MONTE CARLO : APPLICATION A LA SEBKH D’ORAN

Hanane Hadjit1, Abdelaziz Oukebdane1 & Ahmad Hafid Belbachir1
1. Laboratoire d’analyse et d’application du rayonnement (LAAR), Département de physique, Université des Sciences et de la Technologie d’Oran, B.P. 1505, El M’nouar, Oran, Algérie

RESUME

Le principe de la correction atmosphérique d’une image de télédétection repose sur la mesure indirecte de la réflectance au niveau de la surface visée, en éliminant les effets perturbateurs de l’atmosphère. L’estimation des paramètres atmosphériques et géométriques des images étudiées permet de définir le trajet ascendant et descendant du rayonnement incident et, par conséquent, déterminer la réflectance atmosphérique et les transmittances ascendante et descendante qui participent à l’altération de l’information obtenue de l’image. Dans ce travail, une méthode de correction atmosphérique, basée sur les techniques Monte Carlo, a été développée. Cette méthode a été utilisée pour analyser une série d’images LANDSAT, acquises sur plusieurs années, ce qui a permis d’étudier la variation de la réflectance de plusieurs régions de la sebkha d’Oran (figure 1), située au nord-ouest de l’Algérie, et de déterminer l’état de dégradation des zones environnantes. Une comparaison a été faite, entre les réflectances mesurées hors atmosphère et simulées au sol, pour différentes zones de la sebkha et différents sols choisis.

La représentation de l’image de la différence a permis de constater un changement significatif entre l’image brute et l’image corrigée. Ce changement a été confirmé par la représentation des courbes de réflectance et des histogrammes, avant et après correction.

Aussi, une étude multi-date a été effectuée sur la réflectance de la sebkha et les régions avoisinantes pour déterminer l’impact de la sebkha sur son environnement. L’évolution de la réflectance de la sebkha a été obtenue par le calcul de la signature spectrale et le calcul de certains indices tels que l’indice de salinité (NDSI, SI) ou de végétation (NDVI).
Le calcul des signatures spectrales de plusieurs zones de la sebkha a permis le partage de la sebkha en deux zones majeures : la première couverte d'eau située au nord (près de la plaine de Misserghine – Bréédéah) et la deuxième asséchée au sud. La quantité d'eau présente dans la sebkha varie selon les saisons. Alors que pendant les mois de février, avril et mai de l'année 2011 la sebkha contenait une mince couche d'eau, dont l'épaisseur dépendait de la pluviométrie. Pendant les mois de juin, aout et septembre elle devint complètement desséchée.

L'étude de la signature spectrale de la sebkha sur plusieurs années a montré aussi que la sebkha n'a pas beaucoup évolué depuis 1987. A l'opposé, la détermination de la signature spectrale de la plaine de Mleta, située au sud de la sebkha, a confirmé la transformation de la plaine en une zone aride. En revanche, la plaine de Misserghine – Bréédéah n’a pas été influencée.

Le calcul des indices de salinité et de végétation a confirmé que le NDSI et le NDVI sont mieux adaptés pour différencier entre les zones sèches de la sebkha, la mer et la végétation. En revanche, le NDSI et le NDVI des zones couvertes d'eau sont semblables à ceux de la mer. Dans ce cas, le calcul du SI est utile pour distinguer la sebkha de la mer caractérisée par un SI inférieur.

La validation de cette méthode a été confirmée par comparaison avec le code 6S.

A TIME SERIES ANALYSIS OF LAKE VICTORIA SURFACE TEMPERATURE USING MODIS IMAGERY

Gidudu Anthony¹ & Namugga Angela¹
1. Department of Geomatics and Land Management, Makerere University, P.O. Box 7062 Kampala, Uganda

ABSTRACT

Introduction
Lake Surface Temperature (LST) as a water quality parameter is important because it is indicative of a lake’s biological and chemical activity. Different marine species for example have preferred temperature ranges within which they survive. Beyond these preferred ranges their survival is compromised and may diminish their population counts. In similar measure, the rate of chemical reactions is directly proportional with temperature increase, which in turn affects biological activity. By monitoring lake surface temperature one is therefore better placed to monitor the lake productivity.

Lake Victoria is an ecosystem with a lake surface area of 68,800 km². By its size it is home to rich diversity and quantities of flora and fauna. In addition, to the three countries surrounding Lake Victoria i.e. Uganda, Kenya and Tanzania, fish exports constitute an influential component of the Gross Domestic Product (GDP). To be able to monitor the LST of a lake the scale of Lake Victoria presents challenges of no mean feat and yet is imperative to be able to sustain the livelihoods and economies of the East African Community. Currently in Uganda, organizations such as the National Water and Sewerage Cooperation (NWSC) determine water quality of a very small portion of Lake Victoria on a monthly basis. This involves sending boats to the lake, collecting water samples and sending them to the laboratory for analysis. This is invariably proving costly, is done erratically, not consistently and worse still does not give a synoptic perspective of the temperature variation on the lake. This obviously impedes the ability to monitor the LST variation and other water quality parameters. This paper presents the results of exploring MODIS-derived LST as an alternative to conventional means of determining lake surface temperature variation.

Methodology
MODIS level 2 data was used to monitor LST on Lake Victoria for the years 2003 - 2010. SeaDAS version 6.2 software was used to visualize, process and analyze MODIS Level-2 (L2) data. The MODIS L2 images were corrected for both geometric and atmospheric errors during the image pre-processing stage. LST was extracted using the National Aeronautics Space Administration (NASA’s) SST algorithm (SST4).

Results and Discussion
To illustrate the benefit of satellite imagery, the LST for Jinja in Uganda (a town on the Northern shores of Lake Victoria) was extracted from archived MODIS data for the years 2003 – 2010 and is shown in Figure 1. Whereas
this archived Satellite data is available and can be revisited time and again, unfortunately the same cannot be said about the corresponding in-situ data, hence rendering comparisons impossible. Nonetheless, from the results it is evident that the LST at this point exhibits variation that in addition to the diurnal variations expected on Lake Victoria, depicts an annual seasonal variation which generally peaks in week 8 – 12 (i.e. March to May) and week 34 – 38 (i.e September – November). The lower annual temperatures are generally observed in the weeks 21 – 27 (i.e. June – July) and weeks 52 – 2 (i.e. December to February). These temperature patterns coincide with the rainfall season in the Northern part of Lake Victoria and may explain the influence of rainfall on the LST. High LST during the rainy season may be explained by the fact that in the rainy season there is little evaporation from the water surface and hence little heat loss through radiation. The next step in this research will be to collate these temperature results with other water quality parameter variations to model lake productivity, potential fishing zones etc. It is also recommended that Lake Victoria specific algorithms be derived to give more accurate results of LST. This will require collecting in-situ data simultaneous to MODIS overpasses. Being able to extract LST daily will go a long way in improving the management of Lake Victoria water resources.

**Figure 1:** Variation of LST at Jinja in Uganda for the years 2003-2010.

**USING THE WISHART MAXIMUM LIKELIHOOD CLASSIFIER TO ASSESS THE POTENTIAL OF TERRASAR-X AND ALOS PALSAR DATA FOR LAND COVER MAPPING**

J.R Otukei¹, T. Blaschke² & M. Collins³

1. Department of Geomatics and Land Management, Makerere University, P.O. Box 7062 Kampala Uganda.
2. Centre for Geoinformatics, University of Salzburg, Hellbrunerstrasse 34, 5020 Salzburg Austria.
3. Department of Geomatics Engineering, University of Calgary, 2500 University Drive NW, Calgary, AB, T2N 1N4, Canada.

**ABSTRACT**

Introduction

It is generally accepted that land cover is a fundamental variable that impacts on and links with many parts of the human and physical environment. Accordingly, knowledge of land cover has become essential for: the sustainable management of natural resources, environmental protection, food security and successful humanitarian programs. Since the 1970s, remote sensing applications for land cover mapping have increased with the availability of a wide range of satellite sensors. This is due to the fact that remote sensing provides the most cost-effective means of collecting data, desirable for a range of spatial and temporal scales of analysis. Unfortunately, the application of remote sensing data for land cover mapping is not a simple task since it involves the consideration of many factors such as the selection of: the remote sensing data, classification method, classification system, training and test data, pre-processing operations, post classification processing, accuracy assessment methods, and scale of analysis. The main aim of this study was to assess the potential of TerraSAR-X (TSX) and ALOS-PALSAR for land cover mapping using a Wishart maximum likelihood classifier.
The gist of the analysis was to investigate the potential of the dual polarised TSX and quad polarised ALOS PALSAR with varying spatial resolutions for the land cover mapping. The study area is the Bwindi impenetrable National Park located in South-Western Uganda.

**Data Sets and Methods**

The study was carried out using a 2.75 m spatial resolution, dual StripMap mode TerraSAR-X (TSX) data with Horizontal-Horizontal (HH) and Vertical-Vertical (VV) polarizations. Additionally, ALOS-PALSAR data with HH, VV, HV and VH polarisations and a spatial resolution of 12.5 m was also used for analysis.

A pre-determined land cover classification scheme comprising of open water, dense evergreen forest, dry bare farmland, wet bare farmland, aquatic vegetation, mixed rangeland, mixed farmland and degraded wetland land cover classes was the basis for land cover classification. In addition, oreshortening and nodata classes were included for classification where appropriate. Representative samples for the land cover class, each containing at least 700 pixels, were selected for image classification. An accuracy assessment was performed based on 50% of the original training data. The results were reported using overall accuracy, average accuracy as well as individual class accuracies.

**Results and Discussion**

Figure 1 shows the results of the land cover classification for the ALOS PALSAR and TSX data. An overall land cover classification accuracy of 86% was obtained using ALOS PALSAR data, compared to only 43.9% overall accuracy obtained using TSX data. The corresponding average accuracy for ALOS data was also higher than that of TSX data. The per-class accuracy obtained using ALOS data was also higher than that of TSX data. In addition, ALOS data provided the possibility of identifying more land cover classes than TSX data. The low accuracy obtained using TSX data can be attributed to the high spatial resolution of the image, resulting in high image texture. High image texture results in inter-class confusion and hence low classification accuracy. Furthermore, the lack of the HV and VH cross-polarised channels for the TSX data resulted in low classification accuracy.

**Conclusions and Recommendations**

This study has demonstrated the potential of ALOS-PALSAR and TSX data for land cover mapping in the BINP. Overall, full quad polarimetric ALOS-PALSAR data provides a high potential for land cover mapping compared to dual polarimetric TSX data when analysed using WMLC. The ALOS data does not only result in high overall classification accuracy but also provides the ability for improved identification and classification of more land cover features. It is also evident that the lack of cross-polarised channels results in low classification accuracy for TSX data. Further research is therefore envisioned for the full quad TSX data to assess its potential for land cover mapping in similar environments.
TIME SERIES MODELLING OF MONTHLY SEA LEVELS IN THE WESTERN INDIAN OCEAN

S.B. Mahongo¹, E.N.N. Nortey² & A.A. Mather³

1. Tanzania Fisheries Research Institute, P.O. Box 9750, Dar es Salaam, Tanzania.
2. Department of Statistics, University of Ghana, P. O. Box LG 115, Legon, Accra, Ghana.
3. Coastal and Catchment Policy, Co-ordination and Management, eThekwini Municipality, P.O. Box 680, Durban 4000, South Africa.

ABSTRACT

A statistical modelling study was carried out implementing the Auto Regressive Integrated Moving Average (ARIMA) technique for selected tide gauge stations in the Western Indian Ocean region. The significance of the research emanates from the importance of sea level and its practical applications in various fields such as oceanography, meteorology and hydrology. The lack of detailed knowledge of the local oceanography and meteorology in the region makes statistical modelling of sea level particularly relevant. The choice of the ARIMA technique is due to the model’s ability to accommodate for two of the inherent properties of sea level data, namely, autocorrelation and seasonal dependency. Generally, autocorrelation behaviour in ordinary linear regression modeling violates the underlying assumptions, and hence ARIMA is more appropriate. The ARIMA technique is a coherent, versatile, state of the art model with many options and capabilities which, apart from sea level, it can be configured for use in a diverse range of other applications.

The main objective of this study was to find appropriate ARIMA models that can be used for short term prediction of monthly mean sea level at each of the selected sites in the region¹. The ‘Revised Local Reference’ data were used in the analysis. These were archived from the Permanent Service for Mean Sea Level (PSMSL) database, available online at http://www.psmsl.org/data/. However, most of the tide gauge records in the region are tainted by considerable gaps (Woodworth et al. 2007); hence the choice of stations was based on the length and continuity of the time series data. Only those stations with continuous records longer than 15 years were therefore considered in the analysis.

In the model formulations, the last three years of each record was spared for later comparison with the forecast values within the same time period. The ARIMA models were fitted by a least squares iterative algorithm (Box et al. 1994), and diagnostically checked for adequacy by the Ljung-Box Q statistic (Ljung & Box 1976) to ensure that they are non-stationary and non-invertible. The aim was to find an effective but parsimonious model of the process that provides an adequate description of the actual observations. This is a general principle of process identification, which is the most crucial part of the modelling procedure.

The final models, which were verified by the Root Mean Square Error (RMSE), showed that the predicted values at each location were very close to the actual observations. As an example, the actual and predicted values of sea level at Port Louis station in Mauritius for the period between Jan 2009 and Dec 2011 are presented in Fig 1, showing that the forecast values are within 95% Confidence Level. The RMSE in each case was < 0.005 and hence were considered acceptable for an adequate model.

This is an on-going work, the total number of selected stations will be known soon.

In conclusion, this study has demonstrated that the ARIMA methodology can be used to make short term predictions of mean sea levels in the region within the limits of acceptable errors.

Figure 1: Plot of actual and predicted values of sea level at Port Louis Station in Mauritius with ARIMA (112) (121)12. The green dotted lines represent upper and lower bounds of the 95% Confidence Level.
References

VARIABILITY OF UPWELLING INTENSITY AND THE DYNAMICS OF THE POPULATION OF OCTOPUS, OCTOPUS VULGARIS, NEAR MBOUR

OUSMANE DIANKHA¹ and MODOU THIAW²
1 Laboratoire de Physique de l’Atmosphère et de l’Océan Siméon Fongang (LPAO-SF), ESP/UCAD, Sénégal,
2 Institut Sénégalais de Recherches Agricoles (ISRA), Centre de Recherches Océanographiques de Dakar-Thiaroye (CRODT), Pôle de Recherches de Hann, Dakar, Sénégal, BP 2241

ABSTRACT
The Eastern Boundary Systems are known for their seasonal and interannual fluctuations and their key biological and socio-economical roles. The variability could have consequences for marine resources, particularly on short lived species. The life cycle of octopus is very short and its recruitment in the waters near Mbour is usually considered highly dependent on the upwelling intensity. Therefore, fisheries management has to take into account diagnosis based not only on stocks assessment, but also on the impact of environmental variability.

The present study analysed the spatial and temporal variability of the upwelling intensity and its effects on seasonal and interannual octopus recruitment in Senegalese waters from 1996 to 2005. Senegalese coasts were divided in three areas: the first one is from 12.5 N to 13.5 N, the second from 13.5 N to 14.5 N (area of octopus catch) and the last one from 14.5 N to 16.5 N. This division was based on the temperature distribution along the Senegalese littoral. To explore the relationship between octopus recruitment (R) estimated by the Virtual Population Analysis (VPA) from the Research Centre of Oceanography Dakar-Thiaroye (Centre de Recherche Océanographique Dakar-Thiaroye in French (CRODT)) data and environmental variability, we used coastal upwelling index, CUI, and sea surface temperature, SST, derived from satellite data available at the National Oceanic Atmosphere Administration (NOAA) website.

Our results showed that upwelling intensity varied seasonally and year to year along the Senegalese coasts. From December to March, upwelling intensity is higher in the area of octopus fishing. At the interannual scale, during years when upwelling intensity was more important in this area, coincided with periods of high recruitment. Thus, marine resources were submitted to an unstable environment. Octopus recruitment varied seasonally and inter-annually. Significant correlations were found between environmental factors and recruitment. The variability in CUI and SST explained 81% of seasonal variance in recruitment. In winter, recruitment variation was controlled by upwelling intensity (36.39%), while in spring, SST explained the most part (29.57%). And the year to year variability of recruitment was mainly explained by the combined environmental factors (48.69%).

DEVELOPMENT OF NEW INDICES FOR EXTRACTION OF BUILT-UP AREA & BARE SOIL FROM LANDSAT DATA

Johum Fatimah Mirza [1], Mirza Muhammad Waqar [2], Rafia Mumtaz [3], Ejaz Hussain [4]
Institute of Geographical Information Systems, School of Civil and Environmental Engineering, National University of Sciences & Technology, Islamabad, Pakistan
[1][2][4]Department of Computing, School of Electrical Engineering & Computer Science, National University of Sciences & Technology, Islamabad, Pakistan

KEYWORDS: Indices, built-up, urban, soil, extraction.

ABSTRACT
This paper presents development of new indices for the identification of built-up area and bare soil from medium resolution remote sensing data, extraction of these two spectrally confusing classes has always been a
Theme 2: Ecosystems Management, And Environmental Applications

Oral presentation

9th AARSE International Conference, El Jadida, Morocco, October 29-November 2, 2012
Earth Observation & Geo-information Sciences for Environment and Development in Africa: Global Vision and Local Action Synergy

Problem. For nearly three decades extensive research efforts have undergone for the development of various techniques including a number of indices to extract land cover features especially if suitable thresholds are used. These indices include for example NDVI (Normalized Difference Vegetation Index), NBI (Normalized Built up area Index), NDISI (Normalized Difference Impervious Surface Index) & NDWI (Normalized Difference Water Index). All these indices use various combinations of bands in order to extract a particular land cover, and their performance depends upon spectral response of the features. As spectral response of land cover features varies from region to region due to climatic & topographic changes so are their spectral curves. Due to this reason, indices developed for one area can’t be effectively applicable to another area. In this research, a few new indices have been proposed for the extraction of bare soil and built-up area using medium resolution satellite imagery (Landsat 30m). A comparison has been made among newly developed indices and previously used indices. The results show that newly developed indices for built-up area and soil increases accuracy up to 10-13% as compared to previously developed indices.

POSSIBLE COLLAPSE OF THE SARDINELLA FISHERY IN THE GULF OF GUINEA AS A RESULT OF GLOBAL CLIMATE CHANGE

George Wiafe1 and Kwame Adu Agyekum1
Department of Oceanography and Fisheries, University of Ghana, Legon

ABSTRACT
The upwelling region of the Gulf of Guinea extends from Cape Palmas in Côte d’Ivoire to Lagos in Nigeria. The region experiences two types of upwelling each year – a minor upwelling which lasts for about 2 to 3 weeks between December and January, and a major upwelling which is consistent from July to September. Though several hypotheses have been postulated to explain these phenomena in the region, the causal mechanism is still not well understood. In view of current trend in sea surface temperature as a result of global climate change, this study investigated the spatio-temporal dynamics of the two upwelling phenomena in the Gulf of Guinea using satellite remote sensing. 4km resolution 8-day weekly AVHRR data from 1985 to 2006 were analyzed to calculate variation in the spatial extent and intensity of the two upwellings. The former was calculated as the ratio of pixels less than a threshold temperature (i.e. 25 deg. C) and the total number of valid ocean pixels. Initial analyses show an increasing sea surface temperature and variation in the duration of the two upwellings. Productivity of the Gulf of Guinea is dependent on the upwelling phenomena which brings cold nutrient rich waters from subsurface up and make them available to the phytoplankton. These are fed on predominantly by the copepod, /Calanoides carinatus/ which dominates in abundance during this period. The species is very sensitive to temperature above 25 deg. C and hence appears only during the cold major upwelling period. This paper argues that observed decline in herrings during the major upwelling period could be attributed to changing trend, especially in the major upwelling. It concludes a regime shift in community structure of zooplankton and hence collapse of herring fishery in the Gulf of Guinea.

DROUGHT MONITORING OVER AMMA-CATCH SITE USING SMOS SOIL MOISTURE DATA: CORRELATION BETWEEN CANOPY LATENT HEAT AND SOIL MOISTURE

Ju Hyoung Lee1,2, A. Al Bitar2, Y. Kerr2, M. Mancini1
1 Politecnico di Milano, Piazza Leonardo da Vinci 32, Milano, Italy
2 CESBIO, 13 avenue du Colonel Roche, Toulouse, France

ABSTRACT
Climate change in the West Africa can be found in an annual basis. Each sub-region in the West Africa has been differently evolved in terms of climate change. Drought in some country has been intensified, while green forestation in other regions has been ameliorated. To investigate the resilience and evolution of drought and flooding, NDVI or LAI are often employed. However, their responses are usually slower than soil moisture evolution that can cause a flash flooding such that it shows a limitation as an indicator. Active microwave satellite for monitoring of soil moisture can lead to a bias stemming from the volumetric scattering caused by vegetation growth associated with Monsoon rain fall events. The SMOS satellite that contains a different error structure from thermal infrared or active microwave sensors was launched in 2009. It is the first satellite to be
mainly designed for soil moisture monitoring. It is anticipated to demonstrate some convergence and consensus in soil moisture estimation.

However, the limitation of satellite application is that it can only demonstrate the surface layer evolution of geophysical parameters, although root zone layer monitoring is a key in drought or flooding crisis. Therefore, this study attempts to estimate the sub-surface layer using a land surface hydrological process. Taking into account that surface soil moisture evolution may not influence on the root zone layer due to low vertical hydraulic conductivity, this study monitors canopy latent heat as a proxy indicative of root zone soil moisture, which will be further compared with surface soil moisture detected by SMOS. This approach is considered useful since it can show the unseen dimension of remote sensor products from the land surface process in a deep layer employing metrological forcing data and land surface information. Findings and observations that this study demonstrate will be useful to agricultural and livestock industry. AMMA (Africa Monsoon Multidisciplinary Analyses)-CATCH site is located in the limited region of the West Africa (0° - 5°E; 13°N - 14°N) including Mali, Benin, and Niger.

LATEST GENERATION OF LEICA AIRBORNE DIGITAL SENSORS FOR HIGH PERFORMANCE, MULTISPECTRAL OPTICAL AND LIDAR SENSING AND MANAGEMENT OF THE ENVIRONMENT AND PRACTICAL BENEFITS FOR THE DEVELOPMENT OF NEW COUNTRIES IN AFRICA

Arthur Rohrbach\textsuperscript{1}, Giovanni Righetti\textsuperscript{2}

\textsuperscript{1} Airborne Sensors Sales Dir, Europe, Middle-East & Africa (EMEA), Leica Geosystems AG, Heinrich-Wild-Strasse, CH-9435 Heerbrugg, Switzerland

\textsuperscript{2} Managing Director, Geotechnos Srl, Via del Follatoio 12, I-34148 Trieste (TR), Italy

ABSTRACT

Latest, most advance Sensing Systems manufactured by Leica Geosystems AG (Hexagon Group) are presented, reviewing their latest, high performance level, the complementarity of the different Sensors as well as their individual benefits for the End-users in Mapping, Engineering and Environmental Remote Sensing. Typical application fields will be addressed and illustrated with different practical examples of projects finalized in various African countries. These examples will document the unique benefits offered by the latest generation of Airborne Digital Sensing tools for all Engineers in charge of

- Environmental Protection and Monitoring,
- Agriculture Planning and Monitoring
- Coastal Mapping / Hydrological Monitoring
- City Development planning, 3D city mapping
- Constructions related to Infrastructure Projects (road, railways, water dams, etc...)
- Management & Monitoring of the exploitation of Natural Resources.

AN ASSESSMENT OF VEGETAL-COVER TRANSITION IN NIGERIA USING TEMPORAL ANALYSIS OF SATELLITE-DERIVED DATA

Oyedepo,J.A. Adeofun, C.O. Aduradola, A.M. and Gbadebo, A.M.

College of Environmental Resources Management
Federal University of Agriculture Abeokuta

KEYWORDS: Vegetal Cover transition, Satellite derived data, Harmonic Regression, Time series

ABSTRACT

An assessment of vegetation dynamics in Nigeria from 1982 to 2009 was conducted using satellite spectral measurements of the earth. The study established current trends in vegetal cover transition and its response to environmental changes. Monthly satellite-derived data for vegetation, land surface temperature and precipitation were acquired. Land measured data obtained from Nigerian Meteorological Agency were supplemented with field data. In this study, “Normalized Difference Vegetation Index” (NDVI) data sets from two satellite sensors; the National Oceanic and Atmospheric Administration’s Advanced Very High Resolution
Radiometer (NOAA-AVHRR) and the National Aeronautics and Space Administration’s Moderate-Resolution Imaging Spectroradiometer (NASA-MODIS) were combined to characterize seasonal and inter-annual performances of vegetation through time. Harmonic Regression Analysis of Time Series (HARANTS). The observed trends were correlated with variation in climatic and other environmental conditions in order to identify true change from mere environmental variations. From the results, a habitat index of 19.66 revealed that less than 20% of national land cover remains as natural vegetation as more than 56% of the total geographical area in Nigeria is human dominated. The graph of mean NDVI values for the month of July in all the years indicated a rise from 0.33 in 1982 to a peak of 0.52 in 1994 and a decline to 0.39 in 2009. Phenology of the vegetal-cover revealed shifts in the commencement and termination dates of growing season from one decade to the other; a decline in length of growing season of 10 days was recorded in the south while as high as 80 days was recorded in the North. The study demonstrated a general decline in the performance of Nigerian vegetal-cover and also supported utility of remotely sensed data as input to vegetation mapping indicating a very reliable source of real-time monitoring of environmental changes. The result of this study could be applied for early warning against natural disasters like drought and desertification.

SPECTROSCOPIC AND HYPERSPECTRAL SOIL STUDY AND SURFACE STATES TO CHARACTERIZE WATER EROSION IN A MOUNTAINOUS REGION OF SOUTHEAST TUNISIA

Z. B. Rabah\textsuperscript{1,2}, S. Ayadi\textsuperscript{1}, I. R. Farah\textsuperscript{1,2}, B. Solaiman\textsuperscript{2}

1 RIADI GDL laboratory
School of Engineering and Computer Science
Manouba, Tunisia

2 ENST-Bretagne, ITI laboratory
Technopôle Brest Iroise CS 83818, 29238 Brest Cedex France

KEYWORDS: Remote sensing, water erosion, surface, hyperspectral image, Hyperion image, spectroradiometry, spectral data, spectral unmixing, Endmember.

ABSTRACT
In the field of the processing of hyperspectral images, the pixel mixture is a serious problem to resolve. This difficulty comes from several outliers which affect seriously the reliability of spectral unmixing results. The illumination change effect, where the image do not reflect the true appearance of the scene in many cases due to primarily by slope or shadow facts, is considered one of the most important outliers and it is essential to deal with this problem which can otherwise have a serious effect on the estimation results. The Mediterranean mountainous regions undergo, following changes occupation of land, water erosion varied and often intense: erosion, mass movements, undermining the wadi banks, silting of dams, mudflows, landslides, etc. The erosion process that begins with changes in surface states causes structural degradation, manifested by the increase of the fine fraction of the surface and installation of film and slaking crusts. This structural degradation increases flow, stripping and erosion of surface horizons thereby changing physico-chemical and organic soils and deposits. In the study area (watershed of Oued El Fard in the South West of Tunisia) an uncontrolled exploitation of land led to widespread development process gully erosion that led to the formation of badlands. This study aims to propose a method, based on hyperspectral imaging and spectroscopy and new developments in hyperspectral remote sensing for spectral characterization of surface soil eroded to formally assess the extent, distribution and intensity of this phenomenon.

SOIL AND LANDSCAPE ASSESSMENT IN THE LAKE MANYARA REGION, NORTHERN TANZANIA

Felix Bachofera, Geraldine Quénéhervéa, Michael Märkera and Volker Hochschildb

a Heidelberg Academy of Sciences and Humanities, Ruemelinstr. 19-23, 72070 Tuebingen, Germany
b University of Tuebingen, Ruemelinstr. 19-23, 72070 Tuebingen, Germany

KEY WORDS: Soil Mapping, ASTER, high resolution, multisensoral.
ABSTRACT

Motivation: Lake Manyara is an endorheic basin in the eastern arm of the East African Rift System located in northern Tanzania. It is a shallow soda lake that periodically dries out completely (Deus et al. 2011). The water supply originates from springs at the base of the rift escarpment and from several seasonal drainages, of which the Makuyuni River is the largest. While the lake level is measured over time by researchers from the adjacent national park, the sediments entering the lake are not addressed yet. The semi-arid environment in northern Tanzania is characterized by a variety of degradation processes due to long dry periods and short but intensive rainfall events, as well as contributing anthropological factors like overgrazing (Kiunsi & Meadows 2006). The resulting sediment loads are entering up Lake Manyara and are, as well as changes in water support do, threatening a unique and protected ecosystem. Surface cover, terrain and soil parameters are affecting the runoff generation processes, sediment dynamics and groundwater recharge. Hence, our main objectives for this study are the assessment of terrain parameters, the distribution of soil types, and according soil parameters like soil infiltration and grain size distribution for the whole drainage system for hydrological and sedimentological modeling.

Methodology: Since field work is time consuming and expensive we propose a methodology which is integrating remote sensing analysis, minimal invasive field measurements together with a detailed terrain analysis (based on a SPOT 20m digital elevation model) and advanced statistical modeling. The precipitation input within the study area was measured with high temporal resolution by a digital weather station and TRRM (Tropical Rainfall Measurement Mission, NASA) satellite data.

We conducted field work to derive soil surface information such as grain size, organic content and shear strength for several soil transects. We collected ground truth reference points (ca. 300) and took samples for laboratory analysis. Minimal invasive techniques such as surface runoff detectors, permeameters as well as hood infiltrometers were applied to estimate soil hydrological characteristics and overland flow generation dynamics.

The remote sensing analysis took place on multiple scales. At first we analyzed a WorldView2 scene (8 multispectral (MS) bands, 2 m resolution, 171 km²) which covers the main field work area. A landuse and landcover (LULC) was processed for dry season, assessing 3 vegetation classes, silicia rich soils, carbonate rich soils with high skeleton, carbonatic tuffs, soils with high organic content, mafic material and others. Together with the derived terrain parameters a regionalization of the ground control point measurements and analyzed samples could be processed. We could identify the relevant parameters for this regionalization, which we, in a second step, applied to landcover/soil mapping classification results of ASTER MS data (15 m resolution) to calculate the model parameters for the whole Makuyuni drainage area. To support the ASTER classification we calculated different mineral indices (e.g. Carbonate Index, Principal Component Analysis and Band Ratios) (Amer et al. 2010).

Central Conclusions: We could perform the remote sensing analysis for the Makuyuni drainage system for the high resolution WorldView2 image as well as for the ASTER data with high accuracies. We could identify
persistent vegetation cover, as well as soil type distribution. Together with the terrain parameters a regionalization of the derived parameters from ground control points took place. The study shows that, with minimal invasive techniques as well as with the support of remote sensing analyses, detailed results on soil cover, runoff generation dynamics and related sediment transport can be derived also in environments with sparse data.

Literature

FRACTION IMAGES DERIVED FROM TERRA MODIS DATA FOR LAND COVER MAPPING AND MONITORING THE TROPICAL REGION
Yosio Edemir Shimabukuro1, Egidio Arai1, Ramon Moraes de Freitas1, Valdete Duarte1
1. Instituto Nacional de Pesquisas Espaciais (INPE), Av. dos Astronautas, 1758, São José dos Campos, SP, 12227-010, Brasil

ABSTRACT
The objective of this paper is to present a methodology using fraction images derived from Linear Spectral Mixing Model (LSMM) for mapping and monitoring land cover in tropical regions using Terra MODIS (Moderate Resolution Imaging Spectroradiometer) data. The proposed approach is based on image segmentation to the fraction images derived from MODIS data, using a non-supervised classification per region algorithm followed by an image edition procedure for minimizing misclassifications. The LSMM has been used to analyse the mixture of signatures of vegetation, soil, and shade in each MODIS pixel. The available methods estimate the proportion of each component inside the pixel by minimizing the sum of squares of the errors. The soil fraction image highlights mainly non-vegetated areas (clear cuts, bare soil, etc.); the vegetation fraction image shows the vegetation cover condition; and the shade fraction image enhances the water bodies, burned areas, and also the vegetation cover structure. The image segmentation approach, based on a region growing technique, requires two threshold parameters to be set by the analyst to define segments (regions) that will be used in the subsequent classification procedure: (a) similarity threshold (the Euclidean distance between the mean digital number of two regions, under which they will be grouped together); and (b) an area threshold (minimum area to be considered as a region, set by the number of pixels). Then the segmented images were classified using ISOSEG, a region classifier algorithm based on clustering techniques. This non-supervised algorithm uses the covariance matrix and the mean of the regions to estimate the centers of the classes. The analyst defines an acceptance threshold, which is the maximum allowed Mahalanobis distance that a mean digital number may be from the center of a class, to still be considered as belonging to that class. After the classification process, some classes may be regrouped to express more faithfully terrain features. The map editing phase consists of a visual inspection directly on the computer monitor correcting the commission and omission errors in the classified areas. The Brazilian Amazon region in South America and Africa continent were considered for this study. The vegetation, soil, and shade fraction images were derived from MODIS 16-days composite of surface reflectance images (bands 1 (620 – 670 nm), 2 (841 – 876 nm) and 6 (1628 – 1652 nm)) using SLMM. Figure 1 shows the RGB color composite showing vegetation in green, soil in red and shade in blue for Africa in February 2006 (Fig.1a) and in August 2006 (Fig.1b). The results of the proposed methodology for Brazilian Amazon region show the analysis of deforestation and burned areas for 2005 and 2010 dry years in South America. For Africa continent, the proposed methodology shows the potentiality of fraction images for mapping and monitoring land cover in this tropical region. In Figure 1, the desert regions and the savannah regions can be mapped exploring the seasonality variation between February and August months. The results of multitemporal analysis with MODIS showed the potential of the proposed methodology for global and regional environmental studies in the tropical regions.


**Figure 1**: RGB color composite (R-Soil, G-Vegetation, B-Shade): (a) February 2006 and (b) August 2006

**References**


Duarte, V.; Martini, P. R.; Shimabukuro, Y. E.; Freitas, R. M.; Arai, E., 2007. Monitoramento do desflorestamento em escala global: uma proposta baseada nos projetos PRODES Digital e DETER.


**COASTAL UPWELLING INDICES DERIVED FROM SATELLITE SEA SURFACE TEMPERATURE AND WIND DATA EXAMPLE: CANARY UPWELLING SYSTEM**

**BENAZZOUZ Aïssa**

INRH, CasaBlanca, Morocco

**KEYWORDS**: Upwelling index, remote sensing, SST, sea wind, EBUE, CCLME, Nort-west Africa and Iberian ecosystem, warning signal, manager, climate change

**ABSTRACT**

Here we develop satellite-derived indices to quantify variation in the timing of the onset and of the end of coastal upwelling activity in the North West Africa Upwelling Ecosystem and Iberian Peninsula, the temporal evolution and overall intensity of upwelling, and the duration of the upwelling season, as well as the spatial variations of these properties along the Northwest of Africa and Iberian peninsula. Operational indicators such as the upwelling index can provide an information of the changes in the amplitude and phasing of the upwelling during all seasons and could provide an early warning signal to resource managers of the probability of a disruption to the upwelling ecosystem in this big context of climate change.

For this purpose many upwelling index have been developed by several others based both in the insitu measurement (Wooster, 1976) or based in the remote sensing SST (Sea Surface Temperature) (Van an Camp and Nykjaer, 1994; Demarcq, 2000; Santos, 2005; Lathuiriere, 2008; Demarcq, 2009; Santos, 2011, Benazzouz, 2012) and satellite sea wind (QuikSCAT). Such indices are used to describe the spatial and the temporal variability of the intensity of the upwelling phenomenon in different Eastern Boundary Upwelling Ecosystems (EBUE).

The objective of this work is to set a new sophisticated upwelling index based SST data which well be general for all EBUE according to the seasonal variability of each region in the world, with a new review of all previews indices.
For this topic, the Canary Current Large Marine Ecosystem (CCLME) as a system which present a big seasonal variability from north to south (8°-43°N) is chosen as example to test our idea.

Figure: Climatological hovmöller of Ekman upwelling index along the shore and zoning to homogeneous potential upwelling areas accompanied with a mean vector time series (8 days values) satellite wind measurements for 1999 to 2009 at the given potential upwelling sub-areas.

THE UTILITY OF INTEGRATIVE EARTH OBSERVATION (EO) TO MONITOR LAND SURFACE DYNAMICS IN THE CONTEXT OF THE NEW WASCAL INITIATIVE (WEST AFRICAN SCIENCE SERVICE CENTER FOR CLIMATE CHANGE AND ADAPTED LAND USE)

Tobias Landmann¹, Ursula Gessner², Gerald Forkuo³, Christopher Conrad¹, Martin Wegmann³, Stefan Dech¹²

1. University of Wuerzburg, Department of Remote Sensing in cooperation with the German Aerospace Centre (DLR), German Remote Sensing Data Centre (DFD), Am Hubland 97074 Wuerzburg, Germany.
2. German Aerospace Center (DLR) – German Remote Sensing Data Center (DFD), Oberpfaffenhofen, 82234 Wessling, Germany.

ABSTRACT

Human induced global change, including climate change and habitat loss, is currently the biggest threat for natural resource availability, biodiversity and ecological functioning in West Africa [1, 2]. Global models are often used to predict and understand the impact of emerging environmental global change effects. Their predictions and results are often a key information source to derive sustainable and adapted land use policies from. There is increasing demand for actual and consistent remote sensing driven measures on the state and dynamics of natural resources over wider and often inaccessible areas. If well processed, these measures can be used complementarily to existing local scale data measures. Data assimilation of various sensors and information feeds at various scales, with validity over a range of conditions and biomes, will ultimately improve and regionalize global models and predictions.

In West Africa 80% of the population is dependent on rainfed agriculture, and hence food security and livelihoods are largely related to climate. Climate models often suffer from a lack of locally derived information on land cover and land use dynamics, and thus the formulation of locally adapted climate change adaptation and mitigation strategies is challenging [3]. However, consistent multi-sensor and multi-scale satellite data observations that utilize and assimilate in situ measures for integrative monitoring of land cover and land use dynamics are still not readily available [4]. This is especially true for Africa. Moreover many remote sensing based studies in West Africa are haphazardly scattered throughout the region. These studies are often performed within individual projects; thus only one specific region or country is investigated [4, 5]. As a result thematic mapping legends are largely inconsistent and non comparable. There is a need for more integrative and seamless monitoring routines in earth observation (EO), that also make use of existing socio-economic or climate and biodiversity observation networks.

Through the WASCAL initiative, funded by the German Ministry for Education and Research (BMBF), many of the above mentioned constraints can be addressed. WASCAL aims to bundle research, capacity and technical expertise in West Africa (Burkina Faso, Ghana, Mali, Benin, Ivory Coast, Togo, Nigeria, Gambia and
Senegal so that the region gains self-sufficiency in dealing with the effects of climate change and climate variability.

Innovative research and development solutions within a multi-disciplinary consortium will be developed, that specifically deal with adapted land use in this context. A key aspect is the utilization and integration of existing data feeds from previous projects, institutions and observation networks in the region (BIOTA-Africa, GLOWAVolta, and AGRYHMET, AMMA, IGB).

Earth observation (EO) has the potential to synoptically map land surface dynamics related to key user demands formulated in WASCAL, e.g. deforestation and carbon dynamics, land cover and land use change, habitat change mapping, of particular plant and animal species, and near real-time and multi-sensor flood mapping. An integrative EO approach would imply that multi-disciplinary and multi-scale data feeds are intelligently integrated and in some cases used inter-changeable. Ultimately this information can be employed within scenarios based land use models for more optimized land management decision making.

This paper illustrates examples, possibilities and shows perspectives from current EO research in West Africa and discusses their applicability to the key WASCAL user and stakeholder demands. Two EO examples are showcased; an integrative that is multi-data monitoring approach for assessing woodland habitat dynamics and, secondly, a multi-sensor approach to map inundation dynamics and flooding in semi-arid African wetlands.

Results from the first study (example) clearly show that when land cover change from ‘actual’ remote sensing observations are integrated with species diversity models (SDM), as well as point reference data on species occurrences, more meaningful and realistic species distribution maps can be produced for West African woodlands. Results from the second example show the possibility of using radar derived flooding magnitudes in synergy with (optical) MODIS time-series data to comprehensively monitor wetland dynamics, wetland characteristics and flooding.

Both examples show the possibilities of integrative EO approaches for wide-area and seamless monitoring of land surface dynamics. Given the availability of more long-term data trajectories, monitoring of land surface dynamics versus climate variability and climate change becomes possible.

References

ASSESSING LAND DEGRADATION IN ARID AND SEMI-ARID REGIONS OF SOUTHERN AFRICA USING NPP TIME-SERIES FROM VEGETATION MODELLING

Markus Niklaus¹, Markus Tum³, Christina Eisfelder¹, Kurt P. Günther¹
1. German Aerospace Center (DLR), German Remote Sensing Data Center (DFD), Münchner Straße 20, D-82234 Weßling,

ABSTRACT
Wide areas of the Earth’s land surface suffer from land degradation. Dry areas as the arid southern Africa are, on the one hand, strained by unfavorable climatic conditions. On the other hand, intensive land use as rangeland and for livestock farming leads to an additional encroachment of these ecosystems. The consequence of this long-time stress is degradation in terms of loss of the vegetative cover. Several studies have already mapped and observed these processes in southern Africa, albeit there is still a lack of
objectiveness in the long term assessment of degradation on a larger scale. We here present a method of applying remote sensing time series in a vegetation model helping to fill this gap. We use the Soil-Vegetation-Atmosphere (SVAT) model BETHY/DLR (Biosphere Energy Transfer Hydrology) to compute time-series of carbon uptake by vegetation. The model needs meteorological and remote sensing based time series. Temperature, precipitation, wind speed and cloud cover are taken from the European Center for Medium Range Weather Forecasts (ECMWF). Leaf area index (LAI) and land cover (Global Land Cover, GLC2000) information are based on SPOT-VGT and are used to describe the phenology. Since the model highly relies on LAI we need a long term, spatio-temporal continuous time series of this parameter in model resolution. Here we use the product derived from SPOT-VGT satellite data, provided by Medias France for the years 1999-2003 and by Vito Belgium from 2004 onwards and reanalyze the data for gap filling using the method of harmonic analysis. Results of the model are Gross Primary Productivity (GPP), autotrophic Respiration (Ra) and Net Primary Productivity (NPP) in daily time steps on a 1 km grid.

For our approach we use time series of modeled NPP over twelve years to analyze trends in vegetative activity in the arid and semi-arid regions of southern Africa (covering Botswana, Lesotho, Namibia, South Africa, Swaziland and Zimbabwe). NPP is calculated as the difference between GPP and Ra. For our analysis, the cumulative NPP is calculated for the annual vegetative period, which we assume from July to June of the following year. This results in a twelve year time series of seasonal vegetation productivity that can be analyzed for trends in vegetation development. Additionally, considering precipitation trends over this time period, we index four degrees of degradation for each land cover type (agriculture, grassland, scrubland and tree cover). This helps to value influences of climate or human activities.

The advantage of using modeled NPP is the applicability on a regional, national or continental level. With this method we are able to localize and quantify vegetative trends and hotspots of degraded areas for southern Africa on a sub-continental level. A total of 31% of the considered area is flagged as degraded land with a different status of degradation. Comparisons with regional studies show good agreement in several areas. Next steps will include the application to other regions (for example West Africa) and the use of an advanced version of BETHY/DLR for scenario modeling, to get future trends for the vegetation development under certain assumptions.

**MAPPING IVORIAN CONTINENTAL SHELF SURFACE CURRENT USING MODIS OCEAN COLOR IMAGES: A MAXIMUM CROSS CORRELATION APPROACH**

Mobio Brice¹, Affian Kouadio¹, Djagoua Eric¹, Kouame Adonis¹, Robin Marc²

1- Centre Universitaire de Recherche et d’Application en Télédétection (C.U.R.A.T.) ; Unité de Formation et de Recherche des Sciences de la Terre et des Ressources Minières, Université de Cocody ; 22 BP 801 Abidjan 22 Côte d’Ivoire ; Tel : (225) 22445270 ; Fax : (225) 22445270 ; LETG (UMR 6554 CNRS), Laboratoire Géolitomter, Institut de Géographie et d’aménagement régional de l’Université de Nantes ; BP 81227, 44312 Nantes cedex 3;

**KEYWORDS:** remote sensing, ocean color, maximum cross correlation, surface current, continental shelf, Ivory Coast.

**ABSTRACT**

The Ivorian continental shelf hosts important activities that include the industrial fishery, oil exploitation and port exchanges. The fisheries industry is one of the main sources of food provision for the country but not efficient mainly due to lack of knowledge about the physical and biological parameters of coastal marine system. This is illustrated by the improper management the fish species Sardinella Aurita, larvae exploitation during the year 1972 significantly reduced their abundance. As for oil exploitation, it is an activity that plays an increasingly important role but with lots of environmental hazards primarily from discharge of pollutants into the ocean (oil spill off the city of Jacqueville in 2006). When spilled pollutants are not mapped, and their trajectories are not predicted, optimum mitigation measures to prevent environmental and economic catastrophe cannot be effectively implemented.

Water motion in the Gulf of Guinea is to a certain extent the basis of the pelagic species distribution and on the other hand, is also the pollution vector. In the Gulf of Guinea in general and on the Ivorian continental shelf in particular, the ocean surface current is quantified using in- situ data from oceanographic campaigns which are spatially dispersed. These data unfortunately do not give a synoptic view on currents which has a high spatial and temporal variability pertaining to ocean parameters. The use of remote sensing is in complementary to conventional methods providing high spatial and temporal resolution information at a low cost compared to in-
situ measurements. Thus, Hardman-Mountford and McGlade (2003) used images of 4km x 4km spatial resolution to study the surface current of the Gulf of Guinea giving a good regional view but no sufficient on a local scale.

The purpose of the study is to thoroughly understand the sea surface current of the Ivorian continental shelf on the local scale. For this study, the Maximum Cross Correlation (MCC) method is applied on chlorophyll concentration data at 1.1 Km resolution, extracted on selected MODIS satellite imageries acquired from the orbiting AQUA satellite and are thereafter filtered to produce an image of composite vectors showing sea surface velocities.

Velocities are estimated by tracking feature displacements in two successive images. The first image is divided into subwindows (template window) that are cross correlated with all possible subwindows in the search area (search window) of the second image. The location of the subwindow in the second image giving the highest cross correlation with the subwindow in the first image indicates the most likely displacement of that feature. The velocity vector is then calculated by dividing the displacement vector by the time separation between the two images.

The generated current field map highlights both the eastward Guinea current mainly occurring at the surface and the westward sub-current which generally occurs at a deeper water layer (figure 1). These apparent simultaneous antagonistic current motions along the coastline occur mainly during the major cold season, the period of transition and the small warm season through the year. The convergence area moves from West to East during the above mentioned periods.

Acquisition and analysis of ADCP (Acoustic Doppler Current Profiler) in-situ surface current data from oceanographic cruises of IFREMER (Institut Français de Recherche pour l’Exploitation de la Mer) shows the simultaneous presence of the both currents on the surface of the Ivorian continental shelf and confirms the result obtained from satellite data.

Figure 1: September 2007 vector fields

SPATIAL ANALYSIS OF THE IMPACTS OF KAINJI HYDROPOWER DAM ON THE DOWN STREAM CUMMUNITIES

DUKIYA, J. J.
Department of Urban and Regional Planning, Federal University of Technology, Minna.

KEYWORDS: Dam, Down Stream, Ecosystem, Human Settlements, and Socio-economic.

ABSTRACT
The effect of human interference with the natural river course at the upper, middle or lower course has always been negative on the bordering ecosystem including human settlements. This is exactly the case of the River Niger right from its source in Futa-Jalon Highlands (Sierra Leone) down to its delta in Nigeria. This paper examined the spatial transformation of the down stream sector of Kainji Dam and its effect on those communities within two and half kilometers away from the river course using satellite image (Landsat 7 MSS), Topographical maps and field survey .The image analysis shows that Primary vegetation has given way to secondary vegetal cover due to the change in the primary occupation of the people (from fishing to farming) and over grazing. And this has direct negative impact on the Burgu and Zugruma sectors of the Forest and Game Reserve. Socio-economic life of the people has worsen than when the dam was newly constructed since they still lack basic infrastructural facilities except for towns like New Bussa. The paper recommended that a re-evaluation of the dam be carried out as contained in the Environmental Management Plan (EMP).
THE APPLICABILITY OF GEOGRAPHIC INFORMATION SYSTEMS AND REMOTE SENSING IN IDENTIFYING POLYBROMINATED DIPHENYL ETHERS SOURCES USING NOAA NATIONAL STATUS & TRENDS MUSSEL WATCH PROGRAM DATA

Patrina L. Bly\(^1\), Michael A. Edwards\(^2\), Linda Hayden\(^3\)
1. Elizabeth City State University, Elizabeth City, North Carolina, 27909
2. NOAA, NOS, NCCOS, CCMA, Silver Spring, Maryland 20910
3. Elizabeth City State University, Elizabeth City, North Carolina, 27909

ABSTRACT
A plentiful source of revenue within the aquaculture industry of Africa, mussels and oysters are ideal platforms as it concerns water quality testing. Along the coast of South Africa the European blue mussel (mytilus galloprovincialis) is highly prevalent. This bivalve, which is susceptible contaminants, is ideal to serve as a testing platform to begin a Mussel Watch program within the continent of Africa.

The Mussel Watch Program is one of the longest running contaminant monitoring programs in the coastal ocean with more than 20 years of data. Mussel Watch uses bivalves (Mussels, Oysters, and Zebra Mussels) as a means to assess water quality. The purpose of the program is geared towards assessing contaminants nationally. Utilizing formats such as Geographic Information Systems (GIS) and Remote Sensing data assessment, this project identifies possible releasers of effluent waste into the major coastal watershed regions pertaining to ongoing research conducted within monitored Mussel Watch sites. This project further serves as a platform for testing the mussel, a major source of income for some Coastal African nations. The categorization of possible contaminating locations is made available through the development of a large dataset. This dataset utilizes those derived from agencies such as the United States Environmental Protection Agency (USEPA) and other federal government databases such as the National Oceanic and Atmospheric Administration (NOAA), and the United States Geological Survey (USGS). Utilizing platforms such as ESRI® ArcMap™ software, spatially referenced locations, via point data, vector data, line data, and polygons depicting points and sites of interest were created using latitude and longitude information. Points and areas of interest (AOI) were verified using remote sensing imagery. As such, Polybrominated Diphenyl Ethers (PBDEs) within observable mussel watch sites were assessed by NOAA’s Center for Coastal Monitoring and Assessment (CCMA). Using this data, researchers are able to identify possible sources of contributors to the present contaminant.

In the attempt to identify possible contributors of the PBDEs contaminant with NOAA’s National Status & Trends Mussel Watch Program a suite of software was utilized in assessing and compiling the acquired data. ArcGIS 9.3 was used as the primary software in manipulating the dataset used in this project. Remote Sensing imagery acquired from an ESRI™ database served as the base map within the project and was used to verify Points of Interest (POI).

Data collected from the USGS, was created and edited to show coastal watersheds reflective of Mussel Watch Program and observed coastal regions. A national dataset was collected from the USEPA. Wastewater treatment facilities were closely examined as contaminant release sites due to their potential to release untreated wastewater. Other contributors of contaminated water sources that were identified within this study included brownfields, superfund sites, power plants, hazardous waste sites, unidentified that comprised information regarding active National Pollutant Discharge Elimination System (NPDES) permits permitted...
facilities, and combined sewer overflows. The data gathered was analyzed and checked for irregularities, corrected, and projected using World Geodetic System (WGS 1984).


CARTOGRAPHIE DE LA VULNERABILITE DES COTES LIEES AUX POLLUTIONS MARINES PAR LES HYDROCARBURES A PARTIR DE L’IMAGERIE SATELLITAIRE : APPLICATION A LA ZONE COTIERE DE LA COTE D’IVOIRE (AFRIQUE DE L’OUEST)

Madeleine Cassandre DRO1, Kouadio AFFIA 1, Paul FATTAL2, Patrick POTTIER2, Fernand Koffi KOUMÉ1, Eric Valère DJAGOUA1

1. Centre Universitaire de Recherche et d’Application en Télédétection (CURAT), UFR des Sciences de la Terre et des Ressources Minières (STRM), Université d’Abidjan- Cocody, 22 BP 801 Abidjan 22(Côte d’Ivoire)

2. Laboratoire ou centre de recherche, Institut de Géographie et d’Aménagement Régional, Département IGARUN/Geolittomer-UMR6554, LETG CNRS, Faculté de Lettres, Université de Nantes, Chemin de la Censive du Tertre, BP 81227 - 44312 Nantes Cedex (France)

MOTS-CLEFS: télédétection, pollution marine, imagerie satellitaire, hydrocarbure, zone côtière, Côte d’Ivoire

ABSTRACT
La pollution marine constitue un grave problème géo-environnemental auquel sont exposées les régions côtières. Elle menace l’écosystème marin et affecte, par contrecoup, les populations humaines. Les risques de pollution de la mer par les hydrocarbures notamment, sont intensifiés dans les régions où se déroulent des activités pétrolières.

Sur la côte atlantique, plusieurs épisodes de pollution aux hydrocarbures sont signalés de façon récurrente. Notamment, le naufrage des navires pétroliers Prestige (au large des côtes de Galice en Espagne), Erika, (au large de la côte de Normandie en France), et récemment l’explosion de la plate-forme de forage de British Petroleum dans le Golfe du Mexique, sont des exemples éloquents.

En Côte d’Ivoire, l’exploitation off-shore des champs pétroliers entraîne un intense trafic maritime de transport d’hydrocarbures et multiplie les risques de pollution de la côte ivoirienne. Dans un tel contexte, il est impératif d’entreprendre des opérations de surveillance des milieux sensibles pour une prévention de la pollution marine.

Ce travail est basé sur l’utilisation d’imagerie satellitaire couplée à des données analogiques et in situ. Il vise à exploiter les potentialités des images satellitaires multi-temporelles pour détecter et caractériser les signatures des nappes d’hydrocarbures, afin de déterminer les zones de sensibilité du littoral ivoirien. Il permet aussi l’élaboration d’un plan d’urgence de lutte contre les pollutions accidentelles en mer et dans les zones côtières.

Une série multidate d’images subissent des traitements géométriques (géopositionnement) et radiométriques (filtrage multistate). L’analyse de l’imagerie satellite optique permet d’identifier, d’hiérarchiser et de cartographier les types de côtes (ligne de côte et estran selon leur sensibilité E.S.I (Environmental Sensitivity Index)).
Index), les ressources biologiques sensibles et les infrastructures socioéconomiques, présents tout le long de la côte.

Cette étude, nous permettra d’éditer des cartes qui seront mises à la disposition des autorités en charge de l’environnement et des rapports scientifiques pourront être réalisés :

Au niveau des cartes, nous réaliserons et nous mettrons à jour :
- Une carte de vulnérabilité des côtes au 1/50 000 intégrant : (i) une carte de vulnérabilité des Littoraux (ii) une carte des ressources biologiques sensibles et (iii) une carte des ressources socioéconomiques sensibles ;
- Une carte de stratégie basée sur les zones les plus sensibles. Concernant les rapports, le traitement et l’analyse des données permettront de produire: (i) des rapports océanologiques, (ii) des rapports sur les périmètres de protection des zones côtières, (iii) un schéma de gestion d’urgence en cas d’éventuelle pollution.
- Une base de données fiable du littoral ivoirien sera constituée sous forme de couches d’information moyennant un Système d’Information Géographique (SIG).

L’exécution effective de ce projet aboutira à la définition et à la mise en place d’outils expérimentaux pouvant être mis en œuvre dans l’urgence afin d’apporter des informations opérationnelles aux intervenants en charge de la lutte anti-pollution.

**RELATIONSHIP BETWEEN THE VORTICITY OF THE MESOSCALE EDDIES ON THE NORTHERN PARTS OF MOZAMBIQUE CHANNEL AND PRIMARY PRODUCTIVITY**

A.Â. A. Langa¹, Y.W. Shaghude² & A.M. Hoguane¹

1. Escola Superior de Ciências Marinhas e Costeiras, Universidade Eduardo Mondlane, PO Box 128, Quelimane, Mozambique

2. Institute of Marine Sciences, University of Dar es Salaam, P.O. Box 668, Zanzibar, Tanzania

**KEYWORDS:** ocean eddy, kinetic energy, primary productivity, chlorophyll a, Mozambique Channel

**ABSTRACT**

The mesoscale cyclonic and anti-cyclonic eddies on the northern parts of the Mozambique Channel were investigated to determine the linkages between the variability of the eddies vorticity and primary productivity. The variability of the eddies was parameterized by the eddies kinetic energy (EKE) and the variability of the eddies primary productivity was parameterized by the concentration of chlorophyll-a. The study used the satellite altimetry data containing the geostrophic currents from the AVISO website (http://www.aviso.oceanobs.com/) and satellite net primary productivity (NPP) data from the ocean productivity website (http://orca.science.oregonstate.edu/) for the period between December 2008 and December 2009. Validation of the satellite derived data was accomplished using CTD cast measurements from the Agulhas and Somali Current Large Marine Ecosystem (ASCLIME) cruise covering the same period. The results showed good correlation between the EKE and the concentration of chlorophyll-a, for both cyclonic and anti-cyclonic eddies ($r^2 = 0.88$). The results also revealed features indicative of upwelling at the centers of cyclonic eddies and in the convergence zones of the edges of anti-cyclonic vortices, suggesting that the geostrophic currents play an important role in the dispersion of the phytoplankton in the vortices. The result of the present study is shedding further knowledge leading towards a better understanding of the dynamics of marine ecosystems on the northern parts of the Mozambique Channel and is expected to provide baseline information leading to the improvement of fisheries resources management in Mozambique.

**DECADAL VARIABILITY IN PHYTOPLANKTON PHENOLOGY ALONG THE COAST OF THE GULF OF GUINEA LARGE MARINE ECOSYSTEM (GCLME)**

Lazare Akpetou¹, Marie-Fanny Racault², Stéphane Saux Picart², Steve Groom², Shubha Sathyendranath³ and Trevor Platt²


2. Plymouth Marine Laboratory, Prospect Place, The Hoe, PL1 3DH Plymouth, United Kingdom.

**KEYWORDS:** Phytoplankton phenology, ecological indicators, Gulf of Guinea LME, Sea-Surface Temperature.
ABSTRACT

The Gulf of Guinea LME is one of the world’s most productive ecosystems subjected to particularly strong anthropogenic pressure. Phytoplankton biomass and phenology are key indicators to characterize, monitor and assess marine ecosystem status. Using remote-sensing data of chlorophyll concentration and Sea-Surface temperature (SST) during the period 1998-2007, we examined the variability in the timing and amplitude of maximum phytoplankton chlorophyll concentration in the three sub-regions along the Gulf of Guinea coastal 3000 m isobaths. The Eastern Gulf of Guinea (EGOG) showed quasi continuous annual phytoplankton growth sustained by the nutrient inputs through Congo River runoff, with average chlorophyll values of 4 mgChl.m-3 and extreme values up to 26 mgChl.m-3. Chlorophyll concentration in the Central West African Upwelling (CWAU) showed clear seasonality with average chlorophyll values of 1 mgChl.m-3 during the growing period and extreme values reaching 3 mgChl.m-3. Phytoplankton growth within the Sierra-Leone Guinea Plateau (SLGP) was also shown to be seasonal, averaging 4 mgChl.m-3 during the growing period and peaks reaching up to 16 mgChl.m-3.

During the decade 1998 to 2007, timings of maximum chlorophyll concentration in the EGOG showed an alternation of positive/negative anomalies likely to be regulated by the Congo River regime. The CWAU presented a period of continuous negative anomalies between 2002 and 2005, while the SLGP was characterized by positive anomalies between 2001 and 2004 followed by negative anomalies between 2005 and 2007. Highest positive anomaly of +5 weeks was observed in the year 2001 in CWAU and lowest negative anomaly of -7 weeks was observed in the year 2005 in EGOG. The timing of chlorophyll maximum within the EGOG was significantly correlated with minimum SST values originating from the Indian Ocean and local upwelling. In the heat tongue of the CWAU, the timing of the minimum SST appeared significantly correlated with the timing of peaks in phytoplankton biomass occurring during the wet seasons. In the SLGP, phytoplankton growth conditions showed no correlation with the timing and values of minimum SST. Establishment of such time series of indicators with a high frequency and spatial resolution will allow at low cost to improve our management of marine ecosystem and resources as well as to monitor and better understand the impact of climate change in the region.

Figure 1: Interannual variability in chlorophyll concentration (in mgChl.m-3) during the period 1998-2007 along the Gulf of Guinea LME coastal 3000 m isobaths. Regions: (1) Eastern Gulf of Guinea, (2) Central West African Upwelling, (3) Sierra-Leone Guinea.

Figure 2: Phytoplankton phenology anomalies in the timing of chlorophyll maximum (in weeks) in the 3 regions of study. (Blue) Eastern Gulf of Guinea, (Red) Central West African Upwelling; (Green) Sierra-Leone Guinea Plateau.
EXPLORING MODIS TIME SERIES DATA IN MONITORING CHLOROPHYL-A IN LAKE VICTORIA

Gidudu Anthony¹ and Banura Constance¹
1. Department of Geomatics and Land Management, Makerere University, P.O. Box 7062 Kampala, Uganda

ABSTRACT
Introduction
Lake Victoria is the largest fresh water lake in Africa covering a surface acreage of 68,800 km². It supports the economic livelihood of over 200 million people that depend on it directly and indirectly through fishing, transportation, agriculture, as a source of portable water etc. It spans three countries namely Uganda, Kenya and Tanzania and is home to numerous flora and fauna. As the main source of the River Nile it also supports the livelihoods of populations in Sudan and Egypt. One of the major challenges facing the lake is pollution especially being a recipient of many outflows like nitrogen and phosphorous from sewage facilities, suspended sediments from soil erosion, heavy metals from industrial waste, pesticides from agricultural etc. All these contribute to diminishing the health of the lake water quality. In the assessment of water quality of any aquatic system, a number of parameters are considered important. Some of these parameters include Chlorophyll-a (chl-a) that exists in all algae groups and is also an indicator of bio production of inland water bodies; turbidity which is caused by soil erosion and leads to a concentration of suspended particulate material (SPIM), Dissolved Organic Matter (DOM) in freshwater that absorbs light and affects water transparency. This paper focuses on chlorophyll-a as a key parameter used to asses water quality on Lake Victoria. Currently in Uganda, conventional methods are used to monitor and assess water quality on Lake Victoria. This involves obtaining in situ data followed by laboratory analysis of the samples. These methods are expensive and do not give a regular or synoptic overview of Chl-a distribution. The size of Lake Victoria means that only a small portion of the lake can be monitored at any one time. It is in this light that this paper explores the use of MODIS satellite imagery in monitoring chlorophyll-a on Lake Victoria. This paper gives an overview of monitoring Chl-a, the methodology developed, results and discussions.

Methodology
MODIS level 2 data was used to monitor Chl-a on Lake Victoria for the years 2003 - 2010. SeaDAS version 6.2 software was used to visualize, process and analyze MODIS Level-2 (L2) data. The MODIS L2 images were corrected for both geometric and atmospheric errors during the image pre-processing stage. Chl-a was extracted using the Ocean Colour (OC v5 algorithm) applied to all the daily images. In order to better assess the data, the annual Chl-a was averaged and categorized according to Carlson’s index. Carlson’s index is one of the commonly used indices used to categorize trophic levels in fresh water lakes. The trophic state is defined as the total weight of biomass in a given water body at the time of measurement. The Carlson index uses the algal biomass as an objective classifier of a lake’s trophic status.

Results and Discussion
From Figure 1, it is obvious that one of the advantages of employing satellite imagery is the ability to derive a synoptic view of the Chl-a distribution on Lake Victoria. To be able to extract this perspective from in-situ measurements would call for heavy investment that may be beyond the means of the organizations interested in this sort of data. The other advantage of the MODIS imagery is that it has a daily temporal resolution implying that the daily synoptic perspective of Chl-a on Lake Victoria can be accessed and can go a long way in better managing the water resources. Figure 1 shows that on average the areas closer to the shores are hypertrophic while Lake Victoria is largely an eutrophic lake. The figure also indicates that there are instances when the lake depicts mesotrophic characteristics. The 2009 and 2010 image also have a portion in black (in the NE part of the lake) which means that no chl-a data for that portion was obtained, in this case due to cloud cover. It therefore depicts one of the limitations of using data derived from optical sensors for such studies. This study shows that satellite imagery can provide a viable means to supplement the efforts in monitoring water quality in Lake Victoria.
APPLICATION OF REMOTE SENSING AND GIS FOR ESTIMATING CROP EVAPOTRANSPIRATION OF WINTER WHEAT AND SUGAR BEET CROPS IN A SEMI ARID REGION OF MOROCCO

S. Er-Raki¹, S. Khabba², M. Le Page³, L. Jarlan³, S. Belaqziz², A. Tavernier³, M.H. Kharrou⁴, AG. Chehbouni³

1. LP2M2E, Faculty of Sciences and Techniques, BP 549, Marrakech, Morocco
2. LMME, Faculty of sciences Semlalia, BP 2390, Marrakech, Morocco
3. CESBIO- Centre d’Etudes Spatiales de la BIOsphère, Toulouse, France
4. ORMVAH, Office Régional de Mise en Valeur Agricole du Haouz, Marrakech, Morocco

ABSTRACT
Remote sensing becomes a useful tool because it provides synoptic view and multi-temporal Land uses / Land cover data that are often required for management and planning of water resources. The monitoring of irrigation and crop production at a regional scale can be based on the use of ecosystem process models and remote sensing data. In this context, this work aims to estimate spatial evapotranspiration of winter wheat and sugar beet crops in the semi-arid region of Tensift-basin (central of Morocco). A time series of high spatial resolution images acquired by SPOT, ASTER and Radar (ENVISAT) was collected throughout the growing season (2011-2012) of these two crops. The satellite data provide spatially distributed estimates of Normalized Difference Vegetation Index (NDVI) and surface temperature, enabling the water managers to estimate the crop water requirements. In addition to the use of remote sensing data, understanding ecosystem-wide functioning cannot be fulfilled without making full use of historical data and newly developed technology: Geographic Information System (GIS), ground-based surface reflectance data using a hand-held radiometer (CROPSCAN Inc. Model MSR87) for radiometric correction of satellite images, ground instruments such as eddy covariance to validate the remote sensing estimates, numerical modelling, and remote sensing data assimilation.

Figure 1: Annual averaged Chl-a distribution according to Carlson’s Index trophic zones
USING REMOTE SENSING TO CHARACTERIZE IRRIGATION SCHEDULING FOR THE GRAVITY IRRIGATION NETWORKS

S. Belaqziz1,2, S. Khabba3, S. Er-Raki3, M. Le Page4, L. Jarlan4, M. El Adnani1, AG. Chahbouni4
1. LSI, Faculté des Sciences Semlalia, département d’informatique, BP 2390, Marrakech
2. LMME, Faculté des Sciences Semlalia, département de physique, BP 2390, Marrakech
3. LP2M2E, Faculté des Sciences et Techniques, BP 549, Marrakech
4. CESBIO, Avenue Edouard Belin, BPI 2801, Toulouse, France

KEYWORDS: Gravity irrigation network, Irrigation priority, Remote sensing, Yield, Wheat.

ABSTRACT
Irrigation scheduling has become an important problem that significantly influences growth, development and production of crops, especially in arid and semi-arid regions, such as the Tensift Haouz in Morocco. In theses areas, water scarcity is one of the main factors limiting agricultural development (Hadria et al., 2007). Thus, a particular attention should be paid to managing irrigation water to ensure sustainable development (Kharrou et al., 2011). In these regions the gravity irrigation networks is most widespread, with no optimization of irrigation scheduling. The irrigation schedule is predetermined at the beginning of the growing season regardless of the actual climate and agricultural practices. However, no consideration is given to the water status of the plots and the type of culture, knowing that many annual crops are very sensitive to water stress (Li et al., 2010). At this situation, the question is, with the current irrigation system, including its constraints, can we better optimize irrigation scheduling? i.e. Can we find a good compromise between system constraints and the establishment of an irrigation scheme in descending order of water stress degree of plots? Fortunately, for the large areas, remote sensing is a suitable tool for monitoring crop phenology, water stress and therefore the crop water requirement (Simonneaux et al., 2009; Er-Raki et al., 2010).

In this paper we present a characterization of the irrigation distribution by this classical system of irrigation. For this, we presented and tested an Irrigation Priority Index IPI. The latter could characterize the priority irrigation of a plot in all plots scheduled for an irrigation round. This index (IPI) is calculated for each plot i and expressed as a function of two main terms: the water stress coefficient, $K_{s_i}$ and the time, $t_i$ (in days) between the start of the irrigation round and the irrigation of the plot i. The proposed expression of IPI is:

$$IPI = \frac{K_{s_i} - K_{s_{\text{min}}}}{K_{s_{\text{max}}} - K_{s_{\text{min}}}} \cdot \frac{t_i}{T}$$

Where: $K_{s_{\text{min}}}$ and $K_{s_{\text{max}}}$ are the minimum and the maximum of $K_s$ map relative to the plots concerned by each irrigation round. They correspond respectively to the most stressed plot and the less stressed one. $T$ is the duration of the irrigation round. Values of $t_i$ are between 0 and $T$, corresponding to the irrigation of the plot i on the first day and last day of the irrigation round, respectively. Thus, regarding this IPI formulation, we conclude that values of IPI close to 0 can be considered as an indicator of a good distribution of water, during an irrigation round.

Before each irrigation round, a region map of plot water stress, $K_{s_i}$, is established. For that, we used the SAMIR model (SAellite Monitoring of IRrigation) which is a software specialized in estimating evapotranspiration (ET) and performing water balance of the irrigated crops from satellite images (Simonneaux et al., 2008 and 2009). The IPI was used to evaluate the actual irrigation scheduling in R3 zone (2800 ha) of Tensift Al Haouz in Morocco, on a data set of 2002/03 wheat season. The results obtained show that about 32% of the R3 zone plots are irrigated late, when they were more stressed and had irrigation priority (IPI less than -0.3). The sensitivity of grain yield to the IPI values was evaluated on a data set for 2008/09, when actual irrigations scheduling are well noted. The spatial yield was calculated using a linear relationship between wheat yields and the spatial accumulated NDVI (Normalized Difference Vegetation Index) of last 10 days of Marsh ($R^2=0.84$). The result shows a high sensitivity of yield grain to IPI; production ranges from 3.8 to 4.7 t/ha and from 1.3 to 2.6 t/ha when the IPI values are in the intervals [0.37, 0.63] and [-0.52, -0.16], respectively.

References

Li, L., Nielsen, D.C., Yu, Q., Ma, L., Ahuja, L.R., 2010. Evaluating the Crop Water Stress Index and its correlation with latent heat and CO2 fluxes over winter wheat and maize in the North China plain. Agricultural Water Management, 97 (8), 1146-1155.


THE ROLE OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS FOR THE CONSERVATION AND SUSTAINABILITY OF MOROCCAN PALM GROVES

Jose A. Guerra-García (1), Mauricio Labrador-García (1), Sergio González-González (1), Manuel Arbelo (2), Pedro A. Hernández-Leal (2), Driss Mammass (3), Soufiane Idbraim (3), Moulid Oudra (3)

(1) Gestión del Medio Rural (GMR Canarias). 38110 Santa Cruz de Tenerife, Canary Islands, Spain.

(2) Grupo de Observación de la Tierra y la Atmósfera (GOTA), Universidad de La Laguna, 38206 La Laguna, Canary Islands, Spain.

(3) Laboratoire Image et Reconnaissance de Formes – Systèmes Intelligents et Communicants (IRF – SIC), Université Ibn Zohr, Agadir, Morocco.

ABSTRACT

Palm groves are one of the most characteristic agro-ecosystems of Morocco, not only for their natural and scenic value, but also because over hundreds of years, they have created a favorable environment that man has used to cultivate, taking advantage of the microclimate and protection offered by the palm trees in this semi-arid environment. The current development process of the provinces in the Souss Massa Draa region is increasing inter-regional mobility of people and materials (including seeds and plants), increasing the risk of spreading pests and diseases potentially lethal to palms, so a phytosanitary control of them is required.

In the context of the border cooperation project PALMERA, between the Canary Islands and Morocco, it is intended to intensively monitor different palm groves in the provinces of Agadir, Ouarzazate and Zagora, by means of modern comprehensive procedures and the use of remote sensing and geographic information systems (GIS).

The first objective is the mapping of palm trees in the study areas and the detection of possible diseases using very high spatial resolution satellite imagery. A field work is being done which involves the characterization of plots (valid for the classification and validation process) by means of GPS and the collection of spectral signatures of healthy palm trees and others with different degrees of affection. A FieldSpec 3 spectroradiometer with a spectral range from 350 nm to 2500 nm will be used. Different classification techniques (pixel and object based) will be evaluated and applied, for mapping and estimating the number of palm trees on one side, and to analyze different satellite imagery vegetation indices for the detection of symptoms on the other side.

The second objective is to design an information system tool for control, prevention and eradication of different diseases that affect palm groves. This tool, completely developed with open-source software, has four operating modules: A field data acquisition application for mobile devices, a web-based application for the management of the collected information, a geographic information system and a web interface which allows the visualization of the GIS data in the Internet. The mobile application allows the collection of geo-referenced field data (palm trees affected by any disease, localization of insect traps, etc). This information is synchronized with a PostgreSQL database that can be accessed via web by a Java application. The geographical information will be handled with gvSIG software and its module PostGIS. A web site, developed with Java, Openlayers and Geoserver, will provide a highly effective way of accessing all the information. This tool will help project managers and field technicians take the correct decisions in order to detect, control and eliminate plagues and diseases found in the palm groves.

This work is supported by PALMERA project, within the POCTEFEX program 2008-2013, financed by FEDER funds.
MONITORING CROP PRODUCTION SYSTEMS USING REMOTE SENSING: THE AGRICAB PROJECT

C. Tote, T. Ceccarelli, H. Boogaard, L. Bydekerke, T. Jacobs
1. VITO, Mol, Belgium
2. Consorzio ITA, Italy
3. Alterra, WUR, Wageningen, The Netherlands

ABSTRACT
As humanity places ever greater demands on the Earth’s resources, a greater ability to understand global change and to predict how natural systems will respond to human activities and policies becomes more vital every day (GEO, 2010). An important tool in this respect is remote sensing, which provides recurrent information on natural resources. The Global Earth Observation system of Systems (GEOSS) provides decision-support tools to a wide variety of users. Nevertheless, training programs are essential for building capacity in Earth observation (EO) and geo-information sciences, particularly in developing countries. A key challenge is therefore to enhance scientific and remote sensing capacity in Africa to enable African institutes to independently monitor and generate information on agricultural and forest resources to adequately support management and policy actions.

The main focus of the recently started AGRICAB project entitled ‘A Framework for enhancing earth observation capacity for agriculture and forest management in Africa as a contribution to GEOSS’, funded by EC-FP7, is to integrate European and African research capacity and advances in the use of EO technology for agriculture and forestry. Apart from the sustained provision of (derived) EO data, the project aims at a continued and better exploitation of satellite data. Twinning partnerships between African and European institutes are being set up in order to integrate EO, agricultural statistics and predictive modelling in agriculture and forest management. This paper focuses on the integration of EO for agricultural monitoring in different sub-themes: (i) yield forecasting for food crops, (ii) early warning and mapping of food crops, and (iii) agricultural statistics. These components are being developed through specific use case studies in Senegal, Mozambique and Kenya.

Crop production in the use case countries can suffer from droughts and flooding due to irregular rainfall, but at the moment no operational service is available that makes use of remote sensing datasets in the generation of crop production statistics (i.e. for crop area and yield estimates) or in monitoring and forecasting the yield of rain fed arable crops by means of deterministic crop growth models. Crop statistics provide official figures of area planted and harvested as well as overall production which can then be used as reference data for crop modelling and potentially for early warning. In the context of AGRICAB, satellite images are used in combination with ground surveys to suggest improvements, at various levels, to the existing crop area statistics systems in Kenya, Mozambique and Senegal. The application of satellite imagery can occur at different stages: in the design of an area sampling frame and its characterization for stratification purposes through visual interpretation of land cover/land use very high resolution images, in the preparation and execution of the surveys for confirming land cover and crop types on the ground as well as in the final estimation of the crop area, where classified images can be used as auxiliary variables for improving the precision of the estimates. As to crop modelling, the WOFOST model (Boogaard et al., 2011) is being adapted to the local needs and conditions. The simulated crop indicators can then be entered in a statistical framework for yield forecast, based on the MARS Crop Yield Forecasting System (MCYFS) of the European Commission (Genovese and Bettio, 2004; Lazar and Genovese, 2004). After developing the use case and building the EO-based data infrastructures needed to run the crop growth model, the operational crop monitoring system will be demonstrated to a wide community of end users. According to Justice and Becker-Reshef (2007), an operational system for monitoring global agriculture should encompass a component of effective early warning of famine, which can be partially provided through improved environmental monitoring. Within AGRICAB, specific tools are being used to enable the partners in the use case countries to perform or to improve their early warning activities, by using time series of satellite derived vegetation indicators and rainfall estimates. Agricultural masks are a key baseline input for crop monitoring, early warning. In the use case countries, the suitability of different crop mapping methodologies are being tested. The main bottlenecks of the classification of distinct crop types are in many cases the small parcel size, the mixture with other land cover types, and the lower crop performance which hampers the distinction between crops and the surrounding sparse vegetation (Delrue et al., in press). Within AGRICAB, local partners are being trained in classification techniques and field collection methods. Although the use cases are based upon current challenges the local partners and end users face, the country cases are developed in a regional context whereby the developed methods are applicable at a regional scale.

References
MODELLING RUNOFFS OF SIMULATED BUFFER ZONES FOR SUSTAINABLE CATCHMENT MANAGEMENT

Sovoe, S.

Environmental Protection Agency, Field Operations, Volta Region, P. O. Box HP 513, Ho, Ghana;
Sponsor(s): International Foundation for Science, Grant No. W/4330-1
Project Period: 01/03/08 – 31/03/11

KEYWORDS: Volta, basin, ecosystem, restoration, water, resources

ABSTRACT

Farming along river banks without buffer zones in the Volta basin has reduced most perennial streams to seasonal ones and some have completely dried up. This development requires restoration of the streams corridor to avert the situation. Selecting appropriate buffer width for optimal ecosystem restoration and meeting local demands of land for farming, settlement development, establishment of industries and other commercial activities is a challenge which requires advanced modelling approaches to aid in decision making. In this research, five buffer zone scenarios (30 m, 45 m, 60 m, 75 m, and 90 m) were simulated using Integrated Land and Water Information Systems (ILWIS) and Hydrologic Engineering Centre – Hydrologic Modelling Systems (HEC-HMS). The scenarios were assessed against five hydrological parameters using spatial multi-criteria evaluation approach. It was found out that, 90 m-buffer zone option performed best followed by 30 m-buffer zone which could be implemented respectively for municipal rivers or reservoirs and minor rivers to restore the degraded watershed.

OPERATIONAL CROP YIELD FORECAST USING REMOTE SENSING AND AGROMETEOROLOGICAL IN WEST AFRICA

Djaby Bakary *, Antoine Royer**, Sven Gilliams**
*b.djaby@ulg.ac.be, ULG, Avenue de Longwy, 185 - B-6700 Arlon - Belgium
** VITO, Boeretang 200 – B-2400 Mol, Belgium

ABSTRACT

The high inter annual variability of the agricultural production and its impacts on food security in the Sahel region require a good forecast of the expected crop yields well before harvest. At present most of the methods are based mainly on agricultural statistics and the counting of cobs. Although the results of these methods is accurate the results are only available after the harvest. The existing operational forecast approaches are primarily based on agrometeorological and water balance models and so far the integration with Remote Sensing data was limited. The use of remote sensing in crop monitoring developed in these regions remained qualitative.

In the framework of the Global Monitoring for Food Security (GMFS) project research has been done to improve the existing forecast approaches by integrating remote sensing data.
On the one hand side, the combination of the water balance models with crop cycle metrics derived from remote-sensing time series was tested for several years on several crops, including cotton, peanuts, millet, maize and sorghum in several countries in the Sahel. Based on this new combination two forecasts are made during the growing season at the sub-regional level. The model's accuracies are good and demonstrate a clear improvement as compared to the more traditional approaches.

On the other hand, parallel to this parametric model a new non parametric approach based on vegetation index profile matching algorithm was developed which shows very promising results. The principle is to identify, at pixel level, the most similar NDVI profile from the historical data base over the same time period. The related yields are then aggregated at administrative level. These models are easy to calculate and implement as they only need one source of remote sensing information. They can be easily launch before the end of the season and the generated forecast accuracy calculate through the simulation of the historical data set.

Several countries beyond Sahel region have adopted these methods into their operational crop yield forecasting system due to the simplicity of their implementation and of their clear accuracy calculation. The adoption of these different approaches will allow to build a forecasting system for many areas over the world.

THE THREAT OF FOREST DEGRADATION ON CONSERVATION: LAND USE LAND COVER CHANGE FOR GORONGOSA MOUNTAIN, GORONGOSA NATIONAL PARK, MOZAMBIQUE

Samuel KUSANGAYA1, Franziska STEINBRUCH1, Alan SHORT1
1. Department of Scientific Services, Gorongosa National Park, Av. Poder Popular 264, 5ºAndar, Beira, Mozambique

KEYWORDS: Gorongosa National Park, forest degradation, conservation, land use land cover change

ABSTRACT
The Gorongosa National Park, located in Central Mozambique, has been undergoing rehabilitation, after years of civil strife lasting from 1975 to 2004, which destroyed most of the national parks' physical and human infrastructure. Mount Gorongosa was proclaimed part of Gorongosa National Park by a government decree published in May 2010 and is the main source of water for the park. One of the biggest conservation challenges for the Gorongosa National Park, is that Mount Gorongosa, geographically detached from the core park, located in north west of the original 4,000 square kilometre park, and one of the few remaining rainforests of eastern Africa, is under threat from excessive deforestation, due mainly from increasing human settlement. The objective of the research was therefore to evaluate the land use change process on and around Gorongosa Mountain from 2000 to 2010, so as to determine the rate, state, magnitude and possible impacts of forestry loss on the Gorongosa Mountain. Land use change was analysed using Landsat satellite images of the years 2000, 2005, 2010. An IKONOS image of 2010 was used for ground truthing and this was complemented with available field survey data. Change detection was carried out on the images for the different year intervals. From the classified images, it was revealed that Montane forest declined by 13% from 29% in 2005 to 16% of the total mountain area in 2010 and this was largely attributed to cutting down of trees for cultivation purposes. Wooded grasslands, however increased from 3% to 22% and this was attributable to the practice of slash and burn agriculture around the mountain as most of the wooded grassland areas were areas of vegetation regeneration after the areas had been abandoned. For the years 2000 and 2005 an analysis of net vegetation changes particularly focusing on the Montane forest revealed that more area was lost to wooded areas and cleared areas in the magnitude of 1.5% and 3.8% respectively. Losses to cultivated areas contributed marginally in the region of 0.3%. Between 2005 and 2010, cultivated areas, wooded grassland, and cleared areas contributed 5.5%, 4% and 1% respectively to the loss in Montane forest on the mountain. The most dominant farming activity threatening the mountain is the cultivation of potatoes on the rich fertile mountain slopes. Overall, the continuous loss of protective vegetative cover from the mountain will not only results in loss of flora and fauna, but will also result in drying of springs, soil erosion, flush floods, loss of animal habitats, reduced water flow and siltation of Lake Urema. This will eventually leads to loss of livelihoods as people will not be able to access the traditional non timber forest products from the mountain. There is therefore an urgent need to preserve the remaining forest areas on the mountain so as to protect the water sources of Lake Urema, hence protect the “pulse” of Gorongosa National Park. There is also need to intensify reforestation activities especially on the highly sensitive areas like river sources especially to combat erosion. Since there are people already residing within the park, there is need to intensify conservation education measures so as to protect the biodiversity on the mountain and on the plains.
DISCRIMINATING THE EARLY STAGES OF FUSARIUM CIRCINATUM INFECTION OF PINUS RADIATA SEEDLINGS USING HIGH SPECTRAL RESOLUTION DATA

Nitesh K Poona1 & Riyad Ismail2
1. Private Bag X1, Matieland, 7602, South Africa, 2Private Bag X01, Scottsville,3209

ABSTRACT
First reported at a nursery in Mpumalanga province in 1990, Fusarium circinatum is a fungal pathogen causing widespread mortality of Pinus radiata and Pinus patula seedlings. The fungus has since become endemic in South African nurseries, with seedlings providing an important pathway for disease propagation. Improved methodologies for early disease detection are thus pertinent. Early detection relies on identifying specific wavebands that correspond to specific physiological responses of the plant to stress. Studies have shown that narrow-band hyperspectral data can be used for early stress detection. Subtle changes in leaf biochemistry, expressed as altered leaf reflectance, indicate the plant’s response to stress. The objectives of this research were to i) determine the earliest possible window period, from time of infection, for disease detection, and ii) identify the specific wavebands that could be used for discriminating healthy and infected seedlings.
To achieve these objectives, we setup an experiment with a sample (n = 150) of 3-month old Pinus radiata seedlings divided into three classes; healthy (n = 50), damaged (n = 50), and infected (n = 50). Reflectance measurements for all three classes were collected using an Analytical Spectral Devices Full Range spectroradiometer, weekly over a four week period. Reflectance measurements were later analysed using a random forest with a feature selection algorithm implemented utilizing the R statistical software. Results of the analysis indicate that the best possible discrimination occurs at week three (KHAT = 0.81; out of bag (OOB) error = 12.67%). The results further indicate that wavelengths in the red-edge and near-infrared regions show the most promise in discriminating the healthy, damaged, and infected classes. These results could be explained by reduction in needle chlorophyll content expressed by the blue shift – a shift in the red-edge toward shorter wavelengths. Furthermore, lowered near-infrared reflectance has been associated with disease-induced stress. Overall, this study provides a basis for the early detection and discrimination of infected Pinus radiata seedlings that could be operationalized within a nursery environment.

SAVANNA GRASS SPECIES CLASSIFICATION BASED UPON NON-LINEAR SPECTORADIOMETRIC MODELLING

Nichola Knox1,2, Andrew Skidmore1; Paida Mangara2
1. Faculty of Geoscience and Earth Observation; Twente University; PO Box 217; 7500 AE; Enschede; The Netherlands
2. Earth Observation Division; South African National Space Agency (SANSA); P.O. Box 484; Silverton; Pretoria; 0127; South Africa

ABSTRACT
Within South Africa savanna and grassland biomes cover close to 60% of the land surface. These biomes form the basis for a prominent agro-industrial, and wildlife sector which together contribute towards approximately 15% to the countries’ GDP. The savannas are biologically highly diverse, however they are sensitive to over-utilisation. Because of the extensive areas covered by these biomes they are difficult to monitor to determine the health of the ecosystems.
Remote sensing (RS) offers the opportunity to cover large areas in single images, thereby providing a non-destructive and efficient means to map and monitor regions efficiently. The high diversity of the savanna and grassland ecosystems prevents the use of multispectral sensors to capture individual species diversity. Hyperspectral RS has been shown to be capable of identifying invasive species at the landscape scale by studying how a species phenological response differs from native plants [2,4]. Individual tree species have been identified through their unique chemical fingerprints [1], or different flowering [3], and individual grass communities have been identified using field spectroradiometry [6].
In a number of soil spectroradiometric studies non-linear modelling has been shown to produce models with higher accuracies than models produced using linear modelling [5]. In this study we apply ensemble tree non-linear modelling to determine if this modelling technique can be used to classify dominant savanna grass species based upon differences in their spectral signatures.
A field campaign was conducted on the Northern Plains of the Kruger National Park, South Africa, during late summer and early winter of 2007 and 2008. Spectral data (ASD Fieldspec Pro FR field-spectroradiometer) and accompanying ancillary data were collected of the dominant grass species in the study area. Ensemble tree models were developed for classifying dominant savanna grass species. The ensemble tree models were developed and compared based upon a variety of data input subsets including: a) ancillary data, b) spectral data and c) combined spectral and ancillary data. We found that ancillary data alone could best be used to classify grass species, however wavelengths within the region of 550 nm and 720 nm contributed most significantly to species identification. This indicates that from a remote sensing perspective plant health (pigment and cell water content) was the spectral region which contributed most significantly to plant species identification. Our findings suggest that remote sensing will be suited to identifying dominant grass species, but unsuited to identify rare grass species. Mapping through the use of hyperspectral data of dominant species, in particular key stone species would allow managers the means to monitor the health of their savanna ecosystems.

References

EARTH OBSERVATION (EO) FOR CHARACTERISING FOREST DEGRADATION OR FOREST COVER CHANGES

Lauriane Cayet¹, Nathalie Stephenne¹, Mathieu Rahm², Ides Bauwens², Pierre Mathoux³, Benoit Mertens² and Anton Vrieling²
1. Walspot, Belgium
2. Eurosense, Wemmel, Belgium
3. Earth and Life Institute - Université catholique de Louvain
4. Institut de Recherche et Développement, France
5. Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, The Netherlands

KEYWORDS: Earth Observation, Central Africa, Republic of Congo, Gabon, Forest degradation, REDD.

ABSTRACT
Forests play an important role in the global carbon budget, acting either as carbon sinks or sources (Van der Werf et al., 2009). In 2007, the international community agreed on the need and the emergency to accurately and precisely measure, report and verify (MRV) carbon stocks, sinks and emissions. Reducing emissions from deforestation and degradation, as well as conservation, sustainable management of forests and enhancement of forest carbon stocks, known as “REDD+”, is a major objective in climate change mitigation. This paper aims to quantify forest degradation or forest cover changes in the context of REDD+.
While operational methods exist for monitoring deforestation in Central Africa, there is no agreed way for monitoring forest degradation. This is mainly because of two challenges. First of all, it is very difficult to detect and quantify forest degradation due to a lack of a universal definition, when referring to intergovernmental efforts (UNFCCC and IPCC) and fitting to local conditions. Secondly, it is not easy to address it by remote sensing even if Earth Observation (EO) technologies are the most appropriate to provide spatially explicit information and to cover large areas of forest (De Fries et al., 2007). The main issues for monitoring forest degradation using remote sensing in Central Africa are: (1) persistent cloud cover; (2) short time scales needed...
to effectively address the forest cover change processes (e.g. because of quick regeneration); (3) small size or subtle changes of the degradation processes needing fine scale imagery; (4) non-uniform distribution of deforestation (Duveiller et al., 2008).

This paper focuses on the assessment of small clearings using Very High Resolution (VHR) satellite imagery, as a result of selective logging or slash and burn agriculture. In fact, not all processes associated with forest degradation can be assessed by remote sensing (Herold et al., 2011). This paper presents experience and results from three case studies in Central Africa, gained through three related projects: (1) G-MOSAIC - impact monitoring of the reopening of a road on the surrounding forests in the North of the Democratic Republic of Congo (DRC); (2) REDDiness forest degradation assessment in two local study sites in Gabon and in the Republic of Congo; (3) EO4REDD robust, affordable and reliable forest degradation monitoring method over the Mai Ndombe region in DRC.

The method is based on semi-automated object-oriented image classification of VHR imagery (GeoEye-1, Ikonos-2, QuickBird, and WorldView-2 imagery) using eCognition. In this study, we derive recent land cover maps (2010, 2011, 2012), with categories of vegetation and state of forest for each scene. Forest change maps show areas where “forest” changed into “bare soil” class between two dates. Validation relies on an accuracy assessment of the forest cover maps using primarily a stratified random point sampling approach and visual checks for all sites. We only had field data for the two local sites in Gabon and in the Republic of Congo through REDDiness.

These preliminary results generalises a classification process across several sites in Central Africa. This proves the replicability of semi-automatic classification on various tests cases in tropical forest. Overall agreement for all classes between the land cover maps and control points is around 85% percent. These are promising outcomes for MRV in the context of REDD+. The potential of optimized field sampling and remotely-sensed data (used as samples) for validation and uncertainties measurements is also discussed here.

This paper presents the potential of VHR imagery to detect forest degradation as a requirement to REDD+. We propose a method to improve the measurements’ accuracy and the validation through optimal field data sampling. EO4REDD aims to ascertain robust, accurate and precise measurements of forest carbon stock variations, through calibration, validation, and uncertainties measurements relying on optimized sampling. The ultimate goal is to integrate this method in a certified, scalable, and internationally recognized framework.

References
ABSTRACT
Large scattered trees play an important role in the functioning of savanna landscapes. They act as focal points for various organism activities, which influence the distribution of nutrients and water within the landscape, which in turn influences savanna patch dynamics. They generally are considered as prominent keystone structures associated with a stable ecological stage. A variety of anthropogenic land use and management activities are however putting increasing pressure on the big tree abundance, habitat structure, and ultimately the ecological function of the African savanna biome. Mapping these trees at individual level over large areas could yield valuable information for landscape ecology studies. Recent concerns related to the decrease of large trees in Kruger National Park prompted the development of field protocols for monitoring changes in large trees (Druce et al 2008). Airborne multispectral and LiDAR surveys are technically best suited for this application, but are expensive for large scale studies. Multispectral imagery affords the possibility of regional scale studies, but often lacks the spatial resolution for discriminating tree canopies. High spatial resolution multispectral sensors (i.e. 2-5 m pixel size) do however provide the opportunity to extract large scattered trees (>5 m height and 25m² canopy surface) using their projected shadow. Available SPOT5 imagery was pan-sharpened (to 2.5m) and then subjected to various image transformation techniques, which all aimed to enhance the shadow. The products of the various image transformations were then used in an object based classifier to produce ‘shadow spot’ maps (Fig. 1). The shadow maps were validated against very high resolution tree maps derived from 3D discrete Carnegie Airborne Observatory LiDAR dataset. Depending on the different tree density treatments, the accuracy assessments have produced user’s accuracy figures of between 65 and 85%, while producer’s accuracies have varied between 30 and 55%. The user’s accuracy figures point to the classification methods working well to produce reasonably low commission errors (i.e. classifying an object as a tree shadow, when it’s not). Whereas the producer’s accuracy figures point out that we have high omission errors, which points to the fact that the classification method is missing a number of trees. The low producer’s accuracy (i.e. high omission errors), do not necessarily speak to a failure of the classification methods, but more likely to the actual characteristics of the trees that are not being detected. A number of factors are at play in determining whether or not a tree exhibits a shadow in a satellite image that was taken from several hundred kilometres above the earth. The factors influencing tree shadow mapping that interest us going forward are a) the species of tree, which relates to the growth form, the leaf form, crown size and general crown characteristics; and b) the season of image acquisition, which relates to both the phenology of the tree at the time, as well as the angle of the sun and resulting shadows. For instance, using tree species maps produced from hyperspectral imagery, we found that majority of the trees that were missed were Acacia nigrescens trees. This species of tree has a small leaf form and a resultant compact canopy, which could also have been past its primary growth phase and even experiencing leaf drop off at the time the image was taken (i.e. mid April) (See Fig. 2). Work is ongoing in attempting to account for reasons why certain trees are not being classified, as well as into improving the efficiency with which we successfully detect trees. All of which will be presented at the conference.
ESTIMATING GRASS NUTRIENTS AND BIOMASS AS AN INDICATOR OF RANGELAND (FORAGE) QUALITY AND QUANTITY USING REMOTE SENSING IN THE SAVANNA ECOSYSTEMS

Ramoelo A\textsuperscript{a,b}. Cho Ma. Mathieu R\textsuperscript{a}. Skidmore A.K\textsuperscript{b}. Schlerf M\textsuperscript{c}. Heitkönig I.M.A\textsuperscript{d}.
\textsuperscript{a}. Earth Observation Research Group, Natural Resource and the Environment Unit, Council for Scientific and Industrial Research (CSIR), P.O.Box 395, Pretoria, 0001, South Africa
\textsuperscript{b}. Faculty of Geoinformation Science and Earth Observation, University of Twente (UT-ITC), P.O.Box 217, Enschede, 7500 AE, The Netherlands
\textsuperscript{c}. Public Research Centre, Gabriel Lippmann, 41 rue du Brill, L-4422 Belvaux, Luxembourg
\textsuperscript{d}. Resource Ecology Group, Wageningen University, Droevendaalsesteeg 3a, 6708 PB Wageningen, The Netherlands

ABSTRACT

Introduction
Africa has a long history of pastoralism (livestock grazing) which has been a major source of livelihoods. Most of African people used to be nomadic, i.e. seasonal movement in search of greener pastures for their livestock. Nowadays, livestock production which is dependent on grass or pasture quality and quantity is still a major source of income in the rural economy. Pasture quality can be defined by leaf nutrient content, while quantity can be defined by biomass (mass per unit area). Grass quality and quantity are pertinent to understanding the distribution, feeding patterns and population dynamics of livestock and wildlife and crucial to inform decision making regarding the planning and management of savanna rangelands. Grass nutrients have rarely been...
mapped at the regional scale because of the lack of satellite-based sensors that sample reflected electromagnetic energy in the red-edge region which is sensitive to foliar chlorophyll and nitrogen (N). Medium resolution satellites are also generally not suitable to discriminate grass and tree signals in heterogeneous and patchy savannas. The emergence of high resolution multispectral sensors with red-edge information such as RapidEye, SumbandilaSat, and Sentinel-2 (to be launched 2013) provides new opportunities for rangeland quality and quantity assessment at regional level. The biomass techniques has been developed using already existing satellite images such as medium resolution SPOT and Landsat sensors, but for heterogeneous systems such as the savanna, new high resolution multispectral sensors with red edge could improve the estimation accuracy at regional scales. The objective of the study is to estimate and map grass N and biomass as an indicator of rangeland quality and quantity using vegetation indices derived from RapidEye images.

Material and Methods: The study area covers Kruger National Park (KNP), SabiSands and Bushbuckridge communal rangelands. Grass samples were collected in the field and were chemically analyzed for foliar N concentration. Fresh or green biomass data were derived by weighing grass samples per 0.5 m x 0.5 m subplot size, of 20m x 20m plot. In each subplot, the composition of green or photosynthetic vegetation (PV), dry vegetation and bare soils were recorded. Foliar N was multiplied by PV to derive a canopy N which is a proxy of structure and foliar N (N*PV). RapidEye images were collected at the same time as the field data collection. Commonly used vegetation index such as simple ratio was used with the inclusion of red edge band and the conventional one (without the red edge band) were computed, and foliar N regression models were developed using simple regression. Biomass (g/m2) prediction models were done applying stepwise regression using a combination of vegetation indices and environmental or ancillary variables.

Results and Discussion: Simple ratio (SR54) based on red-edge band (4) and near-infrared (5) produced higher grass N estimation accuracy, as compared to conventional indices (SR53), where (3) is the red-band (Figure 1a). Red edge position is known to be insensitive to background effects, and highly correlates to foliar N. The distribution of nutrients conforms to various geological types, the high nutritious grasses found in a basalt derived soils and low in the granitic derived soils (Figure 1b).

For the biomass estimation, vegetation indices produced poor results explaining less than 15% of variation. The improved result of 41% of biomass variation was explained by integrating vegetation index (SR54) and ancillary data using stepwise regression. The latter approach is crucial because biomass is influenced by various environmental variables, which therefore play a crucial role in model development.

Conclusion: The study demonstrated a potential of forage quantity and quality estimation using new high spatial remote sensing data with the red edge band. Integrating vegetation indices and ancillary data provides an opportunity to map grass biomass during peak productivity. We recommend a further analysis on integrating vegetation index and ancillary data for foliar and canopy N estimation. Forage quality and quantity information is crucial for planning and management of grazing resources.
SPATIO-TEMPORAL ESTIMATION OF LEAF AREA INDEX IN A HETEROGENEOUS FOREST

Yaseen T. Mustafa
Department of Environmental Sciences, Faculty of Science, the University of Zakho, Zakho, Kurdistan region, Iraq.

KEYWORDS: Leaf area index (LAI), Linear Mixture Model (LMM), mixed pixels, Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery.

ABSTRACT

Leaf area index (LAI) is an ecological variable that influences atmosphere biosphere exchange of CO₂ and that can be estimated from remote sensing techniques. The Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery provide LAI product with high temporal resolution. However, the coarse spatial resolution of this data limited the application, e.g., the spatial heterogeneity of land cover. In this paper, we propose a novel approach to spatial estimation of LAI in a heterogeneous forest consists of five species. Decomposition of MODIS pixels is achieved using the Linear Mixture Model (LMM) and class fraction derived from an aerial image. In this way spatially heterogeneous LAI estimation was produced with maximum RMSE of 0.50 and minimum RMSE of 0.35. The approach was tested over the Speulderbos forest located in The Netherlands. The results show that the spatio-temporal estimation of LAI within-MODIS pixel can be estimated successfully. We conclude that the spatio-temporal estimation of LAI can be estimated for any heterogeneous forest using the presented approach.

EFFECT OF RAINFALL ON NDVI IN THE FALGORE GAME RESERVE, KANO, NIGERIA

Tudunwada, I. Y¹ & Mohammed, S.O.²
1. NATIONAL CENTRE FOR REMOTE SENSING, JOS, NIGERIA
2. NATIONAL SPACE RESEARCH & DEVELOPMENT AUTHORITY, ABUJA, NIGERIA

ABSTRACT

The Falgore Game Reserve (FGR) covers a total area of about 932.5981km² and lies between latitude 10° 50'N and 11°20'N and longitude 8°35'E and 8°45'E. It has a mean length of 50km north to south and a width of 28 km east to west. The climate of the area is hot semi-arid, BSh as described by Koeppen. Hitherto, the FGR appeared to be full of wild life and thick forest cover. Over the years, these animals seem to have disappeared and the thick forest cover is gradually wearing out. The high rate of population growth in Nigeria, has led to bringing in more areas of land under intensive agriculture and human settlements which in turn leads to a decrease in forests in most parts of the country. It further leads to increasing demand for fuel wood and other forest products. These factors combine to pose a threat to the vegetative cover of the FGR. However, natural processes especially climate change – can also contribute significantly to the forest degradation process. The aim of this study is to determine the effect of rainfall on NDVI in the FGR from 1975 to 2009, using satellite remote sensing and GIS. The images used in this study were Landsat and Nigeriasat-1. The acquired images were rectified to the UTM zone 32 and WGS84 projection. The images were resampled and subset to the boundaries of the FGR. The corrected images were used to determine the land use/cover and the NDVI. Both ILWIS and ERDAS softwares were used. Averages, percentages, standard deviations as well as correlation analyses were employed. Rainfall was highest in 1975 followed by 1986 and lowest in 1990. The temperature has been steadily increasing after 1990 indicating global warming and possible degradation of the forest. Woodland was the dominant class in the forest: it has been increasing over the years; rainfall correlates positively with its NDVI (r²= 0.46).

Incidence of fire is very high in the dry season, however burnt land class has generally decreased from 1975 to 2009; it decreases with increase in rainfall (r²=0.4225). Disturbed forest has increased spatially and temporally with year 2000 recording highest disturbance; anthropogenic factors are believed to be responsible for the increase (85.55%). Riparian vegetation has been reducing since 1975; it is directly related to the river which has also been decreasing over the years. Rain water contributed only 14.44% to riparian NDVI. Bare lands were seen to decrease over time, rainfall correlates very well with NDVI (r²= 0.7056). The NDVI results correspond well with vegetation cover (riparian and woodland) in particular as well as other themes of FGR in the classification. The combined lowering of rainfall and increase in temperature in the FGR might have caused further lowering of vegetative cover. Enforcement of existing laws and regulations of the forest, reclaiming and
replanting of eroded and cleared surfaces within the forest, stoppage of forest fires, sustainable forest management practices, public awareness programs on the importance of forests and conservation of natural resources and the need to train policy makers and resource managers on remote sensing and GIS were recommended.

EVALUATION OF TERRASAR-X DATA FOR LAND USE/LAND COVER ASSESSMENT USING OBJECT-ORIENTED CLASSIFICATION APPROACH IN THE AFRICAN SAHEL AREA, SUDAN

Khalid Biro¹, Biswajeet Pradhan², Hussein Sulieman¹ and Manfred Buchroithner³

1. Faculty of Agricultural and Environmental Sciences, University of Gadarif, P.O. Box 449, Gadarif, Sudan
2. Institute of Advanced Technology, University Putra Malaysia, 43400, UPM, Serdang, Selangor Darul Ehsan, Malaysia
3. Institute for Cartography, Faculty of Forestry, Geo and Hydro-science, Dresden University of Technology, 01062 Dresden, Germany

ABSTRACT

Recently, object-based image analysis (OBIA) with image segmentation approaches are being exploited using high-resolution image processing tools to extract thematic information. The current study is focused at the Eastern part of the African Sahel, Sudan, where land use patterns are characterised by complex vegetation covers and scattered distribution of small and large agricultural fields. These conditions made it difficult to map the land use/land cover (LULC) classes within the study area using optical remote sensing data. Therefore in order to obtain detailed LULC maps, very high-resolution space borne active remote sensing imageries were acquired for that purpose. The main objective of this study is to evaluate the potential of TerraSAR-X data for LULC classification using an object-oriented approach in the drylands of the African Sahel. Further, it attempts to evaluate the potential of multi-resolution segmentation (MRS) for identifying the field boundaries within the study area. The different LULCs of the study area were analysed by employing an object-oriented classification approach to the dual polarisation (HH and HV) TerraSAR-X data of the year 2009. Prior to classification the image pixel values were calibrated to normalise the backscattering coefficients. Following this process three adaptive filters were applied to reduce the speckle noise. Consequently, the MRS of the Definiens Software was used for creating the image objects. Using the feature-space optimisation (FSO) tool the attributes of the TerraSAR-X images were optimised in order to obtain the best separability among classes for the LULC mapping. Nearest-neighbour classifier was applied through the FSO function to separate classes from each other. Nine LULC classes were identified during the classification scheme, namely cultivated land (CL), woodland (WL), harvested land (HL), fallow land (FL), bare land (BL), settlement 1 (Sett1 = local-roof buildings), settlement 2 (Sett2 = concrete roof buildings), rock and water. The separability of the LULC classes using a combination of HH and HV polarisations was assessed at the object level by applying the shape features as well as the maximum difference of the mean spectral feature (Figures 1). Moreover, in addition to the mean and standard deviation of the spectral features, the grey-level co-occurrence matrix (GLCM) textural features were applied to each individual polarisation. This was to test the potential application of HH and HV polarisations for separating between the different LULC classes using a specific feature (Figures 2). An overall accuracy of 84.7% with a kappa value of 0.82 was resulted from the classification scheme. Accuracy differences among the classes were kept minimal.

Finally, the results highlighted the importance of a joint use of TerraSAR-X data and object-oriented classification approaches as a useful source of information and technique for LULC analysis in the African Sahel drylands.
RENWAL PLAN FOR MAKOKO RESIDENTAL NEIGHBOURHOOD USING SPATIAL ANALYSIS BASED EVALUATION

Kelani Alabamutairu
Department of Geography, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

ABSTRACT
This study evaluates the physical characteristics in Makoko, an urban slum in Lagos, Nigeria and goes further to prepare a renewal plan for the distressed residential neighbourhood. GIS and remote sensing were used to carry out spatial analysis-based evaluation with the view to facilitating decision making while preparing renewal plan. Both primary and secondary data were used. Primary data includes geographic co-ordinates and elevation data which were both collected using Global Positioning System (GPS). Secondary data includes but not limited to existing Makoko Plan and GeoEye Satellite Image. Existing Makoko Plan was used to delineate the study area; while pre-processed GeoEye Image was utilized to extract geographic features of interest. In order to prepare a database and permit surface analysis of the study area, attribute data was processed for every feature class and Digital Elevation Model (DEM) was developed respectively. Further to this, spatial analysis was carried out on sub-area basis with the view to evaluating physical problems peculiar to different areas. Subsequently, renewal plan was prepared for the study area based on the results of analysis. The new plan was finally overlaid on the old plan to establishing the gaps that need to be filled.
Utilisation de la Télédétection et le Modèle SIB 2 pour Évaluer l'Impact de l'Urbanisme sur le Climat en Surface : Cas de la Ville de Marrakech

Lachir Asia\(^1\), Bounoua Lahouari\(^2\), Messouli Mohamed\(^1\).

\(^1\) : Laboratoire d’Hydrologie Ecotoxicologue et Assainissement (LHEA) Faculté des Sciences Semlalia Université Cadi Ayyad, Marrakech

\(^2\) : Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt Maryland, USA

**RESUME**

L’urbanisation consiste à modifier la surface terrestre naturelle, cette modification est traduite par:

1. la réduction de la fraction de végétation qui induit une réduction de la photosynthèse et la transpiration.
2. la modification de l'albédo sur le bilan énergétique en surface,
3. le changement du bilan hydrologique en surface,
4. la modification de la rugosité de surface.

De l’ensemble de ces modifications, résulte la création d’un microclimat urbain principalement caractérisé par le phénomène de l’îlot de Chaleur Urbain (ICU).

L’objectif de cette étude est d’utiliser les données de télédétection pour caractériser la surface terrestre de la ville de Marrakech et d’utiliser le modèle simple de la biosphère (SiB2) pour quantifier l’influence du bâti en zone urbaine sur le climat en surface.

Nous utiliserons une image multispectrale (ETM+) à 30 m pour élaborer un plan d’occupation du sol de la ville de Marrakech, où on discrimineras les surfaces urbanisées par rapport aux différents types de végétation. Les données biophysiques du modèle (FPAR et LAI) seront déterminées à partir des produits MODIS. Enfin on calculera les échanges d’énergie entre l’atmosphère et la surface terrestre par le modèle SiB2.

Par cette étude, nous visons à évaluer l’amplitude de l’îlot de chaleur urbain à Marrakech et son lien avec la surface bâtie. Ceci pourra nous permettre d’explorer les besoins supplémentaires en énergie pour contrepétrailler l’effet de l’îlot de chaleur urbain à Marrakech.

Impact of Urban Expansion on the Agricultural Landuses of Akure, Nigeria

Oyinloye Michael Ajide\(^1\), Kufoniyi, Olajide\(^2\)

\(^1\) : Department of Urban and Regional Planning Federal University of Technology, Akure, Nigeria

\(^2\) : Department of Geography Obafemi Awolowo University, Ile-Ife, Nigeria

**ABSTRACT**

Nigerian cities are experiencing uncontrolled expansion. The city of Akure has experienced rapid growth in the past two or three decades, which has led to the expansion of the core urban areas of the city into the adjoining rural lands. This study examines the urban expansion of Akure and its implication on Agricultural landuses. In analyzing the urban expansion and its implication on Agricultural landuses, 1966 topographic map, 1972 and 1986 Landsat Thematic Map (TM) and Landsat Enhanced Thematic Mapper plus (ETM+) images for 2002 were used in a post classification comparison analysis to map the spatial dynamics of land cover changes and identify the urbanization process in Akure. It also uses questionnaire survey to elicit information on the factors, processes and patterns of growth of Akure and the consequent impacts on the surrounding rural lands, particularly farmlands. The Landcover statistical results obtained revealed that the built-up area has expanded by about 3852.7ha between 1972 and 2002. Based on the GIS analysis, future prediction/trend of the urban landuse and landcover and its subsequent development was modeled between 2002 and 2022.

The urban expansion had been accompanied by loss of vegetation particularly the farmlands and urban sprawl. Possible factors were analysed to influence the phenomena. The integration of remote sensing (RS) and geographic information systems (GIS) was found to be effective in monitoring the landcover changes and providing valuable information necessary for planning and research. The study recommends regular land monitoring, regular land acquisition for sustainable urban expansion and promoting urban agriculture among others.
LANDUSE/LANDCOVER DYNAMICS IN THE LOWER O贡 RIVER BASIN SW NIGERIA AND ENVIRONMENTAL RESPONSE  
*Awoniran D. R., Adegboyega S.A. and Anifowose A.Y.B.  
Department of Remote Sensing and Geo-information System  
Federal University of Technology, Akure, SW Nigeria 

KEYWORDS: change detection, river basin, urban agriculture, land use/land cover. 

ABSTRACT 
This study investigated the pattern of landuse/landcover change in the Lower Ogun River Basin between 1984 and 2007. Two sets of topographical map, a LandSat TM image of 1984, LandSat ETM+ of 2000 and a SPOT image of 2007 were used for the study. The topographical maps and satellite images were digitally processed using ERDAS IMAGINE 9.1 software and exported to ArcGis 9.3 for further processing and analysis. The processed images were subsequently classified using the maximum likelihood classification algorithm, resulting in the identification of seven land use classes, which are, farmland, forested wetland, light forest, non-forested wetland, shrub, urban and water body. Furthermore, change detection analysis was carried out using the cross module of the ILWIS software. The result of the change detection analysis indicated that between 1984 and 2007, 80.08% of the land cover in the area has been converted to other land uses while only 19.92% remained unchanged. Also, light forest, non-forested wetland and forested wetland decreased at average rates of 8.26, 4.66 and 2.81 % per annum respectively, while water body is also decreased at an annual rate of 0.17 %. On the other hand farmland, shrub and urban/built-up areas expanded at average rates of 7.23, 6.74 and 4.65 % respectively. At the same time forested wetland patches decreased from 145 to 57 and non-forested wetland patches decreased from 136 to 70, while mean patch size increased from 16.19 ha to 35.98 ha. Five composite soil samples each to the depth 0-20 cm were randomly collected and analyzed for their physicochemical properties using standard methods to determine the impact of landuse/landcover change on soil quality in the selected forested and non-forested wetlands. 

A PROBABILISTIC APPROACH FOR HIGH RESOLUTION MAPPING OF SMALL-SCALE COFFEE FARMING SYSTEMS OF RWANDA  
A. Mukashema1,2, A. Veldkamp2, A. Vrieling2  
1. Centre for Geographic Information Systems and Remote Sensing (CGIS), National University of Rwanda (NUR),  
2. Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente 

KEYWORDS: Coffee, Object-Oriented Classification, expert knowledge, Conditional probability, Orthophotos, QuickBird, Rwanda  

ABSTRACT 
Rwandan agro-ecosystems are dominated by small-scale agricultural fields that often contain a mix of seasonal, annual and perennial crops. This makes these systems difficult to map by remote sensing. We present a stepwise method developed to extract coffee fields among other small-scale cropping farming systems of Rwanda using an object-oriented probabilistic approach. The model was developed on orthophotos and QuickBird, and tested on the 10 agro-ecological zones of Rwanda. The method consists of a stepwise classification from coffee pixel to coffee object probability using explanatory variables as expert knowledge in the model. The results of pixel probability classification yielded a coffee map with accuracy around 50%, confirming that standard spectral characteristics alone cannot accurately classify coffee fields from high resolution images. The combination of hierarchical neighbor rules created based on explanatory variables and the transformation of continuous pixel information into discrete object information allowed for the creation of a coffee map with an overall accuracy of 87% for orthophoto and 73% for Quickbird image. The proposed method has potential for mapping other perennial cropping systems in the East African Highlands.
MODELLING THE POTENTIAL DISTRIBUTION OF THREE TYPICAL AMPHIBIANS ON CRETE, AND THEIR RESPONSE TO CLIMATIC AND LAND USE CHANGE

ERIC BUEDI
INSTITUTION: CONSERVATION ALLIANCE INTERNATIONAL

KEYWORDS: Ecological niche modelling, MAXENT, AUC, climate change, land use

ABSTRACT

Ecological niche modelling has become a very important component in the management of natural resources. It has been used as a tool to assess the impact of both land use and environmental change on the distribution of species. This study focused on two of the major problems causing amphibian decline; climate and land use change. Three amphibian species found on the Island of Crete were modelled using Maximum Entropy Modelling (MAXENT). The specific objectives of the study are: 1) to determine the geographic distribution of Pelophylax cretensis, Pseudepideleaviridis and Hyla arborea using climatic variables 2) to determine the influence of land cover on the predictive power of habitat suitability models for P. cretensis, P. viridis and H. arborea 3) to assess the potential of predicting the distribution of the three amphibian species in the future based on climate and land cover change scenarios.

Four models were produced for each species in a “stepwise” combination of variables. This begins with the most basic of variables that include elevation and proximity to pond and ends with a model that includes climatic variables and land cover. The current species environment relationships were projected onto future climate and land use under three different scenarios of change. The current distribution models were evaluated with the Area under the Curve (AUC) and Cohen Kappa statistics. Analysis of Variance was used to establish significance between the means of the AUC and subsequently a pair wise comparison was used to determine which two means are different.

The results indicate that the distribution of the three species could be modelled with test AUC that is significantly better than random for all three species. Pair wise comparison of the models suggests that P. cretensis can easily be modelled with relatively high accuracy using just elevation and proximity to water variables. Results also show that land cover does not significantly increase the accuracy of models for P. cretensis and H. arborea; however it increased the AUC for P. viridis. Visual observation of maps produced for all three species suggest that P. cretensis occurs on the lowlands mostly along the coast whilst P. viridis and H. arborea seem to be widely distributed on Crete. Future distribution of all three amphibians suggests there will be some gains and loss of suitable habitats. However, results did not show the clear shift in range as reported by other researchers.

AIRBORNE LIDAR AND HYPERSPECTRAL INTEGRATED SYSTEMS IN SUPPORT OF SAVANNA ECOLOGY AND RESOURCE ASSESSMENT IN SOUTH AFRICA

MATHIEU Renaud1, CHO Moses Azong1, WESSELS Konrad1, ASNER Gregory2, ERASMUS Barend3, VAN AARDT Jan4

1. Council for Scientific and Industrial Research (CSIR) – Ecosystem, Earth Observation Unit, PO Box 395, Pretoria 0001, South Africa
2. Department of Global Ecology, Carnegie Institution for Science, 260 Panama Street, Stanford, CA 94305 USA
3. School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa
4. Center for Imaging Science, Rochester Institute of Technology, 54 Lomb Memorial Dr., Rochester NY 14623 USA

ABSTRACT

Savannas and woodlands cover half of the African continent. They provide many ecosystem services benefitting millions of generally poor people living in African rural environments and are critically important for food and energy security. Savannas are mixed grass - woody ecosystems, highly heterogeneous both in space and time – i.e. tree clumps of various heights and species mixes, with variable phenology influenced by patchy rainfall – which undergo mostly gradual changes, e.g. bush encroachment or thinning. This typical small scale
heterogeneity has traditionally hampered the application of remote sensing for monitoring these environments, and improving our understanding of change trends under the effect of key environmental drivers, e.g. land use, fire, large herbivory, as traditionally based on medium resolution satellite sensors (ca. 30 m).

In 2008 an experiment was initiated using the Carnegie Airborne Observatory (CAO) system which was flown in the Greater Kruger National Park area over various sites, totalling 35 000 ha, and including three dominant land tenure (i) state-owned conservation (Kruger National Park, Andover Provincial Reserve), (ii) privately-owned conservation (Sabi Sand Game Reserve), and (iii) state-owned communal lands (Bushbuckridge). The CAO Alpha system consists of two integrated sensors (i) a high fidelity Compact Airborne Spectrographic Imager (CASI-1500), and (ii) a LiDAR operated in discrete-return modes. The system provided 1-m resolution hyperspectral images (visible-NIR) and 3D canopy height models. LiDAR data were subsequently acquired in 2010 and 2012 for assessing woody structural changes.

The presentation will report on the key results of this experiment, and discuss these in the context of savanna's resource assessment and policy making. In particular, results will illustrate the benefits of this approach for i) characterizing the 3D pattern of woody vegetation and the effect of land use and management on structural diversity ii) assessing the effect of fuelwood collection on energy sustainability iii) mapping dominant tree species at canopy level using hyperspectral and structural “signature” iv) quantifying dynamic of tall trees (>5 m, keystone structure for biodiversity) in the various land use sites. Ongoing research towards the regionalization of structural and biodiversity ecosystem attributes using satellite-based high resolution sensors, e.g. SAR for woody structure, and WorldView-2 for tree species diversity mapping at canopy level, will also be illustrated.

ENVIRONMENTAL MONITORING OF GUIERS LAKE (SENEGAL) WITH MULTISENSORY, MULTITEMPORAL AND MULTiresolution EARTH OBSERVATION DATA

Souleye Wade, Seybatou Diop, Abdoul Jellil Niang, Charles Diedhiou, Suhyb Salama
1. Laboratoire de Télédétection Appliquée, Institut des Sciences de la Terre, Université Cheikh Anta Diop de Dakar BP 5396 Dakar-Fann (Sénégal).
2. ITC - Faculty of Geoinformation Science and Earth Observation, University of Twente, the Netherlands.

ABSTRACT

Guiers Lake Integrated Water Resources Management (GLIWaRM) is the Tiger project number 31. Its overall objective is to build up a geospatial information system dedicated to the integrated water resources management of the Guiers Lake. Specific objectives include: (i) assessment of spatial and temporal variability of water balance in conjunction with climate change; (ii) identification of water pollution sources to serve for further designing protective measures.

In most African countries, supply of drinking water to satisfy population needs is a key issue because of the general decline of groundwater levels, due to high pressure on the resource. To overcome groundwater deficit, Senegal turned, since the early 70s, to the exploitation of surface waters to supply big cities, including the capital Dakar. A great attention is attached to the control, monitoring and protection of the country water resources, with a particular emphasis on the need for integrated and sustainable management of the Guiers Lake water resources, the main surface fresh waters in the country, which supply for almost 40% of the daily needs of the region of Dakar.

The Guiers lake is located in northern Senegal, 20 km southwest of the city of Richard-Toll. It’s a flat lake below sea level, fed by Senegal River via the Taoué Channel. It is approximately 50 km long and 7.5 km wide at its widest point. It covers an area of nearly 200 km², with an average depth of 2 m.

The surrounding climatic conditions are arid, with an average annual precipitation of 250 -250 mm/yr, a mean annual air temperature of about 26°C. Winds are dominated by the north-easterly Saharan ‘Harmattan’.

The use of Guiers lake water resources is multiple: as urban water supply and for the Senegalese Sugar Company. Irrigated agriculture is also important and is dominated by private initiatives. In recent years, fishing generally practiced by local populations, has experienced a major revolution with the emergence of new hydrological conditions inducing freshwater and the stability of the lake water level.

About forty ENVISAT/MERIS full resolution (FR) level 2B images acquired from 2003 to 2010 were used in this study. The data were obtained under the ESA/Tiger Initiative. This temporal coverage (at least one image per season) is representative of the seasonal variability of climate and hydrological conditions of the Sahelian zone. Three important indicators of water quality parameters (wqp) which play a key role in water quality assessment
were investigated using available algorithms to retrieve concentrations of individual substances found in the lake waters, namely total suspended matter (TSM), yellow substance (YS) and chlorophyll-a (algal2). Data were processed and 3 types of results were obtained: (1) the annual means for each parameter; the monthly averages to monitor seasonal evolution (climatology) and annual and monthly trends obtained by linear regression. These results are expressed as concentration maps and analyzed in conjunction with reported data and prior to planned field trips. This kind of monitoring system means that pollution and ‘eutrophication’, where excess nutrients build up in the water, can be detected.

Another time series datasets of radar microwave ENVISAT/ASAR and optical Landsat (MSS, TM and ETM+) data are processed for landuse-landcover mapping, invasive aquatic vegetation monitoring, lake extent mapping. Generated maps are a valuable input to the environmental monitoring of the lake and constitute important components of the GIS under construction and dedicated to the integrated water resources management of the lake.

**LAND USE PLANNING AND PRECISE ENTERPRISE TARGETING USING GIS: A CASE OF A NEW RESEARCH FARM IN NIGERIA**

Oyedepo, J.A., Omotayo, A.M., Adesodun J.K. and Ajiboye
Federal University of Agriculture Abeokuta

**KEYWORDS:** Soil classes, Agricultural land uses, GIS

**ABSTRACT**

Agriculture as major form of land use, involve quite a number of enterprise namely; arable cropping, tree crop plantations rangelands, animal farms, aquaculture, and other agribusiness activities. Land use planning targeted at allocation of and suitable land resource to specific enterprise is a valuable factor that guarantees successful investment. Quite often Land-use planning requires complex decisions within a short period of time especially, when sustainable development, comparative advantage and economic competitiveness must be taken into account. At such instances, application of spatial decision support system tool such as the Geographic Information systems becomes relevant. The paper present an example of precise enterprise targeting in land use planning with the case of a new Agricultural research farm in Nigeria. Land Capability Evaluation system of the proposed research farm covering 2000 ha was conducted with USDA method using nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability to roots, excess salts, toxicities, and workability was adopted for the evaluation of the soils of IFSERAR farm. Base on ratings using these land qualities, the soils were classified into Arable capability classes (II and III) using the most limiting of these qualities. Therefore, most of the soils belong to the land capability class II and subclass Iw, IIs and Iwys, being limited either by stoniness (s), wetness (w) or both (ws). The most limiting soil quality in all the pedon except I and IV is the degree of surface and subsurface stoniness. Mapping units were created with GIS based on the pedons. The Pedons correspond to Mapping Units. Based on soil physical properties of these soils, engineering structures should be located within Mapping Units II, III, IV and V. Mapping Unit I was found to be the best for intensive arable farming. Overall water flow within these soils was very high since they exceed short-time rainfall intensities of 15-30 cm/hr typical for tropical storms. Soil chemical characteristics showed that the soils reaction ranged from slightly acid to slightly saline. Soil microbiological diversity indicated that species of Arthrobacter, Micrococcus, Bacillus, Pseudomonas, Streptococcus, Staphylococcus, Rhizopus, Fusarium and Aspergillus were common in surface soil (0-15 cm) and sub-soil (15-30 cm) of all the Mapping Units

**SHORELINE CHANGE MAPPING OF ANDONI AND BONNY BEACHES, NIGERIA USING GEOGRAPHIC INFORMATION SYSTEM AND REMOTE SENSING TECHNIQUES**

Ngerebara, O. D*; Aitsebaomo F. O**, Oduore T. B* and Gobo, A. E.*

*Geotechnical Division, Institute of Geosciences and Space Technology, Rivers State University of Science and Technology, P. M. B. 5080, Nkpoulu-Oworukwuo, Port Harcourt, Nigeria

**Nigerian Building and Road Research Institute, KM 10 Ota-Idiroko Road, P.M.B. 1055, Ota, Ogun State, Nigeria.
ABSTRACT
This study has been conducted to monitor coastal changes in Andoni and Bonny beaches of Nigeria over a period of time (1986 to 2004). Remote Sensing (RS) and Geographic Information System (GIS) along with satellite imageries of 1986 to 2004 were used to monitor and map out the changes. ERDAS IMAGINE 9.0, ArcGIS 9.2 and Arcview GIS 3.3 geo-referenced to geographic coordinates of Universal Traverse Mercator (UTM) of Minna Datum (Zone 32N) were used in this study. The result of the map derived from the study reveals those areas that were advanced or gained into the sea and retreat or lost to the sea. However, the area of either advanced or retreat of overlaid map was calculated and inputted into the relational database. The database was queried, using QUERY BUILDER (SQL) of ArcGIS 9.2 in order to group the polygons into advanced and retreat and the total sum of the area of the advanced (gain) and retreat (loss) were determined and the percentage gain or loss of land and rate were calculated for the overlaid maps. The result of the investigation showed that during the period 1986 and 2001, the shoreline shifted seaward for an area of 2,881.20 m² and landward for about 4,420.85 m², having a cumulative shoreline difference of about 1,539.65 m², which implies that 21.09% of land was lost within this period. Also, during the period of 2001 and 2004, the shoreline shifted seaward for an area of 3,646.18 m² and landward for about 17,167.01 m² with a shoreline difference of about 13,520 m², which implies that 64.96% of land was lost. The shoreline retreat within 2001 and 2004 was alarming compared to the amount lost between 1986 and 2001. It is therefore imperative that the methods of analyzing shoreline movement will need to take shoreline stabilization activities into account so that the documented trends and derived rates of change can be expressed in their proper context.

ASSESSMENT OF LAND-USE/LAND-COVER DYNAMICS AND IMPLICATION OF ENVIRONMENTAL REGULATION AROUND LAKE NAIVASHA, KENYA

Adegbite, A.A¹, Oladosu O.R¹ and Naliaka W.B²
¹ Centre for Space Science and Technology Education, Ile–Ife, Nigeria.
² Mount Kenya University, P. O. Box 562-20107, Njoro, Kenya.

KEY WORDS: Land-use/Land-cover, RS/GIS, Environmental regulations, Lake Naivasha, Kenya.

ABSTRACT
This paper examines the Land Use/Land cover (LULC) changes using Geographic Information Systems (GIS) and Remote Sensing (RS) techniques and implications of environmental regulations around Lake Naivasha, Kenya. The information about implication of environmental regulation around Lake Naivasha were gathered using Questionnaires and administer using focus group discussion. The study examines changes in LULC between the years 1986 – 2006. Result showed 1% reduction in area occupied by water body between 2000 and 2006, necessitated by human and natural activities impacted on spatiotemporal LULC variability. The study also confirmed that strict government environmental regulations on both domestic and non-domestic land-users around Lake Naivasha have provided the natural vegetation to regenerate 1% between 2000 and 2006, having lost 5% of the vegetation between 1986 and 2000. This result showed that certain progress have being made with environmental plans provided to regulate human activities around Lake Naivasha.

SEASONAL AND INTER ANNUAL VARIABILITY OF THE CHLOROPHYLL CONCENTRATION IN THE GULF GUINEA COASTAL ZONE USING SEAWIFS IMAGES

Éric Valère Djagoua¹, Pierre Larouche², Kouadio Affian¹ et Bachir Saley¹, ³
¹ Centre Universitaire de Recherche et d’application en Télédétection (CURAT), Université de Cocody, 22 BP 801 Abidjan 22, Côte d’Ivoire,
² Institut Maurice-Lamontagne, Pêches et Océans Canada, BP 1000, Mont-Joli, QC, Canada G5H 3Z4
³ Laboratoire des Sciences et Techniques de l’Eau et de l’Environnement (LSTEE), Université de Cocody, 22 BP 582 Abidjan 22, Côte d’Ivoire.

KEYWORDS: Chlorophyll concentration, Sea surface temperature, SeaWiFS, gulf of Guinea

ABSTRACT
The gulf of Guinea seasonal and inter-annual chlorophyll variability is analysed for the 1997-2004 time period using SeaWiFS and sea surface temperature images. Results show that the gulf of Guinea coastal zone is...
characterized by a large spatial and temporal variability of its physical and biological properties. The coastal regions of Guinea Bissau and Ivory Coast and in a lesser measure of Ghana are the only ones showing a classical behaviour linking coastal upwellings to higher chlorophyll concentrations. The Liberia coastal zone is characterized by an almost null inter-annual variability while the Nigerian and Gabonese coastal zones show no relation between chlorophyll and temperature. Many physical processes appear to play an important role in the biological response regions such as the Inter-Tropical Convergence Zone (ITCZ) that considerably modifies the winds patterns throughout the gulf of Guinea and the Atlantic El-Niño that modifies the water masses in the eastern equatorial region.

WATER MASS CLASSIFICATION IN THE MARINE ECOSYSTEM OF CÔTE D'IVOIRE: OUTLINE OF REMOTE SENSING OCEAN OPTICS DATA

Eric Valère DJAGOUA¹, Jeanne Maffoué KOUADIO¹, Cassandre Ziné DRO¹, Mireille BELLA¹, Jean Baptiste KASSI¹, Brice Abaka MOBIO¹, Kouadio AFFIAN¹,² et Simon BELANGER³

¹ Centre Universitaire de Recherche et d’application en Télédétection (CURAT), Université de Cocody, 22 BP 801 Abidjan 22, Côte d’Ivoire.
² Laboratoire de Géologie Marine et de Sédimentologie, U.F.R des Sciences de la Terre et des Ressources Minières, Université de Cocody, 22 B.P. 582 Abidjan 22 (Côte d’Ivoire)
³ Université de Québec à Rimouski (UQAR), 300, allée des Ursulines, C. P. 3300, succ. A Rimouski (Québec) Canada, G5L 3A1

KEYWORDS: Côte d'Ivoire, water masses classification, inherent optic proprieties (IOP)

ABSTRACT

The environment management, in the durable development, is necessary in our society (Jaquet, 1989). The coastal zones, restricted and fragile, were the strategic targets for the populations installed to establish their economic activities. In this condition, the populations and their activities such as fishery, agriculture, industries, etc influence water nature.

However, the monitoring of the coastal zones requires continuous and long-term observation. And remote sensing from satellite sensors is well adapted to the monitoring of this coastal. It is noted that the radiometric signatures of coastal waters mainly depend on three optically-active water components, namely yellow substance, phytoplankton and sediments, which are in highly variable proportions in space and time (Lahet et al, 2001).

Also, this paper will try to classify the water mass of the Ivorian marine ecosystem using the remote sensing inherent optic properties (IOP) or apparent optic properties (AOP) to determinate the origin of the constituents in the coastal water.

MAPPING OF MANGROVE FOREST LAND COVER CHANGE ALONG THE KENYA COASTLINE USING LANDSAT IMAGERY

¹Kirui, K.B., ¹Kairo, J.G., ¹Bosire, J., ¹Viergever, K., ²Rudra, S., ²Huxham, M. and ²Briers, R. A.

¹ Kenya Marine and Fisheries Research Institute, P. O. Box 81651, Mombasa, Kenya
² School of Life, Sport and Social Sciences, Edinburgh Napier University, Sighthill Campus, Edinburgh, EH11 4BN, UK
³ Ecometrica Ltd., Edinburgh

ABSTRACT

Mangroves in Kenya provide a wide range of valuable services to coastal communities despite their relatively small total area. Studies at single sites show reductions in extent and quality caused by extraction for fuel wood and timber and clearance for alternative land use including salt pans, aquaculture, and tourism. Such studies suggest that Kenyan mangroves are likely to conform to the general global trend of declining area but there are no reliable recent estimates of either total mangrove extent or trends in coverage for the country. The total extent of Kenyan mangroves was estimated at four points in time (1985, 1992, 2000 and 2010) using Landsat satellite imagery. Due to its medium resolution, Landsat may underestimate mangrove areas in Kenya where...
relatively small, linear, coastal features occur. There is also a high frequency of clouds in the coastal areas which can cause data gaps during analysis. However comparison with aerial photographs taken in 1992 showed satisfactory levels of accuracy (87.5%) and Cohen’s Kappa (0.54) validating its use in this context. These 1992 data provided an independently validated baseline from which to detect changes (fore- and hind-casted) in other periods after removing cloud coverage. We estimated total mangrove coverage in 2010 at 45,590 ha representing a loss of 18% (0.7% yr−1) in the 25 years between 1985 and 2010. Rates of mangrove loss for Kenya varied both spatially and temporally with variations possibly due to legislative inadequacies and differences in habitat alteration patterns. Hence freely available Landsat images proved adequate to detect changes in mangroves and revealed that Kenya shows rates of decline similar to (although slower than) global estimates.

**SPATIAL MAPPING OF WETLAND LOSS IN PARTS OF LAGOS COASTAL AREA**

Ivo Kashimana Amanda
Department of Geography, University of Lagos, Lagos Nigeria.

**KEY WORDS:** Coastal area, Wetland, Global change, Remote Sensing, Landuse/Landcover.

**ABSTRACT**

Wetlands are productive and dynamic systems of biological diversity supporting millions of people by related ecosystem services. As a major carbon sink, wetlands have been noted for balancing biogeochemical fluxes between the land surface and the atmosphere, thereby modifying the local climate. The distribution, pattern, and biodiversity character of this ecosystem have directly or indirectly been altered by changes in human systems. Multiple pressures from anthropogenic activities to satisfy socio-economic needs, especially in developing countries have further aggravated wetland losses. This paper utilized remote sensing technique for landuse/landcover (LULC) changes analysis for the study period covering 1970, 1990 and 2005 using aerial photographs (1970 and 1990) and satellite imagery (2005) to assess part of Lagos coastal wetland losses. The results show excessive built-up area and slum development activities encroaching on the coastal wetland thereby reducing the potential of wetland as a carbon sink system and its biodiversity functions.

**EVALUATION OF MERIS CASE-II WATER PROCESSORS FOR MONITORING OF WATER QUALITY IN THE SOUTH-EASTERN MEDITERRANEAN**

Wahid Moufaddal1 and Steve Groom2

1 National Institute of Oceanography & Fisheries (NIOF), Qayet-Bey, Al-Anfoushy, Alexandria, Egypt.
2 Plymouth Marine Lab. (PML), Prospect Place, the Hoe, Plymouth, PL1 3DH, UK.

**KEY WORDS:** MERIS satellite data, case-II water, correction processors, water quality, southeastern Mediterranean.

**ABSTRACT**

The present work investigates the performance of MERIS reduced resolution (level-2) satellite data and relevant Case-II water processors to monitor water quality parameters (chlorophyll-a and total suspended matter concentrations) in the southeastern Mediterranean north of the Nile delta for the purpose of deciding which processor provides the best performance and use for the production of water quality information in this area. For this purpose, three standard MERIS Case-II water processors are studied, compared and evaluated against contemporaneous in-situ measurements and sea-truthing data. These processors include: Coastal Case 2 Regional Processor, Boreal Lakes Processor, and FUB Processor. In addition, the effect of adjacency effects from land ICOL on the estimation has been analyzed and the retrieval of level 2 data was evaluated against sea-truthing data before and after ICOL processing. The work still in progress and no concrete results were received yet. However, the anticipated results are expected to show which processor is most effective for retrieval of accurate data on water quality parameters in the southeastern Mediterranean. Overall results are expected to contribute to improvement of MERIS level-2 products in regular monitoring of water quality in highly dynamic and turbid coastal areas.
UNE NOUVELLE APPROCHE BASEE SUR L'OBSERVATION DE LA TERRE ET LES SIG POUR L’EVALUATION DES IMPACTS DU RISQUE DE TSUNAMI SUR LA ZONE COTIERE DE RABAT SALE

ATILLAH, D. El Hadani, H. Moudni, C. Renou, O. Lesne, A. Mangin

RESUME
Dans le cadre projet européen SCHEMA (www.schemaproject.org), une méthode générique a été développée pour produire des cartes de dommages des bâtiments en cas de production du phénomène de tsunami sur la zone côtière de Rabat Salé (Maroc). La combinaison des résultats de la modélisation numérique des scénarios de tsunami, de l’observation de la terre, des enquêtes de terrain et d’outils SIG, a permis d’évaluer le risque de tsunami sur ce secteur côtier vulnérable. Trois scénarios potentiels de tsunami ont été modélisés pour estimer, d’une manière réaliste, les aléas de tsunami sur notre région : un pire scénario issu du cas du Séisme historique de Lisbonne de 1755, un scénario modéré lié au séisme du 28 février 1969 et un scénario produit par un glissement de terrain de l’île La Palma (Canaries). Pour chaque type de scénario, des cartes d’aléa tsunami ont été produites sous formes de hauteur maximale de vagues et d’extension maximale d’inondation. Par ailleurs, des cartes de classes de vulnérabilité des différents bâtiments à l’intérieur de la zone inondable ont été élaborées selon des critères de résistance intrinsèqués (primaire) et externes (secondaire), exploitant aussi bien les données de l’imagerie haute résolution et les observations sur terrain. L’approche finale est basée sur la combinaison des cartes d’aléa et de cartes de vulnérabilités, via une application SIG, pour produire des cartes de classes de dommages pouvant affecter chaque bâtiment en fonction de la hauteur d’eau reçue et du degré (classe) de sa vulnérabilité. Ces cartes de dommages vont servir comme document de base pour l’élaboration de tout plan d’évacuation approprié par la mise en évidence des secteurs à haut risque, des sites refuges potentiels et d’intérimaires d’accès, d’une part, et comme outil de planification pour intégrer les risques de tsunami dans la stratégie de l’aménagement du territoire et de la gestion côtière.

ANALYSIS OF MODIS SEA SURFACE TEMPERATURE ALONG THE COAST OF TANZANIA USING OPEN SOURCE SOFTWARE TOOLS

Yohanna W Shaghude1 and Valbory Byfield2
1. Institute of Marine Sciences, University of Dar es Salaam, P.O. Box 668, Zanzibar, Tanzania;
2. National Oceanography Centre, Southampton, University of Southampton, Waterfront Campus, European Way, Southampton SO14, 3ZH

ABSTRACT
Free and open source image processing and GIS software’s were used to investigate Sea surface temperature (SST) data from the coast of Tanzania with a view to developing a tool for predicting coral reef bleaching risk for use in future coral reef monitoring. The study is part of the Europe – Africa Marine Network (EAMNet) project, which aims to improve the capacity of African countries to use Earth Observation (EO) data for scientific studies and coastal and marine resource management. The study used time series of 1km gridded MODIS SST data (2007 and 2010) available from GEONETCast (a global direct broadcast dissemination system for near real-time and archive satellite data). Rapid cloud masking procedures of the high resolution MODIS data was attempted by defining minimum temperature threshold, obtained through the analyses of in situ data from the temperature logger at Chumbe reefs, on the western coast of Zanzibar. The analysis shows that the temperatures along the coast of Tanzania were generally highest towards the end of March, with the month of March having the highest maximum mean temperatures. Although the observed temperature trends were consistent with the data from the temperature logger as well as the global sea surface climatological data, the data quality was not sufficient enough to permit for the assessment of thermal stress along the coast of Tanzania needed for prediction of coral bleaching risks. Further perfectation of the methodology was attempted by comparing the high resolution MODIS data with high quality SST products from Operational Sea Surface Temperature and Sea ice Analysis (OSTIA), processed according to the international Group for High Resolution Sea Surface Temperature (GRHRSST) protocol. The later approach used the EAMNet SST data analysis algorithm. With this algorithm, the cloud contaminated pixels were scrutinized by defining threshold conditions and comparing the high resolution MODIS data with a reference OSTIA image, so that when a pixel in MODIS image is significantly colder than the corresponding pixel on the reference (OSTIA) image then that pixel is
masked as an invalid (cloud) pixel. The threshold conditions were defined using two different approaches, namely, a constant numerical threshold, or a series of thresholds, defined by the analysis error fields of the OSTIA data. Masking of the clouds using the analysis error fields revealed that maximum error fields were highest on shallow waters near the Tanzania Mainland and least in deeper waters, suggesting that cloud masking using a constant numerical threshold would not be the best approach for processing the SST MODIS data along the coast of Tanzania. Masking of the clouds using the analysis error fields was therefore adopted for the present study. The methodologies developed and described here are considered to be useful in future coral reef monitoring studies.

THE SCIENCE, PROGRAMMING AND CAPACITY BUILDING CHALLENGES OF GLOBAL NAVIGATIONAL SATELLITE SYSTEMS (GNSS) IN WEST AFRICA

Fabiyi O.O.¹, Ikhuoria I.A.¹ & Enaruvbe G.¹
Regional Centre for Training in Aerospace Surveys (RECTAS) Ile-Ife Nigeria

KEYWORDS: Global navigation satellites, Continuously Operating Geodetic Reference station, geospatial, West Africa

ABSTRACT
The geospatial community in West Africa is growing and now transcends the initial narrowly defined pure science based professionals to accommodate a wide range of practitioners in the human and life sciences. Though the requirements and the level of expertise of these new arrivals in geospatial disciplines differ, there is renewed quest for greater accuracy in horizontal and vertical measurements and velocity measurements and yet with less complicated techniques. The answer to this quest for precision and in measurements is GNSS.

The paper discussed the status of Implementation and deployment of GNSS resources in West Africa with particular reference to mapping and identified problems and prospects for active participations in GNSS programmes. It identifies the roles of strategic partnership i Organisational learning to advance knowledge creation and transfer in the sub region

THE DYNAMICS OF AGRICULTURAL LAND USE USING MULTI-SPECTRAL IMAGERIES IN SOUTHERN PART OF NIGERIA

Oluwagbenga O.I. ORIMOOGUNJE¹, Olusegun EKANADE¹, and Okwudili Endurance NDIDI¹
1. Obafemi Awolowo University, Department of Geography, Ile-Ife, Nigeria

KEY WORDS: Multispectral imageries, agricultural land use, environmental degradation, spatial change.

ABSTRACT
The study examined the factors influencing agricultural landuse change, the trend of spatial change and modeled the factors for detecting change in agricultural landuse in the Southern part of Nigeria. This was with a view to assessing the dynamics of agricultural landuse using multi-spectral imageries in the study area. The study integrated fieldwork and satellites imageries from Landsat Thematic Mapper (TM) 1987, Landsat Enhance Mapper (ETM+) 2002 and NigeriaSat-1 2007 couples with socio-economic survey to assess agricultural land use change in the study area. Digital image processing was carried out for satellite imageries. Spatial analysis was achieved using the ArcView (3.2), ArcGIS (9.2) and ILWIS 3.3 software packages. Spatial change in agricultural landuse from 1987 to 2007 was tracked from the classified imageries by digitization, overlay operations (by subtraction) and graphical displays. The trend of the change of each identified agricultural landusw type between the study periods was determined using cross operation of the ILWIS 3.3 software. The population for the study consisted of farmers in the 28 settlements in the study area, out of which ten settlements were randomly selected using the table of random numbers. Data collected were analyzed using descriptive and inferential statistics. The results showed the trend of changes in the study area, as arable farmland/shrub increased by 0.27% between 1987 and 2007 and decreased by 2.63% between 2002 and 2007, bare land decreased by 1.23% and 6.69% between 1987 and 2002, and between 2002 and 2007 respectively. Moreover, built-up area experienced increase by 3.8% and 9.39% between 1987 and 2002, and between 2002 and 2007 respectively. The forest region also experienced increase by 4.49% between 1987 and 2002 and 0.70% between
2002 and 2007. The plantation cover reduced by 3.15% between 1987 and 2002 and experienced an increase of 2.26% between 2002 and 2007. The results also showed that the factors responsible for the landuse changes were population increase (38.7%), rate of development (14.3%), fertility of the soil (19%), availability of roads (7.7%), encroachment into plantation and conversion of forest into farmland and settlement (3.0%) and expansion of crop land (17.3%). The study concluded that human activities were significant drivers that determined environmental degradation in the study area.

ESTIMATING CULTIVABLE AREAS IN CENTRAL AND SOUTHERN SOMALIA USING REMOTE SENSING

Ambrose S. Oroda\(^1\), Mary Cherono\(^1\), John M. Musau\(^1\), Simon M. Oduori\(^1\) and Zoltan Balint\(^1\)

1. Somalia Water and Land Information Management, Ngecha Road, Lake View. P.O Box 30470-00100, Nairobi, Kenya.

ABSTRACT

Somalia is largely a hot, arid and semi-arid country with rainfall amounts between 50 and 500 mm per annum. The prolonged civil war which culminated in the fall of the Somali Government in 1991 and the subsequent lack of a functional government led to a situation of dysfunctional public institutions. Consequently Somalia faces many environmental and socio-economic challenges including lack of up-to-date data for planning. Food and Agriculture Organization (FAO) is supporting smallholder farmers in the whole of Somalia but due to insecurity and accessibility difficulties, the information on agriculture in Somalia is based on oral tradition, assumptions, rough estimates and historical data. Most of these data are inaccurate and in a number of cases obsolete. To support FAO agricultural interventions, there is a need to know, based on actual data, the total cultivable land in Somalia, especially in the southern and central regions where agricultural activities are concentrated. To provide a first estimate of the cultivable land, this study analyzed ASTER satellite images (and where not available, Landsat images) for 2010 and 2011 to generate information about cultivation in central and southern Somalia. The overall objective of the activity was to provide a quick estimate of the potential cultivable area in central and southern Somalia using medium resolution remote sensing data (satellite images) with the help of the dot grid technique. The specific activities were two-fold and included generating a land cover map of the central and southern parts of Somalia, and the subsequent statistics on land cover and land use of the districts in the study area.

The study area comprises 36 administrative districts covering the central and southern parts of Somalia covering the Middle and Lower Jubba and Shabelle Rivers, which comprise the main agricultural areas of Somalia. The materials used included about 120 ASTER and 6 Landsat images. High Resolution aerial photographs were also used, particularly around irrigated areas along the rivers. The study also made great use of other spatial databases among which are the administrative boundaries, drainage, towns, settlements, and the road network data. It applied the Rapid Land Cover Mapper (RLCM) method, tool that applies a vector/raster hybrid approach to multiple resolution and time series mapping of land use and land cover (LULC) and many other geographical themes. The data obtained using the attributed dot grids were converted into geographical information system (GIS) databases comprising shapefiles for spatial data and attribute data tables that were exported to access and excel for analysis.

The results of this study which are the land cover types and their quantities in terms of hectares and square kilometres are summarised in the table below. These results will be the basis for a successive, more accurate analysis which will include sampling approaches and field validation (through FAO emergency staff and FSNAU monitors) in order to establish the potential cultivable land and estimate production for the different cropping systems at farmer and district levels. This information on cultivable land and cropping patterns will support decision making on agricultural programme design for different regions/districts bearing in mind the major agricultural production limiting factors among them land, labour, water, capital, farmer and market organizations. This information is also crucial for planning agricultural input distribution, cash for work and other interventions for both emergency and regular programmes. In addition, the information generated will help in crop production assessment at the end of each cropping season.

<table>
<thead>
<tr>
<th>Land Cover Type</th>
<th>Percent Cover</th>
<th>Area (Ha)</th>
<th>Area (km²)</th>
</tr>
</thead>
</table>

Summary of the results as obtained from the study.
CARTOGRAPHIE ET SUIVI DE LA DENSITE DES ARBRES DE L’ARGANERAIE (SUD-OUEST DU MAROC) A PARTIR DE DONNEES DE TELEDETECTION MULTI-SOURCES

Bernard Lacaze¹, Ahmed El Aboudi², Mbark Aouragh³, Micheline Hotyat⁴, Rachid Ragala⁴

¹CNRS UMR 8586, Pôle Image et Campus Spatial, Université Paris Diderot-Paris7,
²Faculté des Sciences, Département de Biologie, Rabat-Agdal, Maroc
³Université Paris Sorbonne, laboratoire Espace, Nature et Cultures (CNRS UMRS 8185)
⁴Université Paris Sorbonne, laboratoire LATES (CAMS EHSS-CNRS, UMR 8557)

MOTS CLES: Arganier, couvert arboré, télédétection, classification-objets, analyse diachronique

RESUME
L’arganier [Argania spinosa (L.) Skeels] s’étend actuellement sur une superficie d’environ 800 000 ha dans des zones semi-arides et arides du Maroc, où il joue un rôle crucial dans l’économie agro-sylvo-pastorale et constitue un rempart contre la désertification. Malgré la labellisation de la région en réserve de Biosphère UNESCO (1998), l’arganier est en régression à l’échelle régionale, en raison d’une surexploitation (surpâturage, exploitation excessive du bois, etc.), et, pour les zones de plaine, par l’extension des surfaces agricoles irriguées. En l’absence de cartographie précise de l’arganeraie et d’évaluation des changements survenus dans la période récente, nous proposons de tester l’utilisation de données de télédétection multi-sources à haute résolution spatiale pour la cartographie du couvert arboré et l’analyse diachronique de la densité de ce couvert.

La zone d’étude est située dans la région de Aït-Baha (30° 4’ 18” Nord ; 9° 9’ 42”Ouest) qui a fait l’objet d’une cartographie des groupements végétaux (El Aboudi et al., 1992). Les images-satellite utilisées sont les suivantes :
- Images IKONOS de 2003
- Images SPOT panchromatiques et multi-bandes de 2006
- Images récentes figurant dans Google Earth


Bibliographie
SUITABILITY ANALYSIS FOR RICE GROWING SITES USING A MULTICRITERIA EVALUATION AND GIS APPROACH IN GREAT MWEA REGION

Kihoro J.M, Njoroge J.B., Hunja M.
Jomo Kenyatta University of Agriculture and Technology, P.O BOX 62000 00200 Nairobi, Kenya

KEYWORDS: rice production optimization, bio-physical factors, climatic factors, GIS, land use variance.

ABSTRACT
Land suitability analysis is a prerequisite to achieving optimum utilization of the available land resources for sustainable agricultural production. Comprehensive, reliable and timely information on agricultural resources is very necessary for a country like Kenya, where agriculture is the mainstay of our national economy. Within Kenya, the demand for rice continues to grow as more Kenyans make changes in their eating habits, and as urban population increases but the production is very low. Lack of knowledge on best combination of factors that suit production of rice has contributed to the low production. The aim of this study was to develop a suitability map for rice crop based on physical and climatic factors of production using a Multi-Criteria Evaluation (MCE) & GIS approach. The study was carried out in Kirinyaga, Embu and Mberee counties of Central and Eastern province in Kenya. Biophysical variables of soil (soil pH, soil texture and soil drainage), climate (humidity and temperature) and topography were considered for suitability analysis. All data were stored in Arc GIS 9.3 environment and the factor maps were generated. For Multi-Criteria Evaluation (MCE), Pairwise Comparison Matrix was applied and the suitable areas for rice crop were generated and graduated. The current land use / land cover map of the area was developed from a scanned survey map of the rice growing areas in the region. According to the present land use/cover map, the rice cultivated area was 13,369 ha. Finally, we overlaid the land use/cover map with the suitability map for rice production to identify differences and similarities between the present and potential land use. However, the crop-land evaluation results of the present study identified that in the study area, 75 percent of total rice crop currently being used was under highly suitable areas and 25 percent was under moderately suitable areas. The results showed that the potential area for rice growing is 86,364 ha and out of this only 12% is under rice cultivation. This research provided information at local level that could be used by farmers to select cropping patterns and suitability.

DYNAMICS AND IMPACTS OF AGRICULTURE IN THE BRAZILIAN SAVANNAS (“CERRADOS”), USING REMOTE SENSING GEOTECHNOLOGIES

Antonio Roberto FORMAGGIO1, Kleber TRABAQUINI1, Rosana Cristina GRECCHI1, Gustavo Bayma Siqueira da SILVA2
1 Instituto Nacional de Pesquisas Espaciais – INPE (National Institute for Space Research)
Caixa Postal 515 - CEP 12227-010 - São José dos Campos - SP, Brasil
2 Embrapa Monitoramento por Satélite Avenida Soldado Passarinho, 303 - CEP - 13070-115 - Campinas - SP, Brasil

KEYWORDS: Savannas biome, Landsat, multitemporal data, agriculture impacts, sustainability

ABSTRACT
Brazilian Savannas biome occupies approximately two million of square kilometers in the Central portion of Brazil, representing 23% of the country’s extension and it is considered one of the hotspots in our Planet, that is a high-priority area for conservation. However, this important biome has become the object of great and accelerated demand for agriculture and cattle ranching activities since the 1970 decade, because it has favorable soils, reliefs, and climatic characteristics. Native vegetation was the main land cover affected by the human occupation process, with a conversion of approximately 40% of the original area by agriculture and cattle ranching activities. The model of agriculture development practiced in the Cerrados biome has been causing severe damages to the environment. Concomitantly with the replacement of native vegetation land cover, a number of consequences are occurring, such as the loss of biodiversity, the increase in soil erosion processes, the decrease of physical quality of the soils, alterations in the hydrologic cycle and increase in soil surface flow, with consequent loss in soil fertility, followed by silting up and eutrophication of rivers.
Thus, the understanding of land-use and land-cover changes and their environmental consequences have become increasingly necessary, especially with the accelerated velocity of changes and always increasing demands for land resources. However, there is still a lack of studies detailing the different aspects of the land-use and land-cover changes (e.g. rates, types, spatial patterns) in this important biome. Therefore, the objective of the present work was to study the dynamics of changes of anthropic activities in the Cerrado of central Brazil region, considering the last two decades (1990 to 2008), using remote sensing, in order to understand the processes of occupation that took place there, and also in order to evaluate the impacts of the human processes on the environment quality.

Our study area corresponded to the Cerrado biome contained within the limits of the State of Mato Grosso, with an areal extension of about 382.170 square kilometers, between the coordinates 10°00' and 18°05' South x 50°45' and 60°15' West. Twenty eight Landsat scenes (WRS orbits 223 through 229 x points 067 through 070 TM and ETM+) were used, considering the classes of changed areas: commercial crops, planted pastures, reforestation, urban areas, and mining areas. We used a free software developed by Brazil’s National Institute for Space Research, the SPRING-S System.

Because of the intense dynamics of agricultural land use in the area, these images showed some limitation in identifying the targets of interest during the classification process. Therefore, additional images from different dates or sensor were used according to their pertinence and availability. This included the use of Moderate Resolution Imaging Spectroradiometer - MODIS/Terra images. Ancillary datasets included a land-use and vegetation map elaborated by the Mato Grosso planning agency (SEPLAN), and a Landsat GeoCover dataset, provided by the Global Land Cover Facility. A field work was carried out in March 2008, and was designated for acquiring ground reference data for classification calibration and evaluation of the most recent land cover mapping.

In the segmentation phase, we used similarity value of 8 and for area the value of 64, and subsequently, image objects were classified using a supervised classification approach. In the sequence a vector-based edition was executed for obtaining modified and natural areas. In the modified areas the following classes have been considered: (i) agriculture; (ii) planted pasture; (iii) reforestation with pinus or eucalyptus; (iv) urban; and (v) degraded by mining. Multitemporal vegetation index (Normalized Difference Vegetation Index, NDVI) profiles were used for distinguishing pasture from summer crops, using a threshold defined empirically.

Concerning to the amount of modified areas versus the natural vegetation, we observed in the first considered period of time (1990 – 2001) an increment of 43 thousand km2, while in the second period (2002 – 2008), an increment of about 17 thousand km2. The north region presented the highest rates of anthropization. Haplustox (USA Soil Taxonomy) class of soil, occupying about 39% of the study area, followed by the Quartzipsamment class (28% of the area), both totalizing more than 50% of the anthropized soils. The main cultivated crops were soybean (~80%), cotton (~12%), and maize (~8%). Millet, sorghum and corn are used as second crops in rotation with the main crops, and the planted pastures covered areas with more sloping terrains. The overall accuracy obtained was 86% (kappa 0.79) for annual crops and pasture assessed separately, increasing to 93% (kappa 0.87) if pasture and crops are combined as “agricultural use”.

The results indicated that most of the changes in vegetation cover, by the year 2001, occurred in areas of Wooded Cerrado, Oxisols and plan relief, but increased the use of soils related or close to the drainage network. The spectral analysis allowed to separate three classes of vegetation: i) anthropic vegetation; ii) Cerrado with a predominance of forest types; and iii) Cerrado with a predominance of savanna types. This study revealed that important changes took place in the area studied, and the changes were more accentuated in the first period, but the changes continue to progress in the direction of loss of natural vegetation and increase in agricultural areas, but at a lower rate. The annual crops dominated the changes and are the main land cover in the studied area, encroaching into more fragile lands and pasture areas reducing due to conversion to crops, more than from natural vegetation replacement.

Landsat and MODIS imagery were reliable tools for understanding the anthropic transformations that have taken place in recent decades in the central Brazilian savanna regions, specially for unveiling the patterns, rates, and trends of land-use changes. Discussions about the change detection used technics are provided. This study provides the foundation for further understanding of the impacts of these massive changes on the environment.
DES INDICATEURS PAYSAGERS ISSUS D’IMAGES SATELLITES POUR SUIVRE LA DYNAMIQUE D’OCCUPATION DES TERRES EN ZONES ARIDES A UNE ECHELLE LOCALE

Eric Delaître², Aziza Ghram Messedi¹ et Anne-Elisabeth Laques²
1. Laboratoire de Cartographie Géomorphologique des Milieux, des Environnement et des Dynamiques (CGMED), FSHST
2. Institut de Recherche pour le Développement (UMR Espace-dev)

MOTS-CLES : occupation des terres, dynamique des paysages, indicateurs spatialisés, télédétection, SIG, Tunisie, Basses Plaines Méridionales Orientales

RESUME
Depuis les années 70, les zones arides tunisoises évoluent à la fois sous l’impact des actions anthropiques et au rythme des fluctuations climatiques. Le milieu naturel subit donc d’importantes transformations induites essentiellement par les changements des pratiques agro-pastorales. Cela se traduit essentiellement par la régression du couvert végétal et l’augmentation de l’intensité des processus d’érosion, pouvant mener à la désertification. Pour faire face à ces menaces, les différents décideurs locaux ont besoin d’aide pour gérer au mieux leur territoire.

L’objectif visé dans le travail présenté est de contribuer à la mise au point d’une méthode de suivi de l’occupation des terres basée à la fois sur des données de terrain et sur des images satellites (Landsat-TM). La démarche engagée propose d’évaluer l’occupation des terres à partir d’indicateurs spatialisées issus de l’écologie du paysage, calculés à partir d’un SIG. L’application de ces indicateurs paysagers dépend de la problématique étudiée : artificialisation d’un milieu naturel, risque d’érosion...

C’est dans la région naturelle des Basses Plaines Méridionales Orientales que se situe notre cas d’étude, à travers les territoires de trois petites régions. L’étude de l’occupation des terres à travers des indicateurs paysagers calculés sur plus d’une décennie montrent une certaine diversité dans leurs évolutions malgré leur proximité. L’analyse de ces différentes dynamiques montre le rôle important que joue le milieu physique (topographie, morpho-pédologie, hydrologie) sur l’organisation spatiale des pratiques agro-pastorales.

Ce type d’indicateurs spatialisés peut aider les aménageurs à mieux intervenir pour une gestion optimale et une préservation des ressources naturelles, dans le cadre d’un développement durable.

DESSERTISATION EN ALGERIE: UN ETAT DES LIEUX DANS LA WILAYA DE NAAMA

I, Haddouche¹, S, Saidi² and K, Benhanifia³
1 Argo-Forestry Department, SNV-STU Faculty, Tlemcen University, BP 119, Algeria,
2 CIRAD, Montpellier, UMR Tetis Baillarguet, France,
3 Centre des Techniques Spatiales, Arzew, Algeria,

MOTS-CLES : Télédétection, Evolution diachronique, Désertisation, Algérie.

RESUME
En Algérie, la végétation steppique a fortement régressé, couvrant autrefois une partie importante de ces zones et est exposée aux effets néfastes de l’homme et à des conditions écologiques et climatiques agressives. Cette tendance à la dégradation de la végétation steppique est attestée par un ensemble de travaux de recherche sur ces milieux. Une démarche cartographique à l’aide de l’outil «Télédétection» a été retenue comme support d’application à une région aride, située au cœur des hautes plaines steppiques Sud Oranaises.

L’utilisation des nouvelles approches, pour mesurer les états de dégradation à travers des analyses spatiales afin d’entreprendre de réelles options de gestion pour ces milieux devenus très fragiles et exposés au phénomène de la désertisation, reste incontournable.

Cette étude s’intéresse à la caractérisation de la désertisation par l’analyse de l’évolution diachronique, qui traduit mieux la réponse environnementale aux changements climatiques et aux pressions anthropiques. Elle aborde volontairement l’ensemble des facteurs relatifs à la problématique de la dynamique des paysages. Pour ce faire, nous nous sommes basés sur une approche méthodologique multisource et une analyse spatiotemporelle intégrant plusieurs indicateurs, qui nous ont permis d’évaluer l’état de ce phénomène. Les traitements appliqués aux données télédéctectées sur la région de Naâma ont mis en évidence les changements qui ont affecté le secteur étudié et les caractéristiques du milieu écologique. L’étude diachronique par les
images satellitaires optiques à bi-dates et de capteurs différents (TM de Landsat et XS de SPOT) nous a permis de faire des mesures de surfaces de la couverture du sol, entre deux prises de vues (par digitalisation et seuillage). On note que le taux de recouvrement de la végétation, entre moyen et fort, est passé de 39% à 7% de la zone entre 1987 et 2007. Cette régression est expliquée par l’augmentation du taux de recouvrement de végétation faible (< 30%) et les sols nus qui sont passés de 61% à 93%. Les traitements des images satellitaires ont mis en évidence une dégradation généralisée du couvert végétal qui accélère le processus de la désertisation dont l’impact socio-économique se traduit par la baisse de la production agricole et la réduction des espaces pastoraux, autant de facteurs qui alimentent l’exode rural massif vers les villes déjà surpeuplées comme Mècheria, Nàama et Ain-Sefra. Autant, les résultats du diagnostic écologique, par la biomasse combiné à la carte pluviométrique, nous a permis une caractérisation de la productivité par le CEP. En plus des zones à productivité nulle (des surfaces désertifiées), cet indicateur nous a révélé que plus des 2/3 de la superficie touchée par l’étude présentent des zones à faible et à très faible productivité, aboutissant à des CEP inférieurs à l’unité, allant de 0,5 – 3 kg ms/ha/an/mm (végétations dégradées par un surpâturage intense et prolongé).

**OBSERVATION PAR LES IMAGES SATELLITES DES IMPACTS DU TRANSFERT DE LA GESTION FORESTIERE AUX COMMUNAUTES DE BASE : CAS DE LA COMMUNE DE DIDY, REGION D’ALAOTRA-MANGORO MADAGASCAR**

Rakotoniaina S.¹, Rakotomandrindra P. ¹, Ranaivoarimanana S. ¹, Rakotondraompiana S. ¹

1. Laboratoire de Géophysique de l’Environnement et Télédétection, Institut et Observatoire de Géophysique d’Antananarivo (IOGA), Université d’Antananarivo, BP 3843, Antananarivo-101, Madagascar

**MOTS-CLES** : suivi, télédétection, analyse multitemporelle, transfert de gestion, forêt, tavy

**RESUME**

Dans le cadre d’un projet de gestion durable des ressources naturelles pour la conservation des régions hotspot de la biodiversité à Madagascar, le projet COGESFOR (Conservation et Gestion des Écosystèmes Forestiers Malgaches) et l’Institut et Observatoire de Géophysique d’Antananarivo (IOGA) ont collaboré ensemble. Les objectifs principaux du projet sont de produire d’une part des cartes multidates de l’occupation du sol et d’analyser d’autre part l’évolution temporelle de cette dernière (détection des changements) au cours des dates prises comme des références afin d’évaluer l’efficacité du programme de transfert de la gestion forestière aux communautés de base. Le site d’étude est la commune de Didy, dans la région d’Alaotra-Mangoro, centre Nord de Madagascar. Les images satellitaires utilisées ont été celles acquises par le satellite Landsat TM 5 de résolution spatiale de 30 mètres à trois dates espacées de 5 ans (1994, 2001 et 2009). Les descentes sur terrain ont été effectuées au cours de l’année 2011 avec pour objectif de relever les points GPS relatifs aux vérités-terrain correspondant aux différentes catégories d’occupation du sol existantes et de mener une enquête auprès de la population locale sur l’historique de l’environnement forestier dans leur zone. Les différentes catégories d’occupation du sol retenues sont les suivantes : forêt, savoka, tavy, zéra, rizière, savane, lac/rivière et sol nu. En plus de ces différentes classes, on a considéré aussi les classes nuages et ombre dans le cas où ces dernières sont présentes dans l’image. Les vérités-terrain acquises ont été divisées en 2 groupes : le premier en tant que parcelles d’apprentissage pour entrainer l’algorithme de classification et le second en tant que parcelles de contrôle pour valider les résultats de classification. Les images acquises à différentes dates ont été tout d’abord soumises à des corrections atmosphériques. Les classifications d’images qui ont été effectuées à partir des six bandes originales (à l’exception de la bande thermique) de chaque image multispectrale de Landsat ont été ensuite réalisées à l’aide de la méthode de classification non paramétrique SVM (Séparateur à Vaste Marge). Enfin, le module LCM (Land Cover Modeler) du logiciel de traitement d’images Idrisi a été appliqué à nos images classifiées pour détecter les différents changements apparus sur les occupations du sol entre les différentes dates considérées. Une approche d’aménagement concerté global a été définie, testée et mise en œuvre dans le site à travers de ce qu’on appelle organes de Transfert de Gestion (TG). Pour évaluer les actions entreprises au sein des TG au cours des trois années d’étude, deux principaux indicateurs écologiques ont été examinés : les surfaces nouvellement forestées et les surfaces brulées (correspondant surtout à la classe ‘tavy’). La transition des classes vers la classe ‘forêt’ indique ainsi un apport positif des organes de transfert de gestion (TG) sur la conservation des zones forestières et celle vers la classe ‘tavy’ une évaluation de la dimension de l’exploitation des terrains par la population locale (défrichement). Les résultats statistiques montrent en général une nette diminution des surfaces forestières avant l’installation des TG dans la commune de Didy (2001) et une forte augmentation de ces surfaces après installation des TG (soit...
FOREST COVER CHANGE ASSESSMENT USING LANDSAT AND SPOT DATA: A CASE STUDY OF TANGAZA FOREST RESERVE, NORTH-WEST OF SOKOTO STATE, NIGERIA

N.B. Eniolorunda¹, A.G. Bello²
¹. Geography Department, Usmanu Danfodiyo University, Sokoto. Research Interest: Remote Sensing, GIS and Environment
². Forestry and Fisheries Department, Usmanu Danfodiyo University, Sokoto.

KEYWORDS: Forest Reserve, Desertification, Global warming, Green house gas, Carbon sink

ABSTRACT
Tangaza forest reserve is one of the forest reserves in the northern Nigeria aimed at checking desertification. However, it is reportedly undergoing rapid degradation due to encroachment of human activities. The assessment of forest landscape change is a necessity for improved forest management, desertification prevention planning and decision-making. The study therefore aimed at assessing and predicting the dynamics of the forest reserve. Remote sensing technique was used in this study where 1986 and 2005 Landsat data and 2007 SPOT data were processed and analyzed within the Idrisi Andes and ArcGIS environments. With maximum likelihood supervised classification method preceded by unsupervised classification and ground truthing, five classes namely bare surface, shrub/grass, tree/shrub, forest and cultivated land were derived at 88% degree of accuracy. Descriptive statistical tools were used to assess changes between both dates. Also Markov-Chain was used to predict 2020 land covers. Results showed that between 1986 and 2005, bare-surface expanded by 1,033% and will further expand by 15% in 2020. The shrub-grass expanded by 55% and will expand by 17.2% in 2020. Tree-shrub reduced by 42% between 1986 and 2005 and will further reduce by 13.3% in 2020. Cultivation expanded by 271% between 1986 and 2005 and will marginally expand by 0.01% in 2020. The forest cover reduced by 66% between 1986 and 2005. The class will further shrink by 48% of its size in 2005 by the year 2020. Also, between 1986 and 2005, 23.5% of the forest got converted into bare surface, 18.8% into tree-shrub, 11.8% into shrub-grass and 10.5% into cultivation. The study concluded that the area will continue to undergo forest degradation in the face of perpetual human activities without corresponding forest management. Public enlightenment, tree planting, establishment of cattle ranches, improved farming practices, reduction in kerosene price and enforcement of forest management were recommended.

DETERMINATION OF VEGETATION CHANGES DUE TO WORLD BANK AFFORESTATION PROJECT IN DESERT ENCROACHED AREAS OF JIGAWA STATE, NIGERIA USING REMOTE SENSING TECHNIQUES

*T. Garba, **I.D. Choji and *** Taiwo O.Qudus
*Environmental Management Technology Programme, Abubakar Tafawa Balewa University Bauchi, Nigeria
**National Policy and Strategic Studies Kuru, Nigeria
***National Remote Sensing Centre Jos, Nigeria

ABSTRACT
The Federal Government of Nigeria and World Bank funded aorestation project aim at combating desertification between 1988 and 1996. This research integrates Remote Sensing and Geographic Information System Techniques (GIS) to assess changes in vegetation between 1986 and 2007 in the study area. To achieve that Normalized Difference of the Vegetative Index (NDVI), Land use land cover map imageries and sliced image all derived from landsat TM 1986, landsat ETM 1999 and Nigeria sat 1 2007 were used to determine changes in vegetations. From the Classified imageries it was discovered that there were more natural vegetation in classified images of 1986 than that of 1999 and 2007. The figures in the three histogram also indicted that there is increased in vegetative areas from 29.15 Km² in 1986, to 60.58 Km² in 1999 and then to
109 Km² in 2007. The projects indicated that there annual grow rate of 4.5km² per annum between 1986 and 1999 and 13.11 km² per annum between 1999 to 2007. The study recommends among other things that there is need to restore natural vegetation that was encouraged by farming activities of the study area which will also complement the function of the project. The study concludes that there is a positive change in vegetation in the study area due to the project which signifies success on vegetative changes of the project especially between 1999 and 2007 perhaps after the full maturity of species of trees used in the project.

**GLOBAL HOTSPOTS OF INVASION IDENTIFIED FOR OPUNTIA CACTI USING CONSENSUAL MAPPING**

Mhosisi Masocha¹ and Andrew K. Skidmore²

1. Department of Geography and Environmental Science, University of Zimbabwe, Box MP 167, Mount Pleasant, Harare, Zimbabwe
2. Department of Natural Resources, Faculty of Geo-Information Science and Earth Observation, University of Twente, Box 6, 7500 AA Enschede, The Netherlands

**ABSTRACT**

In the “Day of the Triffids”, invasive carnivorous plants eat humans on a global scale. Opuntia cacti are less threatening, but are known invaders of rangelands threatening native biodiversity and reducing rangeland productivity and economic output worldwide. While the consequences of cacti invasion are well documented, little is known about the potential for invasive cacti species at a global scale. Predicting areas at risk of alien plant invasions on a global scale and preventing their introduction increases opportunities for combating invasion, especially through tightening quarantine requirements as well as active management control in the early stages of invasion. The aim of this paper is to identify regions susceptible to potential co-invasion by 4 cacti of the Opuntia genus as well as to demonstrate a new method for mapping co-invasion risk of multiple species with a similar invasion risk profile. Three modeling techniques namely the generalized additive model, generalized boosted regression model and maximum entropy were used to create ecological niche models for four invasive cacti species: Opuntia ficus-indica, Opuntia fulgida, Opuntia imbricata and Opuntia stricta. These four Opuntia cacti have all been identified as problematic invasive species in many rangelands where they contribute to loss of native biodiversity and undermine rangeland productivity. Models were calibrated using geo-referenced occurrence data points from both the native and introduced ranges and subsequently projected onto the geographic space to predict worldwide potential distribution maps and assess invasion risk across countries using a newly developed method we term consensual mapping. The potential consensual maps obtained from the ensemble modeling technique indicate that Opuntia cacti have the potential to invade savannas of southern Africa, east Africa, Australia as well as Mediterranean ecosystems. Fifteen countries including South Africa, Zimbabwe, Spain, and Greece were predicted to be at greatest risk of invasion. The main limitations for the application of species distribution modeling in managing cacti invasion are discussed.

**MODELLING THE DISTRIBUTION OF GLOSSINA SPP. IN THE NORTH WESTERN PARTS OF ZIMBABWE USING REMOTE SENSING AND CLIMATE DATA**

F. Matawa¹*, K.S. Murwira1 and W. Shereni²

1. The Geo-information and Remote Sensing Institute of the Scientific and Industrial research and Development Centre (SIRDC), 1574 Alpes Road, Hatcliffe Extension, Harare, Zimbabwe
2. The Tsetse Control Division, Department of Livestock and Veterinary Services, Ministry of Agriculture, Mechanisation and Irrigation Development, P.O. Box CY52, Causeway, Harare, Zimbabwe

**KEY WORDS**: Remote Sensing, Maximum entropy, Glossina Morsitans, Glossina Pallidipes, Area under the curve (AUC), jackknife, WorldClim

**ABSTRACT**

For managing vector borne diseases, Earth Observation and Geo-information Sciences are adding the crucial component of spatial extrapolation from ground observations. For monitoring tsetse flies (Glossina spp.) the
maximum entropy (Maxent) technique was used to map their distribution based on remotely sensed vegetation cover and elevation as well as temperature and rainfall data derived from WorldClim datasets. In particular, the habitats of Glossina morsitans and Glossina pallidipes were modelled. The main aim was to model the distribution of Glossina spp. in relation to environmental factors such as vegetation cover, elevation, rainfall and temperature variables. The long-term normalised difference vegetation index (NDVI) was used to estimate vegetation cover and the Shuttle Radar Topography Mission (SRTM) digital elevation model was used to estimate elevation. Georeferenced tsetse observation data was collected by the Tsetse Control Division of the Ministry of Agriculture, Mechanisation and Irrigation Development of Zimbabwe. The data was collected at different times spanning the wet and dry seasons in different parts of the study area. A presence-only method, the maximum entropy (Maxent) technique, was applied to model the tsetse distribution. The results of the jackknife of variable importance show which factor contributed the most in defining the outcome of the G. morsitans as well as the G. pallidipes model. The models for both G. morsitans and G. pallidipes have an area under the curve (AUC) greater than 0.9. Therefore, it can be concluded that the distribution of Glossina spp. can be modelled with remotely sensed vegetation cover and elevation as well as climate data.


RANOELIARIVAO S. (1),*, RAKOTONDRAOMPIANA S. (1), RAKOTONIAINA S. (1,2): FARAMALALA M. (3)

1. Remote Sensing and Environmental Geophysics Laboratory, Institute and Observatory of Geophysics Antananarivo (I.O.G.A), University of Antananarivo, Madagascar
2. Department of Physique, Faculty of Sciences, University of Antananarivo, Madagascar
3. Department of Plant Biology and Ecology, Faculty of Sciences, University of Antananarivo, Madagascar.

**KEYWORDS:** Evolution, forest cover, Landsat TM images, Zahamena.

**ABSTRACT**

The aim of this study is to detect forest cover change in Zahamena National Park using multispectral and bi-temporal optical images. In other words, we want to show the contribution of using optical images in land cover mapping and monitoring. This study is an advantage for Zahamena National Park because it is classified in the World Heritage. Our study area is located in the East central of Madagascar, between Alaoitra – Mangoro, Analajirofo and Antsinanana regions. Since our study area presents an exceptional biodiversity in terrestrial ecosystem (dominated mainly by tropical wet forest), two Landsat Thematic Mapper (TM) images of 1993 and 2005 are used to analyze forest cover evolution in 12 years. They were respectively acquired in April, 08 1993 and March, 25 2005. The used bands were TM1 to TM7 bands, except TM6. They have 30 m of spatial resolution. In addition to these images, some biometrical data were collected on the field in 2008. In this study, thirteen land cover classes (including three forest classes) were considered: dense evergreen forest, degraded dense evergreen forest, eucalyptus, crops, rice fields, meadow, savannah, bare soil, swamp, turbid water, clear water, clouds and shadows. First, geometric and atmospheric corrections were applied to the images to allow them to be in the same condition of processing. Then, the two Landsat images were independently classified using Maximum Likelihood (ML) algorithm and taking into account of the biometrical data and land cover classes. This algorithm was chosen because it allowed us to obtain the best accuracies compared to other algorithms that have been tested. For the image classification, sampling to obtain the training and validation plots was performed by block: the selection considers all pixels in each drawn plot as samples. This selection was realized in taking into account of the geographical coordinates of the land cover classes obtained on the field by GPS. The training plots were used to drive the learning phase and the validation plots were used to validate the classified images models. To assess the land cover classes change, especially the forest cover classes change, a change detection method named post-classification comparison technique were applied to the classified images. This method compares the classified images pixel by pixel, minimizes impacts of atmospheric, sensor and environmental differences between multi-temporal images and provides a complete matrix of change information.

The classification result shows that the overall accuracies corresponding to 1993 and 2005 classified images are respectively equal to 92.31 % and 91.58 %. The corresponding values of Kappa coefficient are respectively equal to 0.91 and 0.90. For the 1993 classified image, the accuracies of dense evergreen forest, degraded
dense evergreen forest and eucalyptus are respectively equal to 98.82 %, 74% and 63.16%. For the 2005 classified image, they are respectively equal to 98.31 %, 62.20 % and 87.69%.

The matrix of change shows that in 12 years, 20.30 % of the dense evergreen forest are degraded and 9.63 % are transformed into crops. The change from degraded dense evergreen forest to crops is marked by a significant percentage of 51.07 %. It is also changed into meadow and savannah with respective percentages of 9.21 % and 3.78 %. A percentage of 4.39 % characterizes the regeneration of degraded dense evergreen forest into dense evergreen forest. The eucalyptus are transformed into savannah and crops with respective percentages of 28.40 % and 25.55 %. According to these change results, we notice that the three forest cover classes are generally transformed into crops. An increase of crops fields means an increase of the number and needs of the population around the study area. This situation is coherent to the demographic data of Alaotra – Mangoro and Analanjirofo regions between 1993 and 2006. In fact, the population growth rate of the two regions are respectively equal to 3.11 % and 3.20 % that are higher than the national population growth rate (2.5 %). Human activities have major influence on the Zahamena tropical wet forest.

As this study is only limited for 12 years, the forest cover change modeling will be the future step to be achieved.

**PROBA-V BELGIAN MISSION satellite: Global PRODUCTS FOR VEGETATION MONITORING**

Wouter Dierckx², Iskander Benhadj³
1. VITO, Remote Sensing, Mol, Belgium;

**ABSTRACT**

**Introduction**

PROBA-V is a new global vegetation monitoring mission, scheduled for a VEGA launch in 1st Quarter of 2013. PROBA-V is capable of global coverage within two days and designed to deliver user quality products at 1/3 km and 1km spatial resolution.

To support the existing SPOT-VEGETATION user community, PROBA-V has been developed to ensure a continuity with the heritage SPOT-VEGETATION mission. Aside from the better spatial resolution, PROBA-V is designed to achieve a consistent performance with respect to that of SPOT-VEGETATION.

PROBA-V continues to provide daily Top Of Canopy (TOC) synthesis (S1) and ten days synthesis products (S10). In addition, the new Top Of Atmosphere (TOA) daily synthesis products and radiometrically corrected rawdata (L1C) products are foreseen for scientific users.

**System specifications**

After its successful maiden launch on February 13 2012 [1], VEGA has been confirmed as the official launcher for PROBA-V scheduled for early 2013. This settles the orbital specifications for the mission. PROBA-V will follow a sun-synchronous orbit at 820 km ensuring a swath width of 2250 km. This allows daily coverage from +75° to -56° latitude, aside from equatorial zones. Full global coverage from +75° to -56° latitude is guaranteed every 2 days.

PROBA-V takes advantage of the advanced small satellite technology of the PROBA series developed by QinetiQ Space NV. PROBA-V will fly a very compact and lightweight wide swath instrument consisting of three Three-Mirror-Anastigmatic (TMA) cameras (necessary for global coverage), each equipped with blue, red, near-infrared line detectors and an array of staggered short-wave infrared (SWIR) detectors. The 4 spectral bands of the payload are made similar to those of VEGETATION. This guarantees the goal to continue supply of global vegetation data for the very active community of users currently working with VEGETATION data [2].

**User products**

The products of PROBA-V are very similar to the standard VEGETATION products, to ensure data continuity towards the user community.

With its collection of standard products, PROBA-V continues to provide daily synthesis (S1) and ten days synthesis (S10) products. These contain ground reflectance values, with best-quality and cloud free data selected for the composite time period. In addition, users can request S1-TOA products, containing values with no atmospheric correction applied. Synthesis products are available at two spatial resolutions: a lower resolution of 1km as in VEGETATION products, and a higher resolution of 1/3 km.

A fourth standard product is the radiometrically corrected rawdata (L1C) product, adapted for scientific applications requiring highly accurate physical measurements such as mapping, cloud/ice snow detection and atmospheric correction. Customized products can also be ordered by users. This will be handled by request, starting from the long-term archive of L1C data.

**105**

**9th AARSE International Conference, El Jadida, Morocco, October 29-November 2, 2012**

*Earth Observation & Geo-information Sciences for Environment and Development in Africa: Global Vision and Local Action Synergy*
To serve the needs of the Scientific User community, the retrieval of higher Level (Level 4) products such as basic biophysical variables, is also envisaged. Terrestrial Essential Climate Variables, mainly LAI, fAPAR and surface albedo, will be made available to environmental and agricultural services aiming to assess biomass, carbon and water fluxes. Therefore the GMES Land Service aiming to continuously monitor and forecast the status of land territories will be supported by the “Third Party Mission” PROBA-V. In brief, PROBA-V is meant to be part of the palette of sensors/platforms which shape the GMES Space Component.

Conclusions
As the follow-up for the VEGETATION mission, PROBA-V comfortably meets the requirements for a 1km-product while maintaining good performance for a 1/3km product. Standard synthesis products are available like for VEGETATION. To accommodate non-standard processing requests, an archive of L1C data will be maintained. Higher Level PROBA-V products such as biophysical parameters will support the EU GMES programme. PROBA-V will be part of the GMES Space Component and feed appropriate data into the GMES Land Service.

References

ASSESSMENT OF SPATIAL DISTRIBUTION OF TREE RESOURCES OUTSIDE FOREST IN RELATION TO DIFFERENT LAND USE SYSTEMS USING GIS IN SHYORONGI SECTOR, RULINDO DISTRICT, RWANDA

Jean Nduwamungu1 and Angelot Gashumba1
Geographic Information Systems and Remote Sensing Training and Research Centre, National University of Rwanda (CGIS-NUR) Loiret Building, P.O.Box 212 Butare, RWANDA

ABSTRACT
Rwanda is a small country densely populated in Central-East Africa. The economy is mainly dominated by agriculture where more than 90% of the population are involved in subsistence agriculture. As a consequence, the farming lands are highly fragmented in small pieces of lands owned by smallholders. In this context most forestlands have been deforested and most forest products are currently obtained from tiny private woodlots and trees scattered on farmlands. These tree resources outside forest (TROF) are becoming more and more important for sustainable development of the country because they provide a number of forest goods and services therefore reduce the pressure on remaining forest resources. For example, since the ban of harvesting public forests in 2006, most of the fuelwood needs (mainly charcoal and firewood) in Rwanda are currently met through harvesting of these private tree resources outside forest. Hence, there is a need to make strategies for proper management of TROF. However, in order to formulate appropriate policies for sustainable management of TROF, there is dire need to gather information on TROF quantity, species richness and distribution in different land use systems. This paper reports on a study aimed at assessing the spatial distribution of TROF in relation to different land use systems. The study was conducted in one administrative sector and consisted in collecting data on types of land uses, TROF basal area, number of trees and species richness per hectare and the extent of human disturbance to TROF which was expressed in terms of number of tree stumps per hectare. An Ikonos multispectral image of July 2007 was used to determine different land use classes using ERDAS IMAGINE 9.2 and a land use map for the study area was prepared using ArcGIS 10. Field data were collected using a Stratified Systematic Cluster Sampling method with random start in the field. A one-way ANOVA test was used to test whether there were significant differences between selected parameters. Duncan’s multiple range tests were also carried out to explore which land use system had significant mean compared to the others. The results show that the pasture land use system registered the highest TROF basal area (8 m2/ha), number of trees (123 trees/ha) and species richness (25 species/ha). The highest number of tree stumps (38 stumps/ha) occurred in cropland meaning that TROF are more harvested in cropland than in other land uses either for domestic use or for agricultural purposes (e.g. farm cleaning and mulching). Therefore, on farm tree planting schemes along with improved agroforestry technologies and
adequate TROF silvicultural management activities should be initiated on croplands in the study area and scaled up on other sectors with similar socio-economic and ecological conditions.

**DISCRIMINATING INCREASER SPECIES IN MOUNTAINOUS RANGELAND DEGRADATION USING HYPERSONTICAL DATA RESAMPLED TO WORLDVIEW-2 AND Hymap RESOLUTION**

Khalid Mansour¹ and Onisimo Mutanga¹
1. University of KwaZulu-Natal, School of Agricultural, Earth & Environmental Sciences, Geography Department, P/Bag X01, Scottsville, Pietermaritzburg, 3209, South Africa.

**KEYWORDS:** Increaser species; rangeland degradation; random forest algorithm; field spectrometer measurements; WorldView-2 data; HyMap data.

**ABSTRACT**
Mapping and monitoring indicator species in mountainous rangeland is critical for better understanding the condition of the rangeland and levels of rangeland degradation. The objective of this study was to investigate whether canopy reflectance spectra, resampled to HyMap and WorldView-2 resolution could discriminate four increaser species representing different levels of rangeland degradation. Canopy spectral measurements were taken from the four indicator species: Hyparrhenia hirta (HH), Eragrostis curvula (EC), Sporobolus africanus (SA), and Aristida diffusa (AD). The random forest algorithm and a forward variable selection method were applied in order to identify optimal variables (HyMap and WorldView-2 wavelengths) for discriminating the species. Results revealed that the optimal number of wavelengths (n = 8) and (n = 6) that yielded the lowest OOB error (15.82%) and (17.36%) for HyMap and WorldView-2 respectively in discriminating among the four increaser species. The random forest algorithm could discriminate species with an overall accuracy of 84.1% (KHAT = 0.79) using 8 HyMap wavelengths and an overall accuracy of 82.9% (KHAT = 0.77) using 6 of the WorldView-2 wavelengths. Overall, the study demonstrated the potential of the HyMap and WorldView-2 data for mapping indicator species of rangeland degradation.

**MODELLING THE ACCESSIBILITY OF WOODY BIOMASS DERIVED FROM ALOPS PALSAR RETRIEVALS IN COMMUNAL WOODLANDS - A CASE STUDY OF WELVERDIEND VILLAGE, MPUMALANGA, SOUTH AFRICA**

C. Paradzayi¹ and H. J. Annegarn¹
Department of Geography, Environmental Management and Energy Studies, University of Johannesburg, Johannesburg, South Africa

**KEYWORDS:** SAR, ALOS PALSAR, full polarimetric, scattering mechanisms, woody biomass, fuelwood

**ABSTRACT**
Rural folk spend a much time collecting fuelwood to meet their domestic energy needs. The task is mundane and the collectors mostly use footpaths and tracks to reach the woodlands. We used full polarimetric ALOS PALSAR retrievals to map woody biomass resources available for fuelwood extraction in communal savanna woodlands around villages in the Mpumalanga Province of north-eastern South Africa. However, not all available woody biomass resources are accessible. We used a combination of unsupervised and supervised classification regimes to identify the eight major terrain scattering mechanisms present in full polarimetric retrievals. Five of these mechanisms are closely related to scattering from woody vegetation, enabling the mapping of above ground woody biomass. An application of these maps is developed in the form of a model to determine ‘least-cost’ routes from selected villages and households to selected woodlands. The model takes into account the constraints imposed by land tenure systems and geophysical conditions to estimate travel times and effort for fuelwood collectors. The model identifies accessible woody biomass resources on relatively flat surfaces and excludes woodlands within 30 m wide buffer zones along water courses. Furthermore, the model generates maps indicating woodlands at risk of over exploitation by ranking the vulnerability according to travel times from village centres.
ASSESSMENT OF VEGETATION COVER CHANGES IN NIGERIA USING REMOTE SENSING TECHNIQUE

Fashae¹, Olutoyin A, and Uko¹, Emmanuel
¹ Department of Geography, University of Ibadan, Nigeria

ABSTRACT
Like many African countries, Nigeria is concerned with vegetation cover assessment. The primary goal of this study is to utilize time series satellite data to develop a reporting system for assessing and monitoring vegetation change in Nigeria at different scales from country level to the level of individual states, and local government areas within the country.

The converted AVHRR monthly time-series data for 1981-2000 were used for historical NDVI analyses. In all, a total of 212 images were analyzed for the study. The correlation analyses were done between Normalised difference Vegetation Index (NDVI) data from Advanced Very high Resolution Radiometer (AVHRR) and spatially distributed rainfall data obtained from the Nigeria Meteorological Agency (NIMET).

The NDVI and rainfall data was found to be correlated (r=0.6). Additionally, ndvi-rainfall associated with one month time lag showed rainfall event induced vegetation growth in subsequent periods. Highest ndvi-rainfall correlation was obtained for vegetation types in rainfed crops.

The results show that during the study period there was about 23,901 sqkm loss of vegetation out of a total area of 923,773 sqkm and a 7 day back trajectory analysis using the HYSPLIT model showed that dust haze from the Northern Africa is deposited in the northern part of Nigeria thereby causing dryness to vegetation cover while moist air from the Atlantic Ocean is transported to the southern part of Nigeria thereby giving increase in NDVI value.

Finally, this study reveals the contribution of satellite remote sensing to long term observation of the intra and inters annual variability of vegetation in Nigeria.

CONTRIBUTION OF THE SATELLITE IMAGES AT VERY HIGH SPATIAL RESOLUTION FOR THE MODELING OF BIOMASS IN TROPICAL RAINFOREST: THE CASE OF COMPLEX OF PROTECTED AREAS ZAHAMENA, MADAGASCAR

RAKOTOMALALA, F. ¹; RAKOTONIAINA, S. ¹; RAKOTONDRAOMPIANA, S. ¹; ROGER, E. ²; FARAMALALA, M., H. (²)
1- Institut & Observatoire de Géophysique d’Antananarivo. Université d’Antananarivo (Madagascar)
2- Département de Biologie et Ecologie Végétales, Faculté des Sciences. Université d’Antananarivo (Madagascar)

KEYWORDS: forest biomass, classification images, satellite images, high spatial resolution, Zahamena

ABSTRACT
Ecological and thematic studies have been conducted in the rainforest Zahamena of Madagascar. The purpose of these studies is to quantify biomass in the tropical rainforest by using satellite imagery at high spatial resolution (VHSR). The results of this work will contribute to the development of methods and strategies for sustainable management of tropical forests especially those of Madagascar. The work was funded by the French Institute for Biodiversity project (IFB) and the Agence Universitaire de la Francophonie (AUF).

Our region of study is located in the Complex of Protected Areas Zahamena, in the rainforest Atsinanana, which was classified as world heritage site in 2007. It is located in the Eastern part of Madagascar, which straddles the administrative regions: Alaotra-Mangoro Analanjirofo and Atsinanana. It lies 20 km from Lake Alaotra and 50 km from the Indian Ocean. This area is representative of the ecosystem and land cover of the protected area of West Zahamena. There are two basic types of plant formations in this site: forest formations and grassy formations. Two types of bioclimate exist in the region: the perhumid climate for altitudes below 800 m and the wet climate above 800 m.

The image used in this study was acquired on September 18, 2008 by the sensor High Resolution Geometric (HRG) for Satellite Earth Observation (SPOT-5). This image has a spatial resolution of 10 m for the multispectral mode, with the green channels (XS1), red (XS2), near infrared (XS3) and middle infrared (XS4). For the panchromatic super mode, the resolution is 2.5 m. A merging of these channels was accomplished in order to get simultaneously the spectral information from the multispectral channels with a geometrical accuracy of the
panchromatic channel. The method adopted is that of Gram-Schmidt Spectral Sharpening, proposed by the Free Software Orfeo Tool Box (OTB). Four synthetic channels XS1, XS2, XS3 XS4 with 2.5 m resolution are then obtained. The neo-channels (vegetation index and brightness) and textures used for the image classification have been deducted from these channels. The object-oriented classification method using the Maximum Likelihood algorithm was chosen to realize the map of the vegetation type. The medium texture of the first principal component and the contrast of the XS3 channel were combined with multispectral channels for the classification. In order to know the organization of the plant community in the area of study, we used the survey method recommended by phytosociological Braun-Blanquet. This method enables the evaluation of the floristic richness, species diversity, plant density and the distribution of individuals by diameter, height, basal area and biovolume in a plot of 0.1 ha.

The result of the image classification shows that the vegetation of the Complex of the Protected Areas of West Zahamena is characterized by moist evergreen dense forest of medium altitude or FH and of sclerophyllous foliage or FS. The overall accuracy of the classification obtained is close to 90%. The ecological surveys which are carried out on five parcels of our site show that the canopy height varies from 15 to 33 m. Vegetation with lesser height belongs to FH class and is observed on a ridge of 1417m of altitude. The values of diversity index of Shannon and Weaver range from 4.98 to 3.03. The highest values, measured on the ridge and upper slope are explained by the edge-effect and also by the opening of the area of the FS class. The highest vegetation was found in FH class at an altitude of 1376 m and 1336 m. In addition, individuals with diameter less than 30 cm exist with a relevant proportion. The density of individuals having diameter of breast height or DBH ≥ 10 cm is 1000 to 1550 individus.ha⁻¹. The highest density was found in the FS and on the ridge. Also the individuals having a diameter <20 cm contributed to this high density. Basal area ranges from 20.1 to 58.5 m².ha⁻¹ and the biovolume from 45.8 to 449.6 m³.ha⁻¹. The low potential in trees was observed on the low vegetation of the ridge belonging to the FS class. The highest biovolume was found on lower slopes of the FH class, which is mainly due to the presence of some species with large diameter and also of large size trees. Biomass and carbon stocks vary respectively from 7.84 to 41.04 m³.ha⁻¹ and from 15.67 to 82.08 t.ha⁻¹. The lowest value was recorded on low vegetation of the ridge in the FS class, while the highest value, at fairly high vegetation of the FH class on the low hillside.

A study on the same area using a LANDSAT image with 30m resolution, shows only one FH class; and the overall classification accuracy is 80%. One can thus deduce the advantage of using a high spatial resolution image to estimate forest biomass.

**UTILISATION DES PARAMETRES GEOMORPHOLOGIQUES ET DES INDICES SPECTRAUX POUR LA CARTOGRAPHIE DE L’EROSION HYDRIQUE DANS LA ZONE MONTAGNEUSE DE LA REGION DE KSIBA (HAUT ATLAS DU MAROC)**

* B. Bachaoui*, S. Maimouni*, R. Lhissou*, M. Bachaoui*, A. El Harti*, A. Boudhar* et A. Ghmari*
*Université Sultan Moulay Slimane, Faculté des Sciences et Techniques de Béni Mellal, Equipe de Télédétection et SIG Appliqués aux Géosciences et à l’Environnement, BP. 523 Béni Mellal

**MOTS-CLES**: Haut Atlas central, érosion hydrique, indices spectaux, indices géomorphologiques, AMC.

**RESUME**

Au Maroc, le phénomène d’érosion hydrique est l’un des problèmes qui entrave le développement économique et social en général et agricole en particulier. Selon certaines études, environ 12 millions d’hectares de terres de cultures et de parcs sont menacées par l’érosion hydrique. Ce phénomène présente en plus, un impact majeur sur la pollution diffuse dans les cours d’eau, sur l’envasement des barrages et sur la destruction des infrastructures hydrauliques. Face à cette situation et afin de promouvoir le développement durable, il est nécessaire de mettre au point des outils permettant de cartographier les aires exposées aux risques d’érosion hydrique. Pour ce faire, plusieurs modèles hydrologiques à base physique ont été développés, les plus connus et les plus utilisés sont l’équation universelle de perte de sol USLE et sa version modifié RUSLE. Toutefois, le concept de développement de ces modèles expérimentales est adapté à des zones présentant des pentes uniformes, faibles à modérées ce qui explique que l’application de ces modèles reste limitée voire non adaptée à des zones à topographie complexe comme le cas de notre zone d’étude. Pour cela, plusieurs approches basées sur la télédétection et les systèmes d’informations géographiques (SIG) ont été développées pour caractériser la dégradation des sols en particulier dans les milieux arides à semi-arides.
La zone d'étude de Ksiba, se trouve dans la région de Tadla-Azilal dans le Haut Atlas central marocain. Il s'agit d'une zone montagneuse dont les altitudes oscillent entre 950 et 1140 mètres à climat semi aride et à pluviométrie moyenne annuelle de 550 mm. L'objectif de l'étude consiste à cartographier les zones à risque d'érosion hydrique en utilisant des paramètres géomorphologiques et des données image du capteur TM+ de Landsat. Nous avons exploité le gradient et la forme de la pente ainsi que les indices spectraux de forme (IF), de coloration (IC) et de végétation NDVI. Tous Ces variables ont été classifiés et standardisés pour une intégration adéquate dans un environnement SIG pour des analyses multicritères (AMC). En accordant différents poids à ces variables, plusieurs scénarios d'érosion ont été testés tenant compte particulièrement des caractéristiques des sols et de leur degré de sensibilité aux processus d'érosion. Cette analyse nous a permis de valider un scénario plus proche à la réalité de terrain qu'on peut généraliser dans la zone montagneuse dans la région Tadla/Azilal. Ce travail constituerait une base pour une meilleure planification de stratégies appropriées et d'interventions adéquates pour contrer les effets de la dégradation du sol et renforcer la conservation des ressources en sol et en végétation.

MULTI-TEMPORAL IMAGE CLASSIFICATION AND CHANGE ANALYSIS OF LAND USE/COVER OF A REGION IN SOUTH-WESTERN NIGERIA

Nathaniel Olugbade ADEOYE
Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria

KEYWORD: Multi-temporal image data; image classifications; land use/cover; southwestern Nigeria

ABSTRACT
Different types of land use/cover have a major impact on natural resources thus; land use information at catchment scale has an important role to play in developing effective solutions to natural resource management issues. This paper describes the methods and results of classifications of multi-temporal image data of a region in southwestern Nigeria for Landsat MSS 1978, SPOT XS 1986, 1994 and NigeriaSat_1 2003. The image data were georeferenced to the same coordinates system, resampled and enhanced for visualization in a GIS environment. Six communities with distinct characteristics were identified and selected for ground truthing to validate the tonal values recorded in the images with the features on the ground. The result of ground truthing was combined with visual image interpretation as training sites for supervised classification. Eight different land uses were identified and used to classify the image data. The overall results of classification accuracies were 76%, 67%, 61% and 72% for Landsat MSS 1978, SPOT XS 1986 and 1994 and NigeriaSat_1 2003 respectively. The classifications analysis shows that the amount of urban or developed land increased from 0.79% to 1.60% of the total area between 1978 and 2003 while forest resources decreased from 60.40% to 14.44%. All other land uses/cover exhibited changes over time and space. In conclusion, the study shows a systematic understanding of changes in land use and land cover, which is critical to the understanding of the ecosystem functioning and services, and human welfare.

THE DEVELOPMENT OF A LAND COVER CHANGE MONITORING SYSTEM FOR PROTECTED AREAS IN SUB-SAHARAN AFRICA

Zoltan Szantoi 1, Andreas Brink 2, Dario Simonetti 3
1European Commission - Joint Research Centre Institute for Environment and Sustainability, TP 440, 21027 Ispra (VA), Italy, Tel.: +39 0332 783656, Fax: +39 0332-789960, 2European Commission - Joint Research Centre Institute for Environment and Sustainability 3Reggiani SpA, European Commission - Joint Research Centre Institute for Environment and Sustainability

ABSTRACT
The need for protected areas monitoring is increasingly important as the natural landscape, biodiversity and resources are under continuous and ever increasing pressure. The European Union pledged significant contribution toward conservation and the management of protected areas in developing countries, especially...
in Sub-Saharan Africa. The Convention on Biological Diversity declares in its Aichi Targets the monitoring and assessment of status and trends of protected areas as a key priority.

Assessment of land cover/land use change, particularly deforestation and fragmentation, are essential for planning and managing protected areas and in understanding the dynamics of their surroundings. Additionally, a monitoring system would be able to identify the key questions for long-term decisions, evaluate the current and future values, status and threats of these areas. In response to this need, the European Commission’s Joint Research Centre (JRC) is developing a semi-automatic approach, which would detect land cover/use change from the 1990’s to 2010 and beyond, using medium to high-resolution satellite data, as derived from the Landsat and DMC sensors. The system consists of necessary pre-processing stages, such as radiometric calibration, cloud and cloud shadow masking, topographic correction using Shuttle Radar Topographic Mission’s digital elevation data (90m), de-hazing, mosaicing of images and radiometric normalization. A stratified topographic correction method was developed principally for this application, where the algorithm accounts for not only the changing elevation but for the heterogeneous land cover as well, the other preprocessing steps are based on and improving the method developed within the JRC’s Tropical Ecosystem Environment Observation by Satellites (TREES3) project. The TREES3 project’s aim was to determine deforestation rates over the global tropics over the time period 1990-2000-2010. This work was done in support to and in collaboration with the Remote Sensing Survey of the Forest Resource Assessment 2010 of the Food and Agriculture Organization.

In this study, we describe first the development of the pre-processing steps of the semi-automated method. Subsequently, several protected areas, mainly national parks, and their buffer zones are mapped and the changes in the past 20 years are recorded and presented. The selection of parks for this initial study was based on the following criteria’s: a) the location representing different environmental and climatic characteristics and vegetation types and b) the indicative land cover change results from the TREES3 project over sub-Saharan Africa showing areas of high or low dynamics and therefore pressure on the protected areas. The following land cover classes based on the legend of the TREES3 project were differentiated to map the protected areas and their 20 km buffer zones: (1) tree cover over 70%, (2) tree mosaic between 30 and 70%, (3) other wooded land, (4) other land - non woody land cover such as herbaceous, pasture and crop, (5) bare or artificial (6) water and (7) cloud and shadow. Finally, multi-date segmentation and automatic classification was applied on Landsat and DMC images over the 1990-2000-2010 periods in order to identify changes.

The detected land cover dynamics are presented as change detection maps for the selected parks with different levels of change, and quantitative results reveal specific information on tree loss, vegetation degradation, fragmentation and agricultural expansion or in some cases reforestation throughout the studied years. The detected changes in these areas are then discussed within the framework of tropical deforestation, habitat loss, trends in these protected areas, agricultural intensification and urban development.

**APPORT DE THR SPOT DANS LA CARTOGRAPHIE FINE DE L’OCCUPATION DU SOL DANS ET A LA PERIPHERIE DE LA FORET TROPICALE HUMIDE. COMMUNES DE LA REGION HAUTE-MATSIATRA–MADAGASCAR**

Andrianarivo A.1,2, Laques A.-E.1,3, Delaître E.1,3, Hervé D.1,4
1. Projet Forêts, Parcs et Pauvretés dans le Sud de Madagascar,
2. Département de Géographie, Université d’Antananarivo - Madagascar
3. IRD UMR 228 ESPACE-DEV,
4. IRD UMR 220 GREDA,

**MOTS CLES** : occupation du sol, THR, texture, indices, classification orientée objet.

**RÉSUMÉ**

Le couloir forestier de Fianarantsoa, un échantillon de la forêt qui couvrait tout l’Est malgache, est localisé au Centre-Est et Centre-Sud des Hautes Terres Centrales de Madagascar. Il relie le Parc National (PN) de Fandriana–Marolambo et la Réserve Spéciale du Pic d’Ivohibe. La forêt qui le compose est principalement une forêt dense humide sempervirente, de basse altitude – série à Anthostema et à Myristicaceae – et de moyenne altitude – série à Weinmannia et à Tambourissa (Humbert & Cours Darne, 1965) –, se trouvant le long de l’escarpement oriental. La forêt prend la forme d’un couloir (d’où son appellation) d’une longueur de 400 km et dont la largeur maximale est de 50 km. Ce couloir forestier, dénommé par l’arrêté interministériel n° 16 071-2006/MinEnvEF/MEM du 15 septembre 2006 « Corridor forestier Ambositra-Vondrozo : COFAV », est doté d’une protection temporaire le classant parmi les Nouvelles Aires Protégées dans la catégorie VI de l’UICN.
ASSESSING LAND COVER CHANGE AROUND A BIOSPHERE RESERVE: IMPLICATION FOR SUSTAINABLE MANAGEMENT OF PROTECTED AREA IN WEST AFRICA

Laurent G. Houessou1, Oscar S. Teka1, Anne Mette Lykke2, Brice Sinsin1
1. Laboratory of Applied Ecology, Faculty of Agronomical Sciences, University of Abomey-Calavi, 01 PO Box 526 Cotonou, Benin Republic.
2. Department of Bioscience, Aarhus University, Vejlsoevej 25, DK-8600 Silkeborg, Denmark

KEYS WORDS: Spatial analysis, Landsat images, Deforestation rate, Land cover conversion

ABSTRACT

Biosphere Reserves are targeted as the worldwide strategy of biological conservation. They have been found to be effective in preventing habitats and ecosystems destruction within their borders. However, the current global land use intensification involved extensive loss of vegetation cover around the reserves and increase their vulnerability and their ecological isolation. The overall objective of this study was to assess the trends of land covers change in- and outside the W Biosphere Reserve in Benin as well as the driving forces of land cover change in order to provide tools for its sustainable management. For this purpose, two serial times of Landsat images (TM 1995 and ETM+ 2006) were processed and allowed establishing the land covers map of the area in 1995 and 2006. Socioeconomic surveys based on structured interviews were conducted with 240 households in 8 villages around the reserve. Findings showed that 80.4% of the respondents were aware of land cover conversion around the reserve. Land clearing for crop production, tree logging, settlement and grazing were quoted by the household as main drivers forces inducing land cover change around the reserve. Temporal map analysis showed that the woodland and savanna vegetation were converted to croplands at a deforestation rate of 34.66 % outside the reserve while woodland and savanna vegetation covers increase for 1.05% inside the reserve. Probability transition matrices of land cover showed a high probability of woodland and savanna vegetation to be changed into cropland outside the reserve. This highlighted the persistence of vegetation degradation around the reserve in the coming years.
Our study revealed the relevance of remote sensing data with socioeconomic data to assess land cover change around a Biosphere Reserve in development countries. The high rate of land forest cover conversion into cropland around the W Biosphere Reserve highlighted the importance of the development of urgent action to reduce the ecological isolation and vulnerability of the protected area.

APPLICATION OF DATA MINING TECHNIQUES TO CHARACTERIZE AND ASSESS LANDSCAPE DYNAMICS IN THE EAST AFRICA REGION

Jeniffer Kinoti Mutiga¹, Andrea Heinemann², Kaspar Hurn², Cornelia Hett³, and Boniface P. Kiteme¹
1. Center for Training and Integrated Research in ASAL Development (CETRAD), P.O. Box 144 – 10400, Nanyuki, Kenya.
2. Department of Geography, University of Bern, Hochschulstrasse 4, CH-3012 Bern, Switzerland.

KEYWORDS: Urban Sprawl, Urban Agriculture, Agricultural productivity, Ile – Ife

ABSTRACT
In this paper we describe a methodology for mapping land cover types as a means for characterizing and assessing the landscape dynamics with the east Africa region. The main objective of this study is to perform LU dynamics analysis in the area and develop a methodology on how this could be replicated in similar areas in the African continent.

Well-corrected 250-meter MODIS time-series data (specifically NDVI and EVI products) for the year 2001 to 2010 covering our study area were used. Topographic features such as sinks, clouds, shadows were used to mask areas in order to minimize spectral confusion.

A 16-day revisit with spatial resolution of 250m MODIS products were used to generate the land use land cover information using Vector Support Machine (VSM) classification technique as the main data mining technique applied. EVI data particularly enabled us to calculate predictor variables that describe vegetation phenology and other temporal variation within pixels.

Annual land cover types from 2001 to 2010 were evaluated and compared. Reflectance values were extracted for various classes covering the study area using training areas extracted from high resolution images in Google Earth complemented by ground observations. The results indicate that temporal satellite data at annual interval is suitable to address the seasonal variability particularly in the agricultural lands. The classification algorithm developed during this study is able to exploit the temporal variation in target spectral properties satisfactorily in similar regions for upscaling purposes.

URBAN SPRAWL AND URBAN AGRICULTURE IN ILE-IFE TOWNSHIP, OSUN STATE, NIGERIA

Joseph OLOUKOJI¹, Raphael O. OYINLOYE², Felicia A. SETON
Regional Centre For Training in Aerospace Surveys (RECTAS)
Obafemi Awolowo University Campus, Science and Technology Park, Off Road 1, Ile-Ife Nigeria

ABSTRACT
The present paper aims at assessing the effects of urban expansion on the farmlands in Ile-Ife Township and appraises the changes that occurred in the landscape from 1986 to 2008. It has been observed that the increase in population of Ile-Ife has led to the changes in the land cover trough the conversion of the peri-urban vegetation and farmlands to built-ups in order to meet the accommodation needs of the rapidly increasing population. The conversion is presently affecting the supply of food stuff thereby making food items to be very expensive. Therefore the land cover needs to be properly identified and mapped to support meaningful planning for future food security.

To detect the changes, the study made use of information extracted from Landsat TM 1986, ETM+ 2002, and ALOS 2008. The GPS observations of the existing farmlands around the town were overlaid on the topographic map and on the satellite imageries in order to appraise the changes in the land use and land cover over the period.
The change detection analysis revealed that buildings have occupied what used to be farmlands. The demand for land parcel has gone up. This has led to increased value and cost of the land parcels. Land speculators are fast seizing the opportunity to make business. Many cases of land dispute were noticed during the field data collection. To curb this situation in the study area, education through awareness programmes will be needed for the people and local authorities.

A DIACHRONIC STUDY ON THE URBAN GROWTH OF DAKAR AND ITS IMPACTS

By DIALLO Ngagne
Msc in GIS and Cartography, Senior Cartographer and Gis analyst, Cadastre of Senegal, BP 43 14 Dakar-Senegal

KEYWORDS: urban management system (UMS), space technology, remote sensing, Geographical information system (GIS).

ABSTRACT
Urban evolution is a situation that concerns a very significant problem in today’s world. There is a rapid growth in urban areas especially in coastal regions due to many factors depending on the specificity of each country. Such situation often times have both socio-economic and environmental implications. Therefore, studies in the field of urbanisation which incorporates socio-economic and environmental factors for good town planning using space technology, geographical information system (GIS) and cartography in cities are of utmost importance. Studies of this nature are lacking in most African countries and are necessary for the improvement of the quality of life.

Dakar the capital of Senegal and a major city in the West-African coastal region was used as a case study. It has a population of 2,275,351 inhabitants representing 51 % of the national population. Studies have revealed that Dakar has the highest urban change in Senegal due to better basic infrastructure compared to the hinterland. The aim of the paper is to demonstrate how GIS techniques, cartography and high resolution remote sensing data can be incorporated into a decision support tool for utilization in urban management system (UMS) The urban management issues considered in solving some of the present problems posed by rapid urbanisation include, proper allocation of habitation zone and well defined data infrastructure. The analysis further explains the expected results and suggests some re-orientation in the application of urban management system.

REMOTE SENSING FOR MAPPING LAND USE CHANGES IN THE CITY OF SEKONDI-TAKORADI, WESTERN REGION OF GHANA

Michael Soakadan Aduah
Department of Geomatics Engineering, University of Mines and Technology, PO BOX 237, Tarkwa, Ghana

KEYWORDS: change detection, land use/land cover, Landsat, remote sensing, Sekondi-Takoradi

ABSTRACT
Land use/land cover influences a variety of processes on the Earth surface which also generate feedback affects on the natural environment, economic and social systems. Poorly managed changes in urban areas have resulted in many catastrophic consequences such as floods, landslides, droughts etc. The Landsat satellite system has long term data archives and can be used to assess the land cover changes in the landscape to provide information to support future urban planning. In this paper Landsat images were used to map the landcover/land use changes in the city of Sekondi-Takoradi in the Western region of Ghana from 1988 to 2011 through a change detection process. The post-classification method of change detection was used and the accuracies achieved were high. The analysis showed that a large portion of the city and its surrounding areas has been converted from natural surfaces to impervious surfaces. Also it was observed that precipitation has reduced considerably during the period and high temperatures have been observed. A model developed between land use change and time have showed that in the next 50 years if the trend of land use change continues, there will be complete removal of natural surfaces. These could lead to increased incidence and severity of flash floods and droughts. Therefore the data produced in this study can be used to guide effective
urban planning to mitigate the combined effects of land use changes due to urbanization and climate change. This study demonstrates the critical role remote sensing can play in the developing world in terms of providing data for planning since many countries do not have the resources to map their territories regularly through conventional means.

**HOUSING GRAPHIC USER INTERFACE USING GEOINFORMATICS: A CASE STUDY IN KHARTOUM**

Mohamed Harith Mohamed¹, Carlos M. Pascual¹
Faculty of Geoinformatics, Future University, Khartoum, Sudan

**ABSTRACT**
Locating a suitable house or house searching is one of the most important activities for many families or housing agents worldwide and in developing country such as in Khartoum, Sudan, which is time consuming, needs some geospatial analysis and thinking; and most often incur difficulty in decision making. With the advancement in the field of geoinformatics, which involved the combined-use of GIS, remote sensing, GPS and internet/web-based mapping tools can be harnessed for such challenge. This case study in fast-growing portion in the city of Khartoum, Sudan will demonstrate a user-friendly decision support system (DSS) of housing graphic user interface in capturing, organizing, retrieving, analyzing and presenting geo-referenced data from the real world for a particular set of housing and various socio-economic and environmental attributes. This technology is ideal for the application of location-based services, such as the house property listing and selling in the real estate housing industry. In this case study, such DSS was developed to manipulate the housing property listing for sale geographically, to display the property listing in relation to other social and environmental features including topography, road network, transportation, accessibility or walkability in schools and/or shopping centers, and to provide tools for the house locator to search and inspect properties and make intelligent decision without the need of getting into the houses. As compared to the conventional way of getting a house property list and in field inspection, such geoinformatics-based DSS housing graphic user interface, easy searching and assessment tools are proved to be more efficient, effective and less time consuming. Moreover, such interface can be easily used by the real estate agents in property selling or renting, which will improve their business competence.

**COMPARATIVE ANALYSIS OF SEASONAL RAINFALL AND NDVI USING MERIS IMAGES IN KOLONDIEBA-TIENDAGA BASIN, SOUTHERN MALI**

Daou. Ibrahima¹ , Mariko. Adama² , Diallo. Drissa¹ , Dao. Amidou³ , Cheick M’Bow⁴ , Rasmus. F⁵.
¹ Université de Bamako, Faculté des Sciences et Techniques BP E.2528 Bamako (Mali)
² Ecole Nationale d’Ingénieurs-Aberhamane Baba Touré DER Géologie, Unité Eau Environnement BP 242, Bamako (Mali)
³ Université d’Abobo-Adjamé, Laboratoire de GéoSciences et Environnement, 02 BP 801 Abidjan 01 (Côte d’ivoire)
⁴ Université Cheikh Anta Diop, aboratoire d’Enseignement et de Recherche en Géomatique BP 5005, Dakar (Sénégal)
⁵ Institute of Geography & Geology, University of Copenhagen, Oster Voldgade 10, DK-1350 Copenhagen K, Denmark

**KEYWORDS:** NDVI, Rainfall, Climatic variability, Kolondieba-Tiendaga basin, Mali

**ABSTRACT**
Since the late 1960’s, the sudano-sahelian region is severely affected by the rainfall deficit most important both in its intensity in scale. This deficit coupled with the drastic increase of the population has contributed to further weaken the ecosystems of these areas. It was reported that rainfall is the main limiting factor in the evolution of the vegetation of the sudano-sahelian environments. To study the vegetation dynamics of these environments, the technologies of earth observation appear to be an appropriate tool. Vegetation indices are increasingly used to monitor this dynamic. Among these indices, the NDVI appears as the vegetation index and the most appropriate way to monitor this dynamic. Our study for monitoring of NDVI according to rainfall on
the watershed-Kolondieba-Tiendaga in Mali south area has resulted in satisfactory results. Indeed, the highest value of NDVI (0.79) was observed September, which is the wettest month of the crop and the lowest value (0.48) was recording in May, which corresponds to the beginning of the rainy season. Correlation coefficients that are left are respectively 0.80 for the period May to September, and 0.72 for the period May to August, and 0.5 for the period from May to October. Theses coefficients show that the evolution of the NDVI perfectly follows the dynamic of rainfall in this basin. It should be noted that these coefficients are in the same range as those already found elsewhere.

Ecological indicators in support of comprehensive assessment of pelagic ecosystem

Marie-Fanny Racault\(^1\), Trevor Platt\(^1\) and Shubha Sathyendranath\(^1\)

1 Plymouth Marine Laboratory, Prospect Place, The Hoe, PL1 3DH Plymouth, United Kingdom.

KEYWORDS: Ecological indicators, marine policy, phytoplankton phenology, the Mediterranean Sea.

ABSTRACT

Ecological indicators applied to observations-based monitoring programs are now widely accepted as resource management tools to support comprehensive assessment of ecosystem. The term indicator is used collectively by scientists, policymakers, and the general public. However, the diversity in the ways indicators are perceived and applied by the various user communities is considerable. Here, we present a framework of ecological indicators to assess the state of pelagic ecosystems. The relevance of ecological indicators is discussed in context of both marine policy and science. An example is provided with the analysis of phytoplankton phenology indicators estimated using remote-sensing ocean color observations in the Mediterranean Sea. We review innovative approaches to implement ecological indicators within different streams of observations (i.e. in-situ and remote-sensing). In particular, we show the relevance of relative measurement thresholds, interpolation procedures, and provinces delineation to overcome discrepancies in absolute measurement calibration, sampling coverage, time and space resolutions. Finally, we discuss how indicators estimated from ocean observations play a pivotal role in the development of interactions between society and the marine environment.

APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (GIS) ON THE EVALUATION OF URBAN GROWTH IN (BARKIN- SALEH WARD) MINNA BETWEEN 1991 AND 2010, IN NIGER STATE, NIGERIA.

MOHAMMED A, MOHAMMED ADAMU G..

Department of Geography, Ibrahim Badamasi Babangida University, Lapai

KEYWORDS: Urbanization, Growth and Geospatial Technologies.

ABSTRACT

The major product of urbanization, which poses serious challenge to policy makers and urban planners is rapid urban expansion, most especially that which is devoid of proper planning and control. This paper examines the use of remote sensing and Geographic Information System (GIS) to evaluate the trend of urban growth in Minna (Barikin Saleh ward) between (1991 - 2010). To achieve this, satellite image data from Google Earth; population figures; physical/survey observation, ground truthing and GIS tool to monitor urban growth in Minna were used. The study reveals that population increase is the factor responsible for spatial growth of the study area. Google imagery of Minna confirms spatial change of over 79% land use in terms of intensive built up (develop), which signifies serious land use as a result of expansion, wet vegetated land and water bodies reduces. The research recommends institutional capacity building (training and retraining of staff) on the use and application of Geospatial Technologies to solving urbanization problems, establishment of state of art G.I.S laboratory in Niger State Urban Development Board (NUDB).
REMOTE SENSING THE PHYTOPLANKTON SEASONAL SUCCESSION OF THE RED SEA

Dionysios E. Raitsos\textsuperscript{1}, Yaswant Pradhan\textsuperscript{2}, Robert J.W. Brewin\textsuperscript{3}, Georgiy Stenchikov\textsuperscript{1}, Ibrahim Hoteit\textsuperscript{1}

1 King Abdullah University for Science and Technology (KAUST), Thuwal, 23955-6900, Kingdom of Saudi Arabia.
2 Met Office, FitzRoy Road, Exeter EX1 3PB, UK.
3 Plymouth Marine Laboratory (PML), National Centre for Earth Observation, Prospect Place, The Hoe, Plymouth PL1 3DH, UK.

ABSTRACT

The Red Sea holds one of the most diverse marine ecosystems; however, knowledge on large-scale phytoplankton dynamics is limited. The analysis of a 10-year high resolution Chlorophyll-a (Chl-a) dataset, along with remotely-sensed sea surface temperature and wind, provided a detailed description of the spatiotemporal seasonal succession of phytoplankton biomass in the Red Sea. Based on MODIS (Moderate-resolution Imaging Spectroradiometer) data, four distinct Red Sea provinces and seasons are suggested, covering the main patterns of surface phytoplankton production. The Red Sea Chl-a depicts a distinct seasonality with maximum concentrations seen during the winter time (attributed to vertical mixing in the north and wind-induced horizontal intrusion of nutrient-rich water in the south), and minimum ones during the summer (associated with strong seasonal stratification). The initiation of the seasonal succession occurs in autumn and lasts until early spring. However, weekly Chl-a seasonal succession data revealed that during the month of June, consistent anti-cyclonic eddies transfer nutrients to the open waters of the central Red Sea. Occurring during the stratified oligotrophic period, this could be an important input of nutrients. Remotely-sensed synoptic observations highlight that Chl-a does not increase regularly from north to south as previously thought. The central part of the North Red Sea appears to be the most oligotrophic area (opposed to southern and northern domains) likely due to the absence of strong mixing as evident at the northern end of the Red Sea and nutrient intrusion as evident at the southern end. Although the Red Sea is considered an oligotrophic Sea, sporadic blooms in the open oceanic parts or the coastal reef areas occur that reach mesotrophic levels. Water temperature and wind plays an important role in the productivity of the Red Sea. Through stratification, they control the nutrients level at the euphotic zone or enable the horizontal transportation of nutrients.
GREEN AND ECOLOGICAL TECHNOLOGIES: CREATING SMART SUSTAINABILITY

Agata Lo Tauro

ABSTRACT
Use of eco-technologies in an environment, the consideration of these technologies in planning and design of the settlements, is a new area for professions dealing with sustainability. By means of technology, several kinds of technology can be useful in eco-tech environment: “Environmental Technologies (ET)”; “Information Technologies (IT)”; “Geographic Information Technologies (GIS)”, “Communication Technologies (CT)”, Robotics, Remote Sensing, etc.. This research will address the ecological, technological and social challenges related to urban and natural environments, from sustainable land-use to urban design competitions to municipal applications by eco-technologies towards resilience with the support of nano-technologies and geomatics.

This research will aim to develop an understanding of how the different perspectives of sustainable development and nano-technologies interact through community collaborations, and which measures can be taken in the settlements against climate change with the support of open sources. The research investigates such questions as: What will be the cities of tomorrow? What will be the changes in public and private spaces after applying nano-technologies? What is the impact of nano-technologies on sustainability? Is there any way to incorporate nano-technologies in environmental planning and geomatics to construct sustainable communities? What are the local solutions of protecting the natural resources? How can geomatics support nano-tech planning and design? How is the impact on nature measured by the help of nano-technologies?

Students, researchers, practitioners and educators in the fields of geomatics and design, architecture, landscape planning and design, engineering, agricultural engineering, sociology and geography, chemistry etc, will find that this resource provides cutting-edge research on nano-techniques, trends and practical applications for use in these fields. Central governmental bodies and local governments can find practical clues for application. This is a work-in-progress.

APPORT COMBINE DE L’ECOLOGIE VEGETALE ET LA TELEDETECTION SPATIALE DANS LA CARACTERISATION DE L’ETAT DE SURFACE AU NIVEAU DU SAHEL SUD DOUKKALA – NORD D’ABDA AU MAROC

R. TELLAL*, K. LABBASSI*, M. TELLAL**, N. GMIRA***
* Université Chouaib Doukkali, Faculté des sciences, El Jadida- Maroc
** Division des recherches forestières- DREF – Rabat - Maroc
***Université Ibn Tofail- Faculté des Sciences – Kénitra - Maroc

MOTS CLEFS : Sahel sud Doukkala - nord Abda, Semi-aride, Ecologie, Pastoralisme, Désertification, Télédétection, Dynamique des milieux, Maroc.

RESUME
Le Sahel Sud Doukkala - Nord d’Abda est une bande côtière atlantique au centre ouest du Maroc, de 15 à 25 Kms de large et de près de 100 Kms de long, allant de Jorf Lasfar au Nord, jusqu’à Safi (ville) au Sud. C’est une zone marquée d’une alternance de dunes et d’inter dunes d’ampleur pouvant atteindre 180 m, consolidées, parallèles à la côte. La vocation pastorale marque les milieux intérieurs d’une telle bande de terrain sous climat semi – aride chaud.

A part quelques rares pieds isolés d’arganier et d’oléastre qui marquaient autrefois les formations potentielles, subsistant au niveau de certains Marabouts (lieux saints) ou cimetières, la végétation naturelle au niveau des terres de parcours est généralement réduite à l’état d’ermes (végétation à base d’herbacées basses) dominées par des espèces annuelles.

La pression continue anthropozogène, l’aridité climatique ainsi que la fréquence des vents et leur violence en certaines périodes critiques de l’année, aggravent le processus de désertification et causent d’importants impacts au niveau des caractéristiques de surface de la zone.
Les travaux de télédétection combinés aux analyses écologiques et pastorales des milieux ont permis de par la confrontation de leurs données, la qualification des divers états de surface par leur comportement spectral d’une part et d’autre part l’évaluation du degré d’avancée du processus de désertification. La mise en place d’une plate-forme de données visant la contribution à la surveillance et le suivi des variations spatio-temporelles des unités d’occupation des sols et en particulier des systèmes écologiques de la zone reste l’objectif visé par le présent travail.

**APPORTS DE LA TELEDETECTION SPATIALE ET SIG DANS L’ETUDE ECOLOGIQUE ET LE SUIVI DE LA DYNAMIQUE DE L’ESPACE VERT DU LITTORAL DE HAOUZIA (SIBE) – EL JADIDA – MAROC**

R. Tellal *, B. Chiahou *
*Université Chouaib Doukkali, Faculté des Sciences – El Jadida – Maroc.

**MOTS CLES:** Littoral, SIBE, Haouzia, Ecologie, télédetection, SIG.

**RESUME**

Le littoral (ou baie) de Haouzia est la bande côtière atlantique localisée entre les longitudes Ouest 8° 20’ et 8° 28’ et les latitudes Nord 33° 15’ et 33° 20’, dans un bioclimat semi-aride littoral. Il est situé sur la bordure nord-ouest de la plaine de Doukkala, délimité au nord et nord-est par l’axe embouchure Oued Oum Rbia – ville d’Azemmour et au sud-ouest par la ville d’El Jadida. Il montre un paysage marqué par un relief dunaire d’ampleur maximale atteignant près de 50 m, bordant une plage sableuse remarquable par son étendue ainsi qu’un espace vert s’étendant sur une longueur de 13 Kms et sur une profondeur allant de 150 à 1500 m. Le littoral de Haouzia, classé SIBE (Site d’intérêt biologique et écologique), reste le seul site appartenant à la province d’El Jadida, préservant encore un espace vert relictuel des écosystèmes marquant autrefois le littoral atlantique marocain. Il présente d’importantes valeurs écologiques offrant un paysage devenu extrêmement rare sur la côte atlantique dont le rôle social est d’importance croissante.

L’espace vert du littoral de Haouzia, en plus de la pression anthropique et zoogène reste actuellement sujet à de nombreuses transformations suscitant un suivi minutieux de la dynamique de ses divers composants. Le présent travail, consiste à montrer l’importance de la télédétection et SIG comme outils d’une part de diagnostic de l’état de l’espace vert en question et d’autre part de suivi de la dynamique d’un tel milieu. En plus des relevés phytoclimatologiques de terrain, des photographies aériennes ainsi que deux scènes landsat TM sont utilisées pour la cartographie des unités d’occupation de l’espace et pour le suivi de la dynamique des milieux. Un tel travail reste une contribution visant la mise à disposition d’une base de données et d’informations utiles pour le suivi de l’état des lieux afin de percevoir à temps les changements qui pourraient être occasionnés à de tels milieux d’intérêt biologique et écologique.

**PERI-URBAN VEGETAL DIVERSITY AND THE THREAT OF URBANIZATION; THE CASE OF MINNA-BIDA CORRIDOR OF NIGER STATE, NIGERIA**

Yekeen A. Sanusi
Associate Professor,
Department of Urban and Regional Planning,
Federal University of Technology, Minna. Niger State, Nigeria.

**ABSTRACT**

For long Minna, the capital of Niger State, Nigeria was confined to a small area fairly defined by natural features; River Chanchaga to the east, River Sauka to the West and River Chanchaga to the South. The north is bounded by Paida hills and its gorges. However, a new phase of urbanisation of the town emerged in the 2000s with the advent of civil administration. This phase is witnessing the urbanization of peri-urban settlements along the major corridors leading to the town, especially Minna-Suleja-Abuja and Minna-Bida corridors. This is the setting that is putting pressure on the peri-urban villages. Of particular interest is the Minna-Bida Corridor.
and the immediate village outside the town. The village is called Gidan Mangoro. The word Gidan in the local Hausa language means a house while mangoro is a local adaptation of mango. The two words are combined to indicate dominance of mango trees in the community and the presence of relatively thick vegetal cover in the village. The combination of mango trees and other types of vegetation in the village runs contrary to what is obtainable in the immediate urban land and attracts particular attention both in the preservation of the environment and in the control of urban development. However, the Minna-Bida Corridor along which the village lies is now a new direction of growth. First is the movement of the Federal University of Technology, Minna to its permanent site, second is the movement of the national Examinations Council headquarters to the village and third is the construction of a 500 unit housing estate at the edge of the village. The impact is the invasion of the core land of the village by residential developments and threat of demolition of the vegetal cover.

Not only has the village become popular with the trees, the mango trees also yield economic benefits and livelihood opportunities. The vegetation of the village offers a break to the monotony of the built urban land and a ray of hope for bio-diversity within the vicinity of the main town and possible resilience to climate change effects. The reality of urbanisation of this village and others along the Minna –Bida Corridor is now a threat to this possibility. This paper intends to examine urbanisation along the Minna-Bida corridor, to understand the vegetal biodiversity of the peri-urban settlements; to explore the social and economic values of the vegetation and the livelihood opportunities it offers women; to underscore the threat of urbanization to the conservation of the vegetation and to examine implications of the vegetation for the protection of built environment and resilient of human settlements against possible threat of climate change.

The study depends largely on primary data through a detailed study of the vegetal characteristics of the villages. First, there is broad synoptic view of vegetal characteristics of the villages and then a detailed study of changes happening in Gidan Mangoro. This is because Gidan Mangoro is the closest to the urban land. There is inventory of vegetal types in Gidan Mangoro. This requires actual counting of the trees according by types. In addition are inventory of new housing developments, inventory of trees felled within the last three years and inventory of non-residential developments. The study also involves focused group survey that focused on women within the village. In all two groups of women are covered in the focused group survey. There is also household-based survey meant to assess the household use of the mango trees and other trees. Eighty households were covered. In the same vein, full inventory of household characteristics was also conducted. The change in vegetation is monitored through the use of Google Earth images (29/11/2007) and 19/03/2011). The image results are then compared with the observed demolition of vegetal cover in the village.

The significance of this study is seen in its implication for ecosystem conservation; for firm development control in peri-urban settlements; for human-based interpretation of ecosystem resources; for example within the context of livelihood, the vegetal resources serve as both communal and individual assets and a rallying point for development of local market. In the face of global and local climate change, the unusual presence of vegetal bio-diversity at periphery of a city within Savannah dry belt offers hope for building the city’s resilience against climate change and its impacts.

Largely, the unique combination of vegetal resources and its role for both ecological, social and economic values are recognized by this study. The inevitability of urbanization of the peri-urban settlements is also clear. A balance of the forces of urbanization and the ecology of the villages is clearly desired. This balance will be helpful to both the environment, the urban dwellers and the villages. In general, while current changes to the vegetation maintained over years by the villagers is minimum, this can easily be said to be the beginning of what evidently looks like an impending environmental assault. Therefore, at this stage, the situation could be salvaged and the future of the vegetation guaranteed.

SUIVI DES CHANGEMENTS GLOBAUX DE PAYSAGE DANS LES ZONES SEMI-ARIDES SUD-EST DE L’ALGERIE A L’AIDE DES DONNEES DE TELEDETECTION.

Hassen BENMESSAOUD1 & Yassine BEGHAMI1

1. Laboratoire « Risques Naturels et Aménagement du Territoire, Faculté des sciences -Université El Hadj Lakhdar –Batna- Algérie

RESUME
La connaissance des transformations actuelles des surfaces terrestres représente un enjeu important pour l'évaluation des problèmes environnementaux. Ainsi, les dynamiques spatio-temporelles qui constituent des critères essentiels à prendre en compte dans la mise en œuvre de décisions fondées sur le concept de développement durable.
L'objectif de cette étude est de déterminer l'apport des images satellitaires dans la détection des changements globaux et le suivi de paysages dans une région semi-aride de Sud Est de l'Algérie.
La démarche adoptée consiste à utiliser des images satellitaires de Landsat 5 et 7 à des dates différentes (27 avril 1987 et 10 avril 2006) et un travail d'échantillonnages pour la confrontation avec la réalité de terrain, afin d'effectuer une analyse thématique de ce milieu, et pour visualiser les changements globaux qui se sont produits dans cette zone.
Les résultats obtenus sont représentés sous forme de support cartographique identifiant les diverses composantes de l'espace étudié, notamment l'évolution du couvert forestier, des parcours et les cultures irriguées afin de permettre une analyse des changements globaux de ce paysage semi-aride.

MONITORING AND SPATIAL ANALYSIS OF RED CORAL FISHING ACTIVITY: A NEW APPROACH FOR PREDICTION VULNERABLE OPERATING AREAS
ABDELLAOUI.B
Institut National de Recherche Halieutique. INRH-Tanger, Tanger, Morocco

ABSTRACT
In the Mediterranean Sea the Red coral is an endemic species, located mainly in the western part. It has a very slow growth. Its exploitation is so localized in space that could result sometimes in a irreversible process. The integration of space component through monitoring and identification of exploitation areas of this species are important for the preservation and sustainable management of this resource.
The current study focuses on the spatial analysis of data for the prediction and identification of vulnerable areas of red coral activity (Corallium rubrum) in the north of Morocco. It is based on regular monitoring of fishing activity and the collection of landings data from 2008 to 2011. The data and information collected are: the geographical position of the diving site, the depth, the catch in weights the size and the diameter at the colony basis.
The results of the spatial analysis by estimating Moran index, show a positive values (+0.0465) which indicate a similar association, but this value is so low to indicate a continuous and homogeneous distribution of the red coral in the whole space. However, the identification of local association by estimating the contribution of individual values, using the LISA index (Local Indicator of Spatial Association) shows the presence of two main associations whose exploitation characteristics are opposite. The analysis of the size frequencies distribution of red coral population between 2010 and 2011 confirm these results.

MAURITIUS COASTAL AND MARINE ATLAS - A RELIABLE TOOL FOR INTEGRATED COASTAL ZONE MANAGEMENT
Krisna BUCHA
Mauritius Meteorological Services, St Paul Road, Vacoas, Mauritius

ABSTRACT
The availability of reliable, up-to-date, accessible data and information is an essential basis for integrated coastal zone management, and sustainable management of coastal and marine resources. Government, industry sectors, academic institutions and non-governmental organizations (NGOs) have a tremendous stake in the development and management of geospatial data resources. Coastal mapping plays an important role in
informing decision makers on issues such as national sovereignty, resource management, maritime safety and hazard assessment.

A key aspect of this trend has been the development of coastal web atlases (CWAs), based on web-enabled geographic information systems.

The Mauritius Coastal and Marine Atlas should become a key on-line resource for all those who are interested in coastal and marine data and information for the Republic of Mauritius. As conceptualized, it will be an online resource of public-domain geospatial data for the support of coastal and marine research and management in Mauritius and the whole of Africa.

The project designed and implemented by ODINAFRICA, in collaboration with IOC/UNESCO Project Office for IODE, will identify, collect and organize data sets into an atlas of environmental themes, aiming at the dissemination of appropriate, timely and relevant information. The atlas will provide maps, images, data and information to users who will include scientists, students, coastal resource managers, planners, and decision-makers from administrative institutions and specialized agencies in Mauritius and Africa.

The Mauritius Coastal and Marine Atlas will not only improve access to useful information about the coasts and oceans, and increase capacity for working with spatial data but also build capacity for marine data management and encourage scientists to work together, learn new techniques and build collaborative teams for the future.

The main aim of the atlas is to provide easy and reliable access to information required for coastal and marine management and decision making. In addition to improving access to global data resources, the project will also enhance the use of GIS and remote sensing for coastal management.

**DEVELOPPEMENT D’UN SIG POUR LA CARTOGRAPHIE DES CARTES BIOCENOTIQUES EN UTILISANT LA TELEDETECTION A TRES HAUTE RESOLUTION SPATIALE ET LA PLONGEE SOUMARINE**

1. BACHARI Nour el islam, 2. LAMOUTI Soad

1 F.S.B Université des Sciences et Technologie Houari Boumediene (U.S.T.H.B) Alger
2 Centre Nationale de Recherche de Pêche et Aquaculture (C.R.D.P.A) Bousmail Alger

**MOTS-CLÉS:** cartographie, observation In-situ, télédétection, biocénoses remarquables, espèces invasives, SIG.

**ABSTRACT**

La cartographie des biocénoses benthiques est indispensable pour la surveillance environnementale. L’objectif de notre travail est de contribuer à développer des cartes biocénotiques intégrables dans un système d’information géographique, réalisées par l’observation In situ et observation spatiale très haute résolution spatiale. L’observation in situ (plongée sousmarine) a permis de réaliser une cartographie à grande échelle et haute précision de secteurs réduits. Les cartes obtenues ont été intégrées dans un SIG. Les techniques classiques ont servi pour inventorier l’occupation du fond marin de la zone Sidi Fredj. Une carte biocénotique est réalisée avec un inventaire statistique. Les images traitées sont des photographies aériennes et des images satellites reconstituées à partir de Google Earth. Nous avons utilisé une classification supervisée pour réaliser une carte couvrant un espace étendu. Les techniques satellitaires ont permis d’extrapoler l’étude in-situ et réaliser une carte pour toute la côte ouest d’Alger.
ASSESSING THE CONSEQUENCES OF SALINIZATION IN SALOUM ESTUARY SYSTEM BY LAND USE AND LAND COVER CHANGE ANALYSIS

Ndeye Maguette DIENG¹, Joel DINIS², Serigne FAYE¹, Mário CAETANO²
1 Geology Department /Faculty of Sciences and Techniques University Cheikh Anta Diop, Dakar PO Box 5005 Dakar, Senegal
2 Higher Institute of Statistics and Information Management – New University of Lisbon, Lisbon, Portugal

KEYWORDS: Saloum, salinization, estuary, remote sensing, change detection.

ABSTRACT
The saltwater contaminations constitute a serious problem in Saloum estuary, due to the intermittent and reverse tide flows of the Saloum River. This phenomenon is caused by the runoff deficit, which forces the advance of saltwater 60 km upstream, contaminating surface water and, thus, causing the degradation of biodiversity and large areas of agricultural soils in this region. The present study aims to evaluate the consequences of saltwater contamination in the last three decades in this estuary by assessing the land cover dynamics over this period. Land cover dynamics evaluation consists in tracking the landscape changing process over time to identify land cover transitions. These transitions are closely related to the ecosystem state condition and can be used to assess the combined impacts of both natural and human-induced phenomena over a given period of time. In this study, a special attention was given to the mangrove degradation and to the temporal progression of the salty barren soils locally called “Tan”. The lost of mangrove areas to “Tan” and the general increase of salty barren soil areas can reflect the increase of the level of salinization in the study area over the time period under consideration. To fulfill this objective, four Landsat satellite images from the same season in the years 1984, 1992, 1999 and 2010 were used to infer a time series land use and land cover maps of the Saloum estuary area. In addition to satellite imagery, rainfall record was used to evaluate climatic variation in terms of high to low precipitation during the time span considered.

The methodology adopted in this study consisted in the following steps:
Computation of the Normalized Difference Vegetation Index (NDVI) for the years 1984, 1992, 1999 and 2010; Radiometric normalization for the time intervals of 1984-1992, 1992-1999, and 1999-2010. In this process the most recent image was used as reference. Then a linear regression was established between the two NDVI; NDVI differentiation between the original NDVI value and the predicted in the normalization process; Identification of the areas where change in land cover has occurred by the NDVI difference. The thresholds values were determined using the mean and standard deviation values of the positive and negative NDVI variations, and by an empirical coefficient; Land use and land cover automatic mapping using the linear discriminate classifier; Elaboration of the land cover dynamic matrix for each time period considered.

The results suggest the land cover changes, in particular, toward “tan” (denuded and salty soils), are related with precipitation and with the water salt content. In addition, these results show that significant changes in land cover occur in the study area reflecting in this way environmental degradation, land desertification, caused by the advance of salty bare lands.

SUSTAINABLE AND PARTICIPATORY COASTAL EROSION MANAGEMENT: RELEVANCE OF REMOTE SENSING AND SOCIAL SCIENCE

Oscar S. Teka¹, Laurent G. Houessou¹, Joachim Vogt² and Brice Sinsin¹
(1) Laboratory of Applied Ecology, University of Abomey-Calavi, PO BOX 167, Calavi, Republic of Benin
(2) Institute of Regional Sciences (IFR), Karlsruhe Institute of Technology (KIT), Kaiserstr. 12, 76128 Karlsruhe, Germany

KEYWORDS: Remote sensing, Social surveys, Participation, Coastal zone management, Benin
ABSTRACT

The sustainable natural risk management cannot be done without understanding the social perception of local population who suffers of its direct impacts. Since five decades, the littoral of Guinea Gulf has been subject to coastal erosion, which causes several damages to local populations (loss of infrastructures, changes of livelihood, etc.). National planning programs and strategies were implemented and unsuccessful because local populations remained reserved and did not participate. Thus there is an urgent need for seeking new planning strategies which should enhance the participation of local population through taking into account their perception as well as actions rationalities in the coastal management. The overall objective of this study is to provide relevant data and tools which will help decision makers and planners for the coastal erosion planning in the guinea gulf. To achieve this goal, the adopted methodological approach was based on the integration of remote sensing and GIS data as well as socio-cultural and economic data. The results revealed that the coastline of Benin was differently affected by the coastal erosion. Whereas the eastern part of Cotonou suffered very strong on erosion (about 10 m/year), the western part had a weak erosion speed (about 4m/year). Between Adounko and Ouidah, it was found a sea regression. The coastal erosion was explained and tested objectively by means of rational scientific models (some human activities, the ice smelting, the climate change, etc.) which, however, often do not correspond to the subjective perception and assessment of the local population groups. This subjective perception has been ignored in the past, as there is neither a participatory political and planning culture, nor do the explanations offered by the subjective perception comply with rational scientific understanding. The work also identified the major methodological challenges and solutions for sustainable and participatory coastal erosion management. Findings from this study constitute a prerequisite for sustainable coastal erosion management and provide an important planning tool for decision makers.

SPATIAL DIMENSIONING OF WETLANDS WITHIN OSUN RIVER BASING IN SOUTH WESTERN NIGERIA AND POTENTIAL FOR URBAN FOOD SUPPLY

Fabiyi, O.O, Regional1, Ige-Olumide2, Fabiyi,O.A2
1. Centre for Training in Aerospace Surveys. Ile Ife Nigeria
2. Agricultural Research Council of Nigeria. Abuja Nigeria

ABSTRACT

Urban Wetland mapping River Osun Catchment areas and the potential for dry season farming in South western Nigeria

Nigeria has about 68, 207 Square kilometers of wetlands out of the 923,000 Square kilometers land areas. A significant part of Nigerian wetlands are within urban areas holding high potentials for dry season farming and supplying all year round farm produce for urban teaming population

Wetlands are very valuable areas for rural communities and peri urban agriculture and it serves as the dominant agricultural lands in the arid parts of Nigeria. The South western part of Nigeria is served with rich natural drainage networks with their rich agricultural potentials from wetlands. These networks of river systems are available for agriculture for most part of the year especially around the perennial river systems. The wetland are submerged for some period of the year and could be used for irrigation purpose

The study use SPOT 5 satellite remote sensing to map the wetland resources within the Osun river catchment area and delimited areas accessible for urban and periurban agriculture for the river basin.

The wetland resources were categorized based on the accessibility to farming urban population. The study concludes with estimating potential contribution to the per capita development of urban poor.
EXPERIENCES IN PROMOTING IN-SITU RAIN WATER HARVESTING TECHNOLOGIES IN MLIWO-LIWANGA TECHNOLOGY VILLAGE IN MACHINGA AGRICULTURAL DEVELOPMENT DIVISION

Emily Dingani Therah Luwanda
Senior Land Resources Conservation officer, Machinga ADD, P/Bag 3, Liwonde Malawi.

ABSTRACT
Midseason long dry spells and poorly distributed rainfall combined with poor soil fertility are the major constraints to crop production under rain fed agriculture in Machinga Agricultural Development Division (ADD). Irrigation is the first remedy to the problem, however many smallholder farmers do not have irrigation facilities hence in-situ rain water harvesting (RWH) is the only option to conserve water in the small farmers fields. In-situ rain water harvesting is sometimes called water conservation and is basically a prevention of run off from a given cropping area by holding rain water and prolonging the time for infiltration. In-situ rain water harvesting is achieved mainly by the deep tillage, contour farming, box ridging, use of swales (fanya chini) and good agronomic practices. In-situ RWH technologies in Machinga ADD started long time back except for the swales (fanya chini) which farmers adopted in 2003-2004 growing season. Promotion of these in-situ RWH technologies started with on farm trials. However, the complex nature of the demonstrations prompted one to conclude that they were meant for research. Lessons learnt from the first phase of demonstrations, prompted the inclusion of farmers, to enable them to properly understand the objectives of the demonstrations. This was achieved through conducting of awareness meetings, farmer trainings, mounting of farmer led demonstrations, and provision of start up inputs for the demonstrations by the Department of Land Resources Conservation. Challenges faced in the promotion of the technology were, lack of awareness among the general public, poverty and economic status, lack in technology development and dissemination and lastly policy issues. Apparently in-situ RWH technologies have great potential in Machinga ADD since it is a drought prone area.

APPLICATION OF REMOTE SENSING DATA MINING IN MONITORING WATER QUALITY

Hanan Farag1 and Joel Dinis2
1. Researcher, Environment and Climate Research Institute, National Water Research Center, Egypt
2 Higher Institute of Statistics and Information Management – New University of Lisbon, Lisbon, Portugal

ABSTRACT
Remote sensing techniques play an important role over recent decades in both problems of global climate change and frequent deterioration of the status of aquatic ecology, driven by the ever-increasing needs of growing populations for drinking water, polluted by overland runoff from point and non-point sources. Lake Burullus is centrally situated and consider the second northern coastal lake in size. Around the early 1900s, it had a surface area of about 600 km2; by 1974, land reclamation for agriculture in its southern sector had caused it to decline to about 460 km2, and this decline continues. The lake is suffering from received highly pollutants from the drainage water and fish farms which affected on lake water quality and change the ecosystem. The spectral characteristics of the signal received from water are a function of hydrological, biological and chemical characteristics of water, and other interference factor. Suspended sediments increase the radiance emergent from surface waters in the visible and near infrared proportion of the electromagnetic spectrum, so it is promising and feasible to detect water pollutants using spectral signatures in the visible and near infrared band. The research is aim to classify pollution situation of the lake based on average spectra of training data. The increase of pollutant the reflectance of bands increases. Landsat image ETM have been analyzed and the Optimum Index Factor (OIF) developed which is a statistic value that used to select the optimum combination of three bands in a satellite image with which a color composite image is created. Moreover, mean, standard deviation and correlation coefficient of reflectance values from the three lake basins are calculated. The standard deviation is widely used to measure the variability or dispersion. The band with the higher standard deviation contains the higher amount of
'information' than other bands. Stepwise multiple linear regression analysis is applied for water quality levels and reflectance of bands. It concludes that Band1, 2 and 3 are important bands to monitor water quality and the reflectance value of band 2, band 3 and band 1 change dramatically according to different water quality, which are relate to the water pollutant of different lake basins. The western basin is the most pollutant basin due to receive the drainage waste from agriculture drainage and domestic waste from wastewater treatment plants.

TRANSITIONS AGRAIRES, CLIMAT ET REGIME HYDRIQUE EN MILIEU TROPICAL HUMIDE INSULAIRE : LE BASSIN VERSANT D’OUZINI-AJAHO (ANJOUAN – COMORES). APPORT DE LA TELEDETECTION SATELLITAIRE ET AERIENNE

Nourddine Mirhani1,2, Aude Nuscia Taïbi1, Theodore Razakamanana3, Aziz Ballouche3
1. Université d’Angers, ESO-Angers UMR 6590 CNRS, MSH, 5 bis Bd Lavoisier, 49045 Angers cedex 1 (France)
2. Université de Toliara, Madagascar
3. Université d’Angers, LETG-Angers LEESA UMR 6554 CNRS, UFR Sciences, 2 Bd Lavoisier, 49045 Angers cedex 1 (France);

RESUME

Depuis plus de 30 ans, Anjouan (Comores), île volcanique tropicale humide de l’océan indien, connaît une perturbation du régime hydrique de ses rivières. Les origines du phénomène sont loin d’être identifiées d’une façon systématique pour pouvoir faire face aux conséquences déjà effectives de la diminution des ressources en eau sur les zones côtières et de l’augmentation des crues brutales, ainsi qu’aux défis du changement climatique global.
Le croisement de données issues de traitements d’images satellites (Spot 5) de 2007, de photographies aériennes de 1969 et d’images Quickbird de 2010 extraites du site de Google Earth et d’un Modèle Numérique de Terrain, avec des recueils d’information terrain par observations et entretiens avec la population locale, et l’analyse des statistiques pluviométriques des 30 dernières années, ont permis de mettre en évidence les premiers éléments d’explication pour le site d’Ouzini-Ajaho.
Cette approche multi-échelle et multi-date a permis notamment de diagnostiquer et spatialiser les mutations environnementales et socio-économiques majeures de ce bassin versant de 1900 ha représentatif des processus à l’œuvre dans toute l’île.
Les suivis diachroniques à partir de photographies aériennes et images satellites montrent des changements d’occupation des terres associés à des transitions agraires marquées :
La forêt qui couvrait jadis les versants du bassin de la rivière Havununkuni-Ajaho recule actuellement devant les besoins en terres croissants et les plantations de bananeraies, particulièrement dans la partie amont, modifiant profondément les conditions d’infiltration des eaux de pluies.
La forte demande en produits d’exportation a encouragé les paysans à développer les cultures de girofliers et d’ylang-ylang, introduits pendant la période coloniale, au détriment des cultures vivrières traditionnelles (taro, patate douce, etc.), notamment dans les sections aval et médiane de la vallée, favorisant un accroissement des pompages dans les nappes phréatiques.
L’accroissement démographique et la descente d’une partie des populations des zones de montagne vers la plaine a favorisé des processus d’urbanisation au détrament de ces mêmes plantations dans les parties aval de la vallée, et une exploitation croissante des ressources en eau, bois et sable alluviaux.
EFFECT OF SLOPE ON ICESAT LIDAR MEASUREMENTS

ANWAR, Maeva(1,4); RAKOTONDRAOMPIANA, Solofo (1); OLIVIER, de Jonville, (2); ROUX, Michel (3); RUDANT, Jean Paul (4)

1. Remote Sensing and Environmentnal Geophysics Laboratory, Institute & Observatory of Geophysics, Antananarivo (IOGA), Madagascar
2. Ecole Nationale des Sciences Géographiques, Paris, France
3. Ecole Nationale Supérieure des Télécommunications (ENST), Paris, France
4. Universite De Paris-Est-Marne-La-Vallee, Labo.ESYCOM, Cellule TIG (Télédétection, Information Géographique), Paris, France

ABSTRACT

A good measurement accuracy of canopy height is necessary for different applications such as forest biomass estimation. Lidar is a remote sensing method that allows to realize measurement of tree height with good accuracy. The ICESat satellite, launched in 2003 with worldwide coverage, uses the Lidar technology for atmospheric and soil surface measurement. The measurement profile is 1 point every 170 m with an impact in the ground about 70 m of diameter. ICESat data allow us to obtain measurements of canopy height for different measurement points.

For a surface with a slope, the received signal is more temporally extended compared to the one from a flat surface. This generates an overestimation of the height when there is a slope. However, we intend to highlight the effect of slope on the measurement of tree height. We will use ICESat data in combination with DEM data to do correction of the slope effect.

In order to highlight the effect of slope, we chose ICESAT measurement points on bare soil but with different slope values. These points are in Madagascar, between 47.4 ° and 47.6 ° longitude and between -18.4 ° and 18.8 ° latitude. Another area where canopy height measurements were already done is chosen to validate our results. This area is located between 47.95 ° and 47.97 ° longitude and -18.99 ° and -19.04 °of latitude.

We used GLA01 and GLA14 files of ICESat which contain respectively the waveform and the coordinates of each measurement point. We also used DEM data from ASTER GDEM which has a resolution of 30 m to calculate slopes. This parameter allows us to correlate the slope with the waveform to push out a relationship of slope correction on the measurement of tree height. We choose ICESAT points out of forest, in bare soil so that we can avoid effect of land cover on signals.

Thus, we obtained an empirical relation of the form $h = 0.15 \times w_{Echo} + f(\theta)$ where $w_{Echo}$ is the extent of the real signal and $\theta$ is the slope. This relationship removes the influence of slope on the tree height measurement. In the case of bare soil with slope, this relationship allows to obtain the same response that the case of flat bare soil.

Satisfactory results were obtained for the measurements of canopy height for forest located on a slope.

Bibliography


ESTIMATION OF LEAF AREA INDEX OF THE TROPICAL RAINFOREST ZAHAMENA FROM
REMOTE SENSING USING ARTIFICIAL NEURAL NETWORK

Ravonjimalala, H.R\(^{(1)}\); Rakotondraompiana, S\(^{(1)}\); Rakotoniaina, S\(^{(1)}\); Faramalala, M.,H. \(^{(2)}\); Roger E. \(^{(2)}\)
1. Institut & Observatoire de Géophysique d’Antananarivo. Université d’Antananarivo (Madagascar)
2. Département de Biologie et Écologie Végétales, Faculté des Sciences. Université d’Antananarivo (Madagascar)

KEYWORDS: leaf area index, artificial neural network, neural, spectral parameter, multi-layer perceptron.

ABSTRACT

Neural networks are appropriate statistical methods to solve nonlinear problems such as estimating leaf area index in our case. The network used in most literature is undoubtedly the Multi-Layer Perceptron (MLP) which is organized in several layers of formal neurons. Information flows from the input layer to output layer only. Each layer consists of a variable number of neurons and neurons of the output layer corresponding to the outputs always the system. Moreover, we know that the MLP uses a learning algorithm known as back propagation algorithm of the gradient that was established in 1985 by Rumelhart et al. Our study aims to estimate the values of leaf area index (LAI) from remotely sensed data and the corresponding biomass using the artificial neural network (ANN). A similar study has already been performed using the multiple regression method by Ranaivoarimanana (2012). The study area is the protected area of Zahamena, Madagascar. In fact, the site is located between 17° 30’ and 17° 43’ South latitude and between 48 ° 41’ and 49 ° 03’ East longitude. The eastern part of the site is characterized by a dominance of moist evergreen forest of low altitude. We have implemented plots of 20 m x 50 m during our field works. Measurements of LAI using the LAIL sensor (Cournac et al. 2002) were made within these plots between 10 h and 14 h. These measurements are repeated every 1 m and GPS points were acquired every 10 m. The satellite image used in this study is a multispectral SPOT 5 of 10 m of spatial resolution. This image was acquired in September 2008. The spectral parameters considered are XS bands and vegetation indices. We have performed first pre-treatments on field data of LAI such as brightness compensation (Cournac, L. et al. 2002) and filtering. Then, statistical analyzes based on artificial neural network were applied to our data. After several iterations, the coefficient of determination R\(^2\) maximal is equal to 0.768 with a low Mean Square Error (MSE) equals to 0.333. This result is accepted compared to results obtained from a multiple linear regression with R\(^2\) equals 0.398 and MSE equal to 0.314. We can say that the ANN is reliable for estimating LAI and biomass compared to the method of multiple linear regressions.

References

INVESTIGATION INTO THE NATURE AND DIRECTIONS OF FOREST DEGRADATION AND SUSTAINABILITY AMIDST CLIMATIC ANOMALY IN SOUTHEASTERN NIGERIA

John D. Njoku, Ph.D.
Dept of Environmental Technology, Federal University of Technology, PMB 1526 Owerri, Nigeria

KEYWORDS: tropical forest, temperature rise, degradation, forest impacts map, remotely sensed data

ABSTRACT
The problem we investigated in the study was the role of rising temperature in the rapid depletion and loss of forest cover quality in the region, using remotely-sensed data. Satellite imageries were obtained, for the 1970s, 1980s and 1990s, from http://www.landcover.org and converted to mosaics before analysis. Data of relevant meteorological variables were obtained from five synoptic stations in the study area. The imageries were used to compute the NDVI and to extract static forest impact/extent maps for the 1970s, 1980s and 1990s. The meteorological variables were applied to assess the degree of influence on the forest cover of the variables, and to develop the weather-driven version of a regression model for the prediction and forecasting of the likely effect of global warming on the tropical forest cover of the area. The result showed that there is decline of forest cover quality and health due to rise in the mean annual temperature between 1970 and 2000. By overlaying the 1970s forest impact map on that of the 1980s, it was revealed that the forests were depleted. The total area under the forest cover even went down from 11,705.64 km² in the 1970s to 9,516.21 km² in the 1990s. This amounted to decrease of 34.68% in the 1970s to 28.19% in the 1990s with annual decrease of 3.4% between 1970 and 1980 and 2.5% between 1990 and 1999. The NDVI and health assessment revealed apparent stress and negative trend of the forest cover beginning from the 1970s to the 1990s. Forest health assessment showed reduction in vegetal vigour. Between 1970 and 1979 the extent of distressed vegetation was 0.3m² [0.0%], while between 1980 and 1989 about 44,755m² [21.2%] lost vegetal vigour and was distressed. Between 1990 and 1999 about 166,388m² [78.8%] lost vigour, and showed poor health and deforestation. The extent of forest cover loss in the future was projected from the 10-year moving averages. The regional regression analysis showed significant values as R² = 97%, adjusted R² = 96% and F = 102.446. The result showed that in the region, temperature exerts 57.2% influence on the forest vegetal cover, while sunshine contributes 20.8% and rainfall 11.7% while evaporation and wind speed contribute 5.2% and 3.4%, respectively. Thus, temperature, sunshine and rainfall exert over 89.7% influence on the forest cover. The results showed that sustainable forests management in the region is possible only if, the current global warming are considered in forest programmes probably using remote sensing and GIS techniques.

VULNERABILITY OF GHANA’S FORESTS TO DEGRADATION AND FUTURE CLIMATE CHANGE IMPACTS

E. Tachie-Obeng¹, J. Nkem² and M. Idinoba³
1 Environmental Protection Agency, P.O. Box 326 Accra, Ghana
2 United Nations Development Programme, United Office in Nairobi, Gigiri, P.O Box 30552-00100, Nairobi, Kenya
3 African Union Commission P.O. Box: 3243 Addis Ababa, Ethiopia

KEY WORDS: forest degradation, landuse landcover change, climate change, policy, Ghana

ABSTRACT
Ghana has distinct vegetation zones from high forest in the south-western corner to Sudan savanna in the northern part of the country. The forests are mainly exploited to meet growing socio-economic needs, and have over the years resulted in dramatic deforestation in savanna, forest-savanna transitional and high forest zones at an annual rate of 0.7% to 1.8%. Vulnerability of forests in three major ecological zones of Ghana was assessed using climate change scenarios and forest degradation trends with GIS spatial analyst. Most vulnerable areas in savanna (76%), forest-savanna transition (56%) and high forest (29%) zone, were also found
to associate with rivers and streams basins of the study areas. Areas of protected forest were found to have low vulnerability to deforestation and climate impact compared to farming and built environment. The savanna zone is threatening to desertification and has become more susceptible to future climate impacts. 33.6% of the savanna zone in the study area has degraded to widely open cultivated savanna with tree canopy less than 5 trees per hectare in 2000. Predictive landuse and landcover (LULC) maps for 2050 show 65.5% of savanna zone and 10% in forest-savanna transitional zone threatening to desertification on “business as usual” (BaU) basis. Major causes of forest degradation and vulnerability to future climate impacts were found to be increased pressure on forestlands, logging, bushfires and charcoal production. The study recommended strengthening of forestry-related institutions to consider climate change adaptation and mitigation issues as priority in policy formulation to monitor and ensure sustainable management.

ESTIMATING WOOD VOLUME FROM REMOTELY SENSED DATA AND FIELD MEASUREMENTS IN SAVANNA WOODLANDS OF SOUTHERN AFRICA

T. W. Gara¹, A. Murwira¹
1. Department of Geography and Environmental Science, University of Zimbabwe, Box MP 167, Mt Pleasant, Harare.

ABSTRACT
In this study we compared the predictive ability of vegetation indices derived from high and medium spatial resolution satellite imagery to estimate wood volume in savanna woodlands. Specifically, based on two study sites with different environmental conditions in Zimbabwe, we tested whether vegetation indices i.e. Simple Ratio (SR), Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index (SAVI) derived from high spatial resolution (GeoEye-1 and WorldView-2) predict wood volume better than vegetation indices derived from medium spatial resolution (Landsat5 TM) satellite imagery. Wood volume was estimated using existing allometric equations. Next, using the best regression model we mapped wood volume in the two study sites. Our results showed that vegetation indices derived from high spatial resolution significantly (p< 0.05) predicted tree volume better than Landsat 5 TM derived vegetation indices. Overall, the relationship between wood volume and vegetation indices provides an opportunity for estimating and monitoring forest carbon in African woodlands.

EVALUATION OF THE GEOSPATIAL DISTRIBUTION OF SECONDARY SCHOOLS IN ILE-IFE

Ojo A G¹, Chin G K²
a African Regional Centre for Space Science and Technology Education, PMB 019 OAU Campus, Ile-Ife.
b African Regional Centre for Space Science and Technology Education, PMB 019 OAU Campus, Ile-Ife.

KEYWORDS: Land-use, Secondary Schools, Population and Education facilities

ABSTRACT
Spatio-temporal information is fundamental to school management especially in Urban Centers where the population and other anthropogenic activities are concentrated. An issue to consider in any case is the quality of education offered to the youths and the risk to which this fragile population group is often exposed to, especially in developing countries. However, the creation of balanced urban educational institutions requires adequate and up to date data on the interrelationship between educational facilities and other environmental factors. The problem of inadequate Schools is aggravated by poor siting. This study was carried out in Ile-Ife, Nigeria with the purpose of mapping existing secondary schools, determining their distribution pattern and analyzing the suitability of their locations. Data used for this work included location data collected through the use GPS and questionnaire administered to the school administrators. A model was built-in to show the relationship between commercial centers, roads, slope landuse and schools.
Results obtained showed that secondary schools are neither clustered nor dispersed that is; they were randomly distributed. 53% of the schools fall within the least suitable areas while no secondary school is located in the optimum and most suitable area. From the analysis, Oramiyan Memorial Grammar school is the most centrally located secondary school while Misty-Gee Model College is the most accessible to a large number of students. In this study the standard distance from the mean centre is 3106.2m (3.1062km). Also, 11 of the 43 schools (25.6%) are within 150m, while 20 are within 300m and 24 within 450m from the major roads. This is an indication that most schools in Ile-Ife are not suitably located and this therefore pose students, staff and populace to risk and havoc.

GEOVISUALIZATION AND SPATIAL ANALYSIS OF THE ENVIRONMENTAL IMPACTS OF IFE – MODAKEKE COMMUNAL CLASH AFTER A DECADE

M. Soumah¹, B.F. Agbo² and R.O. Oyinloye³

1 Senior Lecturer in the Department of Geographic Information Systems
2 Principal Lecturer in Department of Photogrammetry and Remote Sensing,
3 Associate Professor and Head of Department of Photogrammetry and Remote Sensing Regional Centre for Training in Aerospace Surveys (RECTAS) Science and Technology Park, Off Road 1, Obafemi Awolowo University (OAU) Campus, PMB 5545, Ile-Ife, Nigeria.

KEYWORDS: Geovisualization, Urban growth, Environment, Remote Sensing, Landuse monitoring, Vegetation degradation, Geo-information, Assessment

ABSTRACT
Ile-Ife (often simply called Ife), the cradle of Yorubaland, is located around the centre of south-western Nigeria. The study assessed the environmental impacts of the communal clash it had with her closest neighbour – Modakeke town – about a decade ago and took a look at the magnitude, trend and pattern of urban growth of the city and Modakeke before and after the clash. The effect of the Obafemi Awolowo University campus on the expansion of Ile-Ife has also been examined. The study covers the period 1991 to 2009. Satellite images (Landsat-TM of 1991, Landsat-ETM+ of 2002 and IKONOS of 2009) of the study area were processed and analysed. Fieldwork data were synthesized with the processed satellite data sets for spatial analysis in a GIS environment. The study revealed that both communities have no physically defined boundaries between them because houses had been built across the boundaries more than a century ago. The corridor of the war front has been abandoned and deserted in some sections. Meanwhile, the two communities continue to increase in spatial extent in spite of the communal clash that ravaged them. The recent spatial urban growth has frog-jumped away from easy reach of possible future re-occurrence of the communal clash. Almost all Yoruba non-natives of the two communities have relocated away from the corridor of the war front to the community outskirt with which individuals have sympathy. From this experience, it could be established that satellite remote sensing data and application of GIS can provide a means of rapidly geovisualizing and assessing the dynamics of urban growth so that timely action can be taken to control and coordinate urban sprawl. The factors attracting the axial/sectoral expansion have been developed to provide a guide for Urban Planners, Local Planning Authorities and developers for improved planning of infrastructural facilities. The study supports the much advocated 5-year period for urban monitoring so as to stem slums in our urban centres.

THE USE OF REMOTE SENSING DERIVED INFORMATION IN SUPPORT OF UGRADE INFORMAL SETTLEMENT PROGRAMME, (Oral, Human Security and Health)

Ilan Guest, SATPLAN
Naledzani Mudau, South African National Space Agency (SANSA)

ABSTRACT
Background
More than 10% of the South African’s 50 million people live urban informal settlements. Living conditions within these settlements are typically poor with residents facing a range of basic livelihood challenges,
including poor access to basic sanitation and water supply, solid waste accumulation, recurrent shack fires, safety and security risks, and a range of health hazards. South Africa has established a National Informal Settlement Development Programme (NUSP) to respond to these challenges. This programme was designed to support the National Department of Human Settlement (NDHS) in its implementation of the Upgrading Informal Settlements Programme (UISP) in the objective of eventually upgrading all informal settlements in the country. South Africa currently has an estimated 2.1 million housing unit’s backlog. This project investigates how remote sensing can be used as a tool to monitor informal settlement expansion dynamics in support of North West Province UISP.

**Objectives**

The objective of the project is use remote sensing technology to map the location of informal settlements, identify key characteristics, and monitor their growth dynamics. Having up to date information regarding where informal settlements are and how they are growing over time will allow the authorities to assess informal settlements housing upgrade progress, and make informed decisions regarding planned development projects taking into consideration the current status and trend of the informal settlements.

**Methodology**

The project was done in three phases:

**Development of informal settlement base layer**

This phase of the project involved mapping of informal settlements using 2.5 m SPOT 5 satellite imagery to create a base layer of informal settlements. This was done through image interpretation and manual digitization of the extent of the identified settlements in a GIS environment. Various workshops were conducted with the local authorities to verify accuracy of the mapping and linking of attributes relating to upgrading status of the mapped informal settlements.

**Development of informal settlement historical layer**

The creation of the historical layer was done by mapping of settlements captured on satellite imagery with medium to high spatial resolution dating back to 1994. This was done to estimate the growth rate of each informal settlement, as well as identify their year of origin and spatial growth patterns.

**Dwelling inventory**

This phase involved mapping of individual structures within each identified informal settlement using very high resolution imagery. The location of each dwelling was represented by a point. This was done through image interpretation in a GIS environment. Given the complex nature of informal dwelling units, that often are not ‘stand-alone single dwellings’, an understanding of informal built form was key in assisting the image interpretation process.

**Results**

The results provide exact position of the location, estimated population and the growth pattern of each informal settlements. Training was provided to the end users to ensure optimum use of the results and integration of GIS data that will assist them in decision making regarding UISP projects. Special attention was given to the User Interface (UI) of the results, in an attempt to integrate the data into the project management activities of the housing authorities. Project information was packaged into a hard copy and interactive ‘Atlas’ format, allowing for simple and rapid access to the results by non-GIS professionals.

**Conclusion**

The results show that remote sensing and GIS can provide invaluable input to the existing informal settlements upgrading programme by providing a standardized dataset upon which government at various levels of jurisdiction can act in unison in addressing a regional phenomenon.

**Way Forward**

There is a need to provide other UISP authorities in other provinces or municipalities with up to-date information regarding the status of informal settlement and to enable them to track their informal settlements upgrade projects. The transfer of human skills capital to the public sector for informal settlement (and other spatial) monitoring is of utmost importance for the improvement of government service delivery.
ETUDE DE LA CROISSANCE URBAINE RECENTE AU MAROC A L’ECHELLE REGIONALE PAR LES IMAGES LANDSAT TM: CAS DE LA REGION DOUKKALA-ABDA

LEBAUT Sébastien\textsuperscript{1}, SGHIR Said\textsuperscript{2}

1. Centre d’Etudes Géographiques, EA n°1105, Université de Lorraine, France
2. Faculté poly-disciplinaire de Khouribga, Université de Hassan Ier, Maroc.

MOTS CLEFS: Image Landsat, croissance urbaine, terres agricoles, Doukkala-Abda, Maroc

ABSTRACT
La double croissance démographique et économique récente au Maroc a provoqué une croissance urbaine soutenue dont découlent des conflits pour l’occupation de l’espace. Si ce trait essentiel de la géographie marocaine actuelle est largement étudié, il l’est sur la base de documents et d’outils traditionnels tels que les statistiques démographiques ou les données cadastrales ; Or de tels sources d’information ne permettent pas une vision spatiale d’ensemble ni synchrone de ces changements rapides depuis le début des années 80, période à partir de laquelle ces croissances se sont accélérées.

Le travail proposé a pour objectif une cartographie multidate de l’habitat à l’échelle de la région administrative Doukkala-Abda. Cette région de 13 285 km\textsuperscript{2} est particulièrement intéressante au titre du thème abordé ; Sa population a doublé depuis le début des années 1980 et elle renferme un des plus grands périmètres agricoles irrigués du Maroc qui fait justement l’objet d’un mitage croissant sous la pression démographique.

La poursuite de l’objectif s’appuie sur des images Landsat TM acquises sur une trentaine d’années. Les méthodes d’extraction de l’affectation des terres permettent d’une part de cibler l’habitat mais également de dériver les autres grands types d’occupation du sol de telle manière à pouvoir également identifier et quantifier les plus affectés. Les résultats obtenus sont validés sur le terrain et assortis d’une incertitude.

TOWARDS MANAGING GIS DATA INTEGRATING GPS TRACKING:
APPLICATION TO TETUAN CITY

Abdellah El Abbous, Naoufal Raissouni, Abdelilah Azyat, Omar Benarchid, Samir El Adib, Nizar Ben Achhab, Mohamad Lahraoua and Asaad Chahboun
Remote Sensing & Mobile GIS Research Unit.
University Abdelmalek Essaadi (UAE: www.uae.ma)

KEYWORDS: GIS, GPS, GPS Tracking, MGISP.

ABSTRACT
Geographic Information System (GIS) fields and solutions are seeing rapidly growing applications and demand, for mapping and location based services. Generally, these platforms rely on rich high resolution satellite imagery, road, land surface, geographic layers, geo-coding, geo-processing capabilities and databases querying. Merging a GIS infrastructure features with some strong web services cloud based creates the best user experience and extends GIS applications and investments. In addition, scalable solutions can be built using an extensible architecture for managing GIS data.

In the present paper, a managing GIS data application has been developed for Tetuan city (Morocco) and surrounds. Thus, integrating Geographic Positioning System (GPS) tracking and high availability techniques. This application, will approach web server tools which have the ability to export or import geospatial information, change detection with GPS tracking capabilities for mobile sensors using an interactive user interface. Furthermore, the application proposes integration with a Mobile GIS Platform (MGISP), and mobile modular GIS database features as well. In addition, analytic work will focus on results driven by data and measures for different GPS equipments. Hence, we will be able to improve GPS accuracy and continuity and adapt the end client measures to the high resolution mapping services.
THE EFFECT OF LAND COVER CHANGE ON SOIL PROPERTIES AROUND KIBALE NATIONAL PARK

Azanga. O, Mwerera, R, Natumanya R., Nyenje R, Oluka M., Ongom, B, Sirike, J, Twongyirwe, R. Makerere University Institute of Environment and Natural Resources, P. O. Box 7062 Kampala Uganda

KEY WORDS: Pollution loading, aspect, household income; livelihood; Uganda

ABSTRACT
The change from natural forest cover to tea and Eucalyptus induced changes in top soil properties. The objectives of this study were to examine the effect of land cover change and landscape position on the physical chemical properties of soils around Kibale National Park. Land cover change, aspect and slope can control the movement of water and material in a hill slope and contribute to the spatial differences of soil properties. A total of 36 soil samples were taken at 0–15 and 15–30 cm depth from natural forest, Tea plantation and eucalyptus on three ridges around Kibale National Park; on the slope positions were Tea and Eucalyptus occur: back slope and foot slope positions. Results showed change from forest cover to Tea and Eucalyptus has induced changes in: exchangeable Mg and Ca, available P, SOM, pH and bulk density of subsoil (P<0.05). Landscape positions within land use also significantly influenced most of the soil properties (P<0.05).

MONITORING INFORMAL SETTLEMENTS USING SAR POLARIMETRY

W. Kleynhans1,2, B.P Salmon1,2
1. Department of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa
2. Remote Sensing Research Unit, Meraka Institute, CSIR, Pretoria, South Africa

ABSTRACT
Introduction
The most pervasive form of land-cover change in South Africa is human settlement expansion. In many cases, new human settlements and settlement expansion are informal and occur in areas that were previously covered by natural vegetation. Informal or unplanned settlements usually evolve as people move closer to employment opportunities. These settlements can occur in various locations and are normally without basic services, which includes electricity, running-water, water-borne sewage and refuse removal. The spatial layout is often not planned but informally developed by the inhabitants of the settlements themselves.

The use of optical satellite data for the detection and mapping of new informal settlements has been an active research topic [1, 2] and the objective of this paper is to investigate the possible role that SAR polarimetry could play in the monitoring of these informal settlements.

Data description
2.1. Study area
The study area that was considered is located on the border of the Kruger national park located in northern South Africa. Two RADARSAT-2 images where used in the study, one was inside (right) and the other outside (left) of the national park (figure 1). The study area covers an approximate 1260 km2 with a center coordinate of (24°51′02.63″S ; 31°20′35.19″E).

Methodology and preliminary results
RADARSAT-2 offers quad polarization and as such gives the potential to use full polarimetry information in the quest for informal settlement mapping. The rationale of the experiment is as follows: The Kruger national park is a protected environment and, as such, there are no unplanned informal settlements within the park boundaries. There are however areas adjacent to the park where there are a number of informal settlements, an example of which is the study area that was chosen (see section 2.1). By utilizing two RADARSAT-2 images, one inside the park and the other, outside of the park (but still in close proximity of the first), transformation
methods targeted at enhancing settlements could easily be tested by contrasting the two SAR images which predominantly represents “settlements” and “natural vegetation” respectively. The image that was generated in figure 1 used the single bounce, double bounce and volume scattering to represent the blue, red and green band respectively. The informal settlements had a high level of double bounce relative to the non-settled areas and could effectively be distinguished (figure 1).

**Fig. 1.** Top: Two RADARSAR-2 images, one on the left and the other on the right of the Kruger national park boundary, examples of settlements are indicated by red circles. Bottom: Optical image of an informal settlement on the park boundary detected using the SAR image (courtesy of GoogleTMEarth).

**Conclusion**

In this paper, the feasibility of using SAR as opposed to optical data in the mapping and detecting of informal settlements in South Africa is investigated. Preliminary results show that using polarimetry, it is possible to effectively distinguish informal settlements from natural vegetation by evaluating the simplest of scattering mechanisms. This was confirmed by evaluating two SAR images, one inside a national park which contained mostly natural vegetation and another in close proximity next to the national park which had numerous settlements.

**References**


**USING THE NON-NEGATIVE MATRIX FACTORIZATION BASED ON SATELLITE IMAGES FOR THE COLLECTION OF AGRICULTURAL STATISTICS**

**Z. BENYELLES D. YOUSFI**

Division of Earth Observation, Centre of Space Techniques, 01, AV.de Palestine, BP 13.31200, Arzew, Algeria

**KEYWORDS**: remote sensing, blind source separation, non-negative matrix factorization, hyperspectral images

**ABSTRACT**

Agriculture is fundamental and remains an important goal in the Algerian economy, based on traditional techniques and structures, it generally has a goal of self-consumption. The collection of agricultural statistics in
Algeria is made using traditional methods which consist in investigating land use through survey and field survey, these statistics suffer from problems such as poor data quality, the long delay between collection of their last final availability and high cost relative to their reduced use. The objective of this work is to develop a processing chain for a reliable inventory of agricultural land by trying to develop and implement a new method for extracting information. Indeed, this methodology allowed us to combine remote sensing data and field data, to collect statistics on the area of different land.

The contribution of remote sensing in improving agricultural statistics - in terms of area - has been studied in the wilaya of Sidi Bel Abbes. It is in this context that we have applied a method of extracting information from satellite images, this method is called the non-negative matrix factorization which does not consider the pixel as a single entity but will look for the components of the pixel itself. The results obtained by the application of the MNF were compared with field data and the results obtained by the method of maximum likelihood. We have seen a greater rapprochement between the results of the MNF and those of field data. We believe that this method of extracting information from satellite data leads to interesting results of the different types of land uses.

**ESTIMATION DES SUPERFICIES CULTIVEES A PARTIR DE L'IMAGERIE SPATIALE DANS LES DEPARTEMENTS DE DIOURBEL ET TAMBAOUNDA (SENegal)**

**Mbaye Diop et Gualbert S. Dorégo**

1. Institut Sénégalais de Recherches Agricoles/Laboratoire d'Enseignement et de Recherche en Géomatique

**ABSTRACT**

Le Sénégal est un pays sahélien essentiellement agricole dont le défi alimentaire reste encore un enjeu majeur. Le secteur agricole occupe 65% de la population active et s'affirme comme un des principaux moteurs de l'économie sénégalaise, en termes de revenus de budget, en contribuant pour 17% du PIB. À l'instar des pays d'Afrique sub-saharienne, le Sénégal fait face à une forte variabilité des productions agricoles mais également à un problème de maitrise de leurs statistiques. Leur acquisition nécessite le déploiement de moyens matériels et humains lourds et coûteux. La méthode utilisée nécessite beaucoup de travail de terrain mais aussi de saisie des informations et le niveau de précision des données est encore difficile à établir. L'allongement des délais de publication officielle des informatiques ne favorise pas une bonne conduite de la politique de sécurité alimentaire.

La démarche proposée dans cette étude a pour objectif, l'amélioration de la méthode d'estimation des superficies, déroulée par les services techniques par l'utilisation de données satellitaires et de données de terrain. Elle permet aussi de raccourcir les délais de disponibilité des informations sur les superficies agricoles.

Le principe repose sur la classification de l'image satellitaire en se basant sur la réponse radiométrique des éléments du paysage agricole. Des espaces agricoles pilotes, identifiés sur le terrain, ont servi de zones d'entraînement pour la classification mais également en vue de valider l'information satellitale et d'affiner la classification automatique établie au préalable.

L'étude a eu pour cadre géographie les départements de Diourbel et de Tambacounda, entre 2004 et 2005. Les premiers résultats montrent une bonne estimation des superficies totales cultivées à partir de la classification supervisée d'images Spot 5. Certaines cultures saisonnières sont également bien discriminées, mais il y'a encore de réelles contraintes liées à l'association des cultures et à l'envahissement des parcelles cultivées par les mauvaises herbes.

**LE SITE D'INTERET BIOLOGIQUE ET ECOLOGIQUE (SIBE) D'AIN ASMAMA : 20 ANS APRES, QUELS CHANGEMENTS ?**

**Adnane LABBACI\(^1\) et B. KABBACHI\(^2\)**

1. Université Ibn Zohr, Faculté des sciences Ibn Zohr d'Agadir, Département de Géologie, B.P 8106, Agadir, Maroc, e-mail : labbaciadnane@yahoo.fr
2. Université Ibn Zohr, Faculté des sciences Ibn Zohr d’Agadir, Département de Géologie, B.P 8106, Agadir, Maroc
MOTS CLES : SIBE, Ain Asmam, LANDSAT, classification dirigée, occupation du sol, Maroc.

RESUME
Concernant ce grand SIBE de l'Ouest du Maroc, ses qualités bioécologiques en particulier sa flore très spécifique et originale a attiré les naturalistes depuis longtemps. Cette région semble toujours assez préservée malgré les menaces avancées anthropiques et celles de l'érosion. 
La sécheresse en cours a bien sûr fortement affecté les écosystèmes, mais pour ce SIBE, l’état des strates herbacées et arbustives permet d’envisager une rapide restauration des potentiels dès que le climat sera plus clément.
Pour cartographier et quantifier les changements de l’occupation du sol de ce SIBE, à partir des images LANDSAT à différentes dates, nous avons opté pour une classification dirigée.
L’analyse des séries temporelles d’images LANDSAT a permis de mettre en évidence que, durant la période 1988-2000, la superficie des forêts a régressé en faveur des pratiques culturales, période avant la création du SIBE, tandis que durant la période 2000-2010, l’aire de répartition des strates arbustives a nettement progressé.

TELEDETECTION ORIENTEE OBJETS DE LA COMPOSANTE ARBOREE DE PARCS AGROFORESTIERS. EXEMPLE DU PAYS DOGON AU MALI

Aude Nuscia Taïbi 1, Aziz Ballouche 2, Benjamin Dolfo 3
1 ESO-Angers, UMR 6590 CNRS, L’UNAM, Université d’Angers, 11 Bvd Lavoisier 49000 Angers, France
2 LETG-Angers LEESA, UMR 6554 CNRS, L’UNAM, Université d’Angers, 2 Bvd Lavoisier F 49045 Angers cedex 1, France
3 ESO-Angers UMR6590 CNRS, L’UNAM, Université d’Angers, 11 Bvd Lavoisier 49000 Angers

RESUME
La caractérisation et le suivi de la dynamique d’évolution de ces parcs agroforestiers sont en général réalisés à partir d’observation de terrain. Lorsque la télédétection est mise en œuvre, elle s’appuie sur des traitements basés sur la composante spectrale des images satellites particulièrement les indices thématiques (NDVI) ou les classifications. Malgré les apports de ces traitements combinés, ils s’avèrent souvent insuffisants à discriminer de manière suffisamment fine les formations végétales de ces régions soudano-sahéliennes, en raison notamment de leur hétérogénéité puisque constituées par l’association en proportion variable de strates herbacée et arborée ou arbustive, difficilement séparables par télédétection.
Nous avons donc mis en œuvre sur des images satellites (Quickbird et Spot 5) et des photographies aériennes du Pays dogon au Mali, une approche orientée objet (sous Envi-ex) permettant de travailler non seulement sur les caractéristiques spectrales des objets, mais sur leurs caractéristiques géométriques (longueur, périmètre...), topologique (position dans l’image et par rapport aux autres objets) et sémantiques (lié à sa signification)
Cette méthodologie a permis d’identifier et dénombrer automatiquement tous les ligneux de cette région et d’en établir un suivi diachronique de 1952 à 2004.
La méthode a également permis de définir une typologie de paysages de parcs agroforestiers et de leur évolution sur cette période. Ces résultats remettent en question l’idée reçue largement diffusée d’une dégradation généralisée de ces milieux soudano-sahéliens au cours du XXe siècle. Les processus d’évolution de ces terroirs mis en évidence relèvent plutôt de changements d’agrosystèmes et de la création de nouveaux équilibres dynamiques complexes entre milieux et sociétés dans le cadre de stratégies d’adaptation et de résilience.
CARACTERISATION ET SUIVI DIACHRONIQUE PAR TELEDETECTION ORIENTEE PIXEL ET ORIENTEE OBJETS DES PAYSAGES AGROFORESTIERS D’AZILAL (MAROC)

Aude Nuscia Taïbi, Mustapha El Hannani, Abdelhalim Benyoucef, Yahia El Khalki, Aziz Ballouche
1 ESO-Angers, UMR 6590 CNRS, L’UNAM, Université d’Angers, MSH, 5bis Bvd Lavoisier 49045 Angers cedex 1, France
2 ESO-Angers, UMR 6590 CNRS, L’UNAM, Université d’Angers, MSH, 5bis Bvd Lavoisier 49045 Angers cedex 1, France
3 FST, Université Sultan Moulay Slimane, Beni Mellal, Maroc
4 FLSH, Université Sultan Moulay Slimane, Beni Mellal, Maroc
5 LETG-Angers LEESA, UMR 6554 CNRS, L’UNAM, Université d’Angers, 2 Bvd Lavoisier F 49045 Angers cedex 1, France

RESUME
Les paysages de la région d’Azilal, comme tous ceux de moyenne montagne du Maroc, sont fortement anthropisés et souvent abordés en termes de dégradation. La végétation y est généralement vue par les naturalistes comme une forme secondaire d’une formation originelle profondément transformée par les activités humaines. En lien avec cette forte anthropisation, les processus morphogéniques, marqués localement par une forte érosion, ont justifié l’emploi des termes de dégradation pour y décrire les processus à l’oeuvre. Pourtant, la réalité semble plus complexe.
L’analyse à partir de télédétection des paysages agroforestiers de la commune rurale d’Agoudi-nl’Khir dans la province d’Azilal, représentative de ces paysages de moyenne montagne anthropisée semi-aride à hiver froid, permet de nuancer ces descriptions et de mettre en évidence la complexité de ces paysages produits de la confrontation sur le long terme entre les sociétés et leur environnement.
La combinaison de traitements d’images satellites (image Spot 5 à 2.5m de résolution de juin 2008 et Juillet 2007 et image Quickbird de mars 2008 extraite de Google Earth) et photographies aériennes (1985 au 20 000 et 1913) orientées pixel et orientées objet (avec Envi ex), permet de travailler conjointement sur les composantes spectrales et spatiales des images satellites, et d’intégrer les attributs texturaux et spatiaux (longueur, périmètre, position dans l’image et par rapport aux autres objets ..) des objets contenus dans les images. Cette double approche permet notamment de caractériser les formations d’arbres hors forêt, mal définies et rarement analysées comme telle dans les travaux sur ce type de milieux.
Ces suivis diachroniques montrent que les paysages de cette région de moyenne montagne, loin d’être des reliques de paysages passés, sont actifs et conservent un rôle social important. Dans un contexte de faible SAU (12%), les paysages agroforestiers actuels de cette zone sont la manifestation des relations entre les hommes, avec leur culture, leur vécu, leurs savoir-faire, leurs pratiques, leurs technologies d’une part, et les formes, les potentialités et les contraintes de leur environnement d’autre part.

MODELING HABITAT SUITABILITY USING ENVIRONMENTAL PARAMETERS AND MACHINE LEARNING ALGORITHM: THE POTENTIAL AREAS OF COSSID MOTH (CORYPHODEMA TRISTIS) INFESTATIONS ON EUCALYPTUS NITENS

Onisimo Mutanga, Elhadi Adam, Riyad. Ismail
a University of KwaZulu-Natal, Discipline of Geography, P. Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
b Geography Department, Elfashir University, P. Bag 125, Elfashir, Sudan

KEYWORDS: Random Forest; environmental variables, Variable Selection, Cossid Moth; Eucalyptus plantations.

ABSTRACT
The first signs of cossid moth, Coryphodema tristis, was first noted on Eucalyptus nitens trees in Mpumalanga province, South Africa in July 2004. Currently, the moth poses a major threat to commercial forestry in the
country. Eucalyptus plantations have been increasingly recognized as the most important component on the South African forestry industry due to desirable pulping and above average paper properties. Therefore, C. tristis poses a significant threat to the South African forestry industry and the markets that are dependent on E nitens products. Developing spatial patterns of the distribution of the moth would be of considerable benefit to both researchers and forest managers, thereby ensuring effective forest management practices and a better understanding of the cossid moth.

In this study, selected environmental and topographical variables were utilized to model the susceptibility of Eucalyptus nitens forests to cossid moth attack, thereby providing insight into key variables that may influence the occurrence and spread of the moth. A zigzag sampling technique was used to measure the number of infected trees within a pre-determined number of transects across each stand. The external symptoms of C. tristis damage in E nitens were used to identify the present and absent of the moth on Eucalyptus nitens (Fig 1).

A random forest algorithm was used within spatial framework to select best environmental and topographical variables to model the susceptibility of Eucalyptus nitens forests to cossid moth infestation. Result indicate that four variables included elevation, maximum temperature for September, maximum temperature for April and the median rainfall for April were able to model the presence and absence of C tristis on the Eucalyptus nitens forests with an overall accuracy of 81.02% and a kappa value of 0.60 (Fig 2). A partial dependence plots were used to explain the relation the relationship between the probabilities of the presence of the cossid moth and selected environmental variables. These results assist forest managers to focus their existing detection and monitoring efforts on specific forested areas that are vulnerable to C tristis infestations.

Fig 1. External symptoms and some examples of physical damage of Coryphodema tristis infestation occurring on Eucalyptus nitens trees: (a) Emergence holes and galleries penetrating into the heartwood (b)Larvae pupate in woven silk and sawdust cocoons(c) Damage to standing trees, and (d) Boring dust evident on of the tree. Pictures provided courtesy of SAPPI forests, South Africa.

Fig 2. Map showing the habitat susceptibility of cossid moth (C tristis) on E. nitens. The map was developed using the selected environmental variables (n = 4) and random forest algorithms.
FOREST FUEL TYPES MAPPING WITH WORLDVIEW-2 IMAGERY IN THE CANARY ISLAND

Alfonso Alonso-Benito (1), Manuel Arbelo (1), Pedro A. Hernández-Leal (1), Lara A. Arroyo (2)
(1) Grupo de Observación de la Tierra y la Atmósfera (GOTA), Universidad de La Laguna, 38206 La Laguna, Canary Islands, Spain
(2) Centro de Investigación del Fuego (CIFU). Fundación General del Medio Ambiente de Castilla-La Mancha, 45701 Toledo, Spain

ABSTRACT
Detailed information about the conditions, quantity and spatial distribution of forest fuels types is important in forest management and predicting fire behavior. In this work, the capability of very high spatial resolution WorldView-2 data with an object-based image analysis (OBIA) approach to map fuel types has been evaluated. WorldView-2 has one panchromatic band and eight multispectral bands with spatial resolution of 0.5 and 2 meters respectively. The study area has an extension at around 25 km2 and is located in the north of Tenerife Island (Canary Islands, Spain). It includes a very complex orography and vegetation endemics species. Field data were collected from 70 circular plots with a radius of 10 m, since May to December 2011. The plots have been used to train and validate the classification results. The first step of OBIA classification is the segmentation, based on shape, size and color, which splits the image into unclassified objects that form the basis for the next step. Different segmentations have been used. In the second step, the objects are classified on forest fuel types. Five classification methods have been evaluated: a) Nearest Neighbor (NN) with samples, b) Membership Function (MF) using threshold values for different classes, c) Support Vector Machine (SVM), d) Bayes Classifier (BC) and e) k-nearest neighbor (KNN). The MF and BC classification have produced an overall accuracy around of 84%, while the NN, SVM and KNN methods have reached values close to 87%. On the other hand, the accuracy has been also evaluated in term of allocation disagreement (errors due to inaccurate allocation of fuel types) and quantity disagreement (errors due to inappropriate proportion of the identified fuel types).

This work was supported by the Ministerio de Ciencia e Innovación (MICINN) under Grant CGL2010-22189-C02.

TRACKING LOGGING ROADS TO ASSESS THE IMPACT OF COMMERCIAL LOGGING ON THE FOREST ABOVE GROUND BIOMASS: THE CASE OF SOUTH EAST (JENGI) CAMEROON

Richard Tamungang
GIS Officer
WWF Jengi South East Forest Programme, Immeuble Panda, Rue La Citronnelle, BP 6776, Bastos Yaounde, Cameroon

KEYWORDS: Logging roads, forest damage, biomass, habitat fragmentation, poaching, GIS, Spot imagery

ABSTRACT
Logging roads pose a serious problem within the Jengi South East Programme area as they lead to negative aspects of commercial logging such as; habitat fragmentation, habitat loss and deterioration, biodiversity destruction on the area covered by the road, opening up of the forest canopy and access into the forest by poachers. The main aim of this study was collecting and analyzing spatial data on logging roads and evaluating their impact on the forest ecosystem. Field data and spot 2.5m spatial resolution imagery was used in the analysis.

The South East lowland forest area of Cameroon constitutes part of the lowland Congo basin forest which is highly rich in biodiversity; including large mammals, birds, fishes, butterflies, amphibians, reptiles and rich forest flora. This species composition is not surprising as tropical forest contain more species than any other biomes, though a high proportion of these species is threatened (Lock and Dearden 2005). This rich forest area which is also a huge stock of above ground biomass has continued to decrease due to increasing urbanization, high demand for agricultural land and agricultural practices of slash and burnt, demands for firewood for domestic use, commercial timber exploitation and mining thereby modifying numerous attribute of the ecosystem (Hall, J. S., et al. 2003).
Timber exploitation or commercial logging which is the main aspect contributing to forest area decline is a viable economic activity in this region. In recent years the government also leases parts of these logging concessions for mining (gold, cobalt, nickel, iron ore and diamond).

**CARTOGRAPHIE DES ZONES INONDABLES À L’AIDE D’UNE MODÉLISATION HYDRAULIQUE.**

**CAS : OUED EL HARRACH.**

ASTITE Samira Wissem et BELABID Nesr-Edine

Université des Sciences et de la Technologie Houari Boumediene, Faculté des Sciences de la Terre, de la Géographie et de l’Aménagement du Territoire

**MOTS CLEFS**: risques naturels, SIG, modélisation hydrologique et hydraulique, système d’alerte, inondation, cartographie.

**RÉSUMÉ**

De nos jours, les catastrophes naturelles sont devenues très fréquentes, très graves et touchent n’importe quel point sur la terre ; et ce, en raison du changement climatique, de la croissance démographique et de l’urbanisation rapide. La vulnérabilité à ces aléas naturels est plus élevée dans les pays en développement, où les populations ont tendance à occuper les zones les plus exposées aux risques, et où l’absence des systèmes d’alerte et des plans de prévention des risques naturels. Parmi ces aléas nous nous sommes intéressés dans ce travail aux inondations, qui représentent le risque naturel le plus grave en raison de l’importance des dégâts causés, du à la participation indéniable de l’homme à l’aggravation de leurs formation par l’urbanisation et l’implantation des activités dans les zones inondables.

L’Algérie est l’un des pays du monde, confronté aux phénomènes de crues et d’inondations. Ces phénomènes ont provoqué des catastrophes destructrices et ont occasionné d’importants dégâts matériels et humains ; Ceci s’explique par la présence d’une forte urbanisation au plus près des cours d’eau et à l’absence des instruments d’urbanisme qui réglementent l’occupation du sol et définissent les espaces non constructibles ; si bien que de nombreux quartiers se sont développés anarchiquement et qui y plus, dans des zones à risques d’inondation ; ainsi, les crues importantes n’ont lieu que rarement, donc les personnes oublient la dangerosité de l’oued et s’installent dans le lit majeur de celui-ci.

Pour cet effet, la problématique des inondations est particulièremen complexe à traiter, elle exige des études de différentes disciplines (hydraulique, hydrologique, géomorphologique, climatique, socio-économique...); pour permettre bien la maitriser. Au temps que géographes et Aménageurs ; nous proposons une méthode qui permet de gérer l’inondation à l’intérieur des espaces urbains. Cette méthode se conjuge avec les situations actuelles c’est-à-dire l’urbanisation qui s’est déjà faite dans l’espace appropriée au cours d’eau, autrement dit, est d’essayer de vivre avec les manifestations de ces cours d’eau, et d’adapter la ville et les comportements des usagers de la ville à cette situation d’inondation.

Cette méthode consiste en la réalisation d’une cartographie des crues au moyen d’une modélisation hydrologique et hydraulique à l’échelle du bassin hydrographique ; qui permet de déterminer et de délimiter les zones d’aléa, de vulnérabilités et notamment les zones à risques d’inondation en précisant l’ensemble des zones inondables et la hauteur de référence pour chaque zone déclarée inondable. Puis les intégrées dans les plans de gestion et d’aménagements des territoires. Cette méthode peut servir de base à l’élaboration d’un Plan de Prévention des inondations pour la gestion et la planification de l’urbanisation.

Après y avoir identifié ces zones et représenter dans l’espace comment ce type d’événement peut se propager, il faut développer des outils technologiques (des systèmes de veilles et d’alertes) qui permettent de transmettre l’information sur le risque d’inondation à venir et d’informer les populations menacées.

Le choix de la zone d’étude était basé sur la présence de l’enjeu humain à l’aval du cours d’eau (Oued El Harrach, à écoulement permanent) dont nous remarquons, l’existence d’une forte urbanisation sur ses deux rives, ajoutons la forte fréquence des événements historiques qu’a connu l’oued El Harrach dont on dénombre presque 14 crues dans le siècle passé. Ainsi que, la situation de sa partie aval dans la plaine, donc l’existence de très faibles pentes à nul, ce qui ne permet pas l’écoulement facile vers l’aval.
UTILISATION DE L’IMAGERIE SATELLITAIRE POUR LE SUIVI GLOBAL DE LA CAMPAGNE AGRICOLE

CRTS, M.F. Smiej, smiej@crts.gov.ma

CRTS, M. Merdas, merdas@crts.gov.ma

ABSTRACT

Cette présentation a pour objectif de dresser un bilan d’une expérience d’utilisation de l’imagerie satellitaire à basse résolution pour le suivi global de la végétation. Après une brève description de la méthodologie adoptée pour la mise en place de ce système de suivi qualitatif de la campagne agricole, une synthèse des résultats obtenus sur une expérience de 10 ans sera présentée, en insistant sur les axes d’amélioration d’un tel système. Il sera également traité, dans cette présentation, une autre application de ce système pour l’estimation de la production agricole des céréales d’automne.
EO DATA TO SUPPORT THE OPTIMAL MANAGEMENT OF IRRIGATION WATER IN WESTERN MOROCCO: CASE OF SEMI-ARID REGION OF DOUKKALA

Nadia AKDIM¹, Kamal LABBASSI¹, Adnane Habib¹, Massimo MENENTI², Latifa GANA³ & Salah Er-raki⁴
1. Faculty of Science, Chouaib Doukkali University, El Jadida, Morocco
2. Technological University of Delft, Netherlands
3. Regional Office of Agricultural Development of Doukkala, El Jadida, Morocco
4. LP2M2E, Faculty of Science and Technology, Cadi Ayyad University, Marrakech, Morocco.

KEY WORDS: Evapotranspiration, Irrigation, remote sensing.

ABSTRACT
Efficient water use is the key for sustainable management of water resources. The major reason of non-efficient management of water resources is non availability of reliable hydrological information about the actual water used by different agricultural crops with in a large irrigation system. Therefore, an estimation of spatially distributed crop water consumption is important and challenging to determine water balance at different scales to promote efficient management of water resources.

Agriculture in Morocco’s Doukkala region is of great importance for national food production. The irrigated area of Doukkala is among the largest and earliest developed areas in Morocco, remarkable for its size and strategic importance for the national production, especially for sugar beet (38%) and wheat (20%). However, increasing numbers of droughts are limiting the supply of water and affecting productivity. Addressing this issue, a scientific activity is developed to implement a system that uses satellite data to estimate the amount of water actually needed by crops. The objective of the work is to assist the ORMVAD (Regional Office of Agricultural Development of Doukkala) in their project of re-conversion of irrigation systems from gravitational to drip.

The research consists to determine the crop water requirement (CWR) for increase efficiency in the use of water. Combination of spot data, meteorological and agronomical data was used to produce maps of CWR. For this, two approaches (FAO-56 model and Analytical Approach) were followed to establish the crop coefficient (Kc) and crop evapotranspiration (Etc), parameters required for the production de maps of CWR.

In this study, SPOT images chosen during a drought year (1994), a normal year (2005) and a wet year (2008), has allowed us to track the evolution of the various parameters needed. The Comparison between the CWR and water allocation given to farmers, show that the water allocations are much higher than the CWR while the satisfaction rate of irrigated waters does not exceed 50%. This is due to the loss of water by evaporation from the soil related to the use of the gravitational technique of irrigation in a semi-arid climate.

The resulting maps are proving instrumental in optimizing the use of scarce water resources for irrigation, protecting the farmers from losing their harvests to drought. In the future the methodology should be developed by the introduction of additional parameters and data, and applied to the pilot areas, taking into account the type of crop (winter crop: wheat, the summer harvest and throughout the year, sugar beet).
COUPLAGE D'UN SIG AVEC LE MODELE AGRO-HYDROLOGIQUES SWAT POUR LA MODELISATION DES ECOULEMENTS ET DE TRANSPORT SOLIDE DU BASSIN D'OUE D'HATHAB EN TUNISIE CENTRALE

Narjes Chaâbane Ben Salah & Habib Abida
1. Institut Supérieur des Etudes Technologiques de Sfax
2. Faculté des Sciences de Sfax et Unité de recherche 'Hydrosciences Appliquées', ISSTEGabès

MOTS CLES: Modélisation hydrologique, érosion, le modèle SWAT.

RESUME
Le problème de gestion des ressources en eau et le risque de dégradation des sols a été centre de plusieurs études en Tunisie. En effet, la Tunisie se caractérise par la rareté de ses ressources en eau et par une variabilité spatio-temporelle accentuée du climat. En plus, l'érosion hydrique combinée aux activités anthropiques, contribuent à l'augmentation des risques de dégradation des sols et de désertification.

Cette étude vise à estimer les apports d'eau et évaluer le risque d'érosion des sols du bassin versant d'Oued Hathab situé en Tunisie Centrale (région de Kasserine) ayant une superficie de 2200km². Ce bassin a été aménagé, depuis 1990, par des ouvrages de Conservation des Eaux et de Sol. L'outil utilisé dans cette étude est le modèle SWAT (Soil and Water Assessment Tool) développé par le Département d'Agriculture des États-Unis. Le modèle, à base physique spatialement distribué à pas de temps journalier, a été conçu pour prévoir l'impact des pratiques de l'occupation du sol sur les apports liquides et solides dans des bassins versants caractérisés par des hétérogénéités spatiales du sol et d'occupation du sol sur de longues périodes. L'application du modèle nécessite une banque de données renfermant les données temporelles et spatiales pluviométriques et météorologiques, les débits, le modèle numérique du terrain, la pédologique et l'occupation du sol.

A partir des résultats obtenus, il ressort que le modèle reproduit efficacement les écoulements. Il permet de mieux comprendre le comportement hydrologique du système pour aboutir à une gestion optimale des ressources en eau et du risque d'érosion.

THE APPLICATION OF REMOTE SENSING ON THE IDENTIFICATION OF POTENTIAL FISHING ZONES FOR THE PELAGIC FISH SPECIES IN THE CONTINENTAL SHELF OF TANZANIA

R.J. Kayanda, S.B. Mahongo, B.L. Kuguru & M.M. Igulu
1. Tanzania Fisheries Research Institute (TAFIRI), P. O. Box 9750, Dar es Salaam, Tanzania

ABSTRACT
Preliminary results from the TAFIRI 'African Monitoring of the Environment for Sustainable Development' project (AMESD), using e-station are presented. An immediate benefit has been to establish a system visualising and processing ocean observation data in near real time to develop oceanographic environmental and meteorological models to produce maps for locating Potential Fishing Zones (PFZs).

The main objective is to identify and map PFZs along the continental shelf of Tanzania so as to optimise costs of locating fishing grounds, reducing search time for fish and the overall fuel costs. The purpose is to encourage local fishing communities to venture offshore thus reducing pressure on overexploited inshore areas. Currently, offshore stocks particularly pelagic fish, are underexploited due to poor knowledge of good fishing grounds. This important study has its origins in national and international policies of poverty alleviation, enhancement of food security and sustainable livelihood of the fishing community. Furthermore, the results will attract more investment in offshore fisheries within the Tanzanian Government’s ‘KILIMO KWANZA’ initiative that is designed to bring about Green Revolution and transform the agriculture and fisheries sectors in the country.
Adaptations of fish to their environment are influenced by many physical environmental factors, such as temperature, chlorophyll pigment concentration, salinity and dissolved oxygen. In particular, feeding and spawning migrations of fish are known to be influenced by environmental variables. Monitoring these variables in time and space using ship-based methods is time-consuming and expensive. With the advent of ocean remote sensing technology, a real-time picture of many factors can be linked to fish aggregations in PFZs.

To identify PFZs, we used satellite-derived Chlorophyll Concentration (CC), Sea Surface Temperature (SST) and Sea Surface Wind (SSW). Using these satellites derived environmental data it is possible to model locations where feeding aggregations of fish are most likely to occur (Solanski et al., 2010). PFZs can be identified through modelling of the interactions between the environmental variables in relation to fish distribution.

In a pilot study, the characteristics of PFZs were analysed alongside a sample of the results from commercial fishing operations off Mafia Island and Kilwa, Tanzania. The fishers were provided with GPS to collect geo-referenced fish catch data. In addition environmental data were collected from, in-situ measurements of temperature, salinity, turbidity, fluorescence and dissolved oxygen profiles, using a CTD (Seabird Electronics®, SeaCat SBE 19 Plus) and Chlorophyl a,(assayed spectrophotometrically) to compare with the fish catch and e-station data. Three day composites of the CC and SST images at 1 km spatial resolution were made from the e-station data, while QuikSCAT derived SSW vectors were used to quantify the variability of wind-induced water mass flow. SST fronts were computed from corresponding SST images using an algorithm developed by Siregar & Waars (2006). These were then overlaid on CC images for the corresponding days. The PFZs were generated wherever the thermo fronts matched with the CC gradients. Finally, the SSW images were overlaid onto the composite images of CC and thermo fronts to refine the locations of the predicted PFZs.

- Preliminary results from the two pilot sites show significantly higher catch rates of pelagic fish in the satellite derived PFZs as compared to elsewhere. High catches in the PFZs were associated with relatively cool and well oxygenated waters with high fluorescence. In conclusion, this study demonstrates that integrating satellite data with information from local communities to investigate PFZs of pelagic fish species in Tanzania can be an efficient synergy of private-public activity.

References
POTENTIAL ANALYSIS OF POLARIMETRIC IMAGES FROM COSMO-SKYMED FOR LAND USE/LAND COVER CHARACTERIZATION IN TEST-SITE OF BRAZILIAN AMAZON

João Roberto dos Santos¹, Adriana Rodrigues Azevedo¹, Fábio Furlan Gama¹, José Cláudio Mura¹ & Paulo Maurício Lima Alencastro Graça¹

¹. National Institute for Space Research – INPE, Av. dos Astronautas, 1758 - CEP.: 12.227-010 São José dos Campos – SP., Brazil
². National Institute for Research in the Amazon – INPA, Av. André Araújo, 2936 - CEP.: 69.060-001 Manaus – AM., Brazil

KEYWORDS: forest mapping, monitoring, radar, land cover, COSMO-SkyMed

ABSTRACT
In recent years, several studies on the application of radar data, both airborne and orbital levels, were performed as subsidies for inventory and monitoring activities of Brazilian tropical ecosystems. Examples of these recent studies are: Santos et al., 2009; Treuhaft et al., 2010; Gonçalves et al., 2011; Saatchi et al. 2011, which are related to the characterization of forest types and/or modeling the volume/biomass using coherent and incoherent SAR attributes at different frequencies and polarizations. Considering the availability of satellite COSMO-SkyMed images, and the request to determine the quality of its products at X-band, we elaborated a research project, whose goal is to expand the use of SAR as a tool for monitoring the forest tropical domain. Thus, the main objective of this study is to evaluate the potential of COSMO-SkyMed images at dual acquisition mode, to map the land cover/land use in the Brazilian Amazon. This area understudy is located in Humaitá municipality, South of Amazonas state, between the coordinates 7º 31’ S / 7º 39’ S and 63º 05’ W / 63º 19’ W. Images from StripMap mode (ascending orbit with incident angle of 27.5º and spatial resolution of 15m) in XHH and XHV polarizations, acquired in 1st Sept., 2011 were used. The images in Single Look Complex format were pre-processed and transformed into intensity mode. These images were geo-referenced using the digital elevation model (DEM) obtained from SRTM (Shuttle Radar Topography Mission) as reference. To reduce the speckle noise were carried out multi-look processing with 11 looks in azimuth and 2 looks in range and then filtering (Lee filter, windows 10x10). Besides the intensity images of HH and HV polarizations, the textural images (derived from the co-occurrence matrix) from the PCI Geomatic package, were also used. The textural attributes considered for the generation of these products were: average, variance, homogeneity, contrast, dissimilarity, entropy, second moment and correlation, totaling 8 images for each polarization. All these images were normalized afterwards, allowing to do a comparative analysis between them. We made an exploratory analysis by graphics of XHH - and XHVband responses of the land cover classes and its standard deviation values. This helps to understand the space of radiometric attributes among classes and the role of the scattering mechanisms which command the interaction of X-band signal with the targets. Then, the thematic classifications were performed based on the Context classifier algorithm. The accuracy of these classifications will be evaluated using the total accuracy and Kappa statistics. We also carried out a test of hypothesis of proportion to verify the significant level of differences among the accuracy values obtained from several classifications generated. Ground survey data (simultaneous to the radar data acquisition) related to the physiognomic conditions of land use/land cover classes (Open Primary Forest, Secondary Succession, Savanna Wooded, Grass and/or Shrub Savanna and Pasture fields), duly geo-referenced, are being used as training areas and test samples for the calibration of thematic classification and its performance analysis. The classification of the data set “textural images + intensity images” showed more overall accuracy (63.64% with Kappa value of 0.334% and k’ value of - 0.035%). Using only the dataset from HH and HV intensity images, the overall accuracy was minus 11%
However, considering the statistical rules, the results of hypothesis of proportion test show a not significant difference among the performance from both classifications, when considering 5% of the significance level
(z = 0.77). Since the structural variations among the different savanna types are subtle, the COSMOSkyMed data (based on dual polarimetric images) treated by contextual classifier are presented a moderate performance. We recommend for improve this thematic stratification the integration of multi-season COSMO-SkyMed data and also, to addition the VV and VH polarizations. Since this study is in progress, it is expected that COSMO-SkyMed data are an adequate tool to subsidize mapping and monitoring of the tropical forest landscape.

Acknowledgements
We acknowledge CNPq and CAPES for the research grants, the PROCAD/CAPES (Projeto 108/2007) and also FAPESP for the financial support of this research (process: 2011/05917-4).

References

APPLICATION OF GIS AND REMOTE SENSING FOR WATER QUALITY ASSESSMENT OF INLAND WATER BODIES IN AFRICA – A CASE OF GHANA AND TANZANIA

Marijani Shabani1, Amos T. Kabo-bah2
1. Ardhi University, Box 35176, Dar es Salaam, Tanzania,
2. Green Waterhut, Box UP913, KNUST, Ghana

KEYWORD: Assessment, Eutrophication, Cyanobacteria, Chlorophyll a, water quality, lakes

ABSTRACT
Water quality monitoring of inland water bodies including lakes are extremely time consuming and expensive. There are usually few campaigns of related water quality assessment of very important lakes around the world. Lakes are usually assessed for their eutrophic levels and based on this; associated management actions are implemented to safeguard water body for aquatic life and recreation. Remote sensing provides an alternative option to evaluate the water quality of lakes in temporally and spatially. The study employed the use of satellite data to evaluate the water quality of lakes in Tanzania (Lake Victoria) and Ghana (Lake Bosumtwi). The Lake Victoria has been used as the case study in Tanzania; the lake is Africa’s largest by area (68,800 Km2) shared by three east African countries, namely: Tanzania (49%), Uganda (45%) and Kenya (6%). The lake offer enormous economical and ecological benefits to local and global residents at large. Social and economical activities surrounding the lake make it vulnerable to pollution which leads to Eutrophication due increase of nutrients especially phosphorous and nitrogen. The increase of these nutrients is contributed to increase of population and human settlements surrounding the lake, pour wastewater management practices and disposal of partially treated wastewater. On the other hand, Lake Bosumtwi is an important and historic resource for the West Africa region being the only natural lake in Ghana. The lake apart from its contribution to tourism, it is also a major source of income, potable water, food and irrigation for the 30 villages settlements around the lake. Due the indiscriminate activities and poor management of this lake resource, it suffers
from issues of water pollution closely related to that of the Lake Victoria. Eutrophication problems show that the presence of Phytoplankton biomass in the water bodies. These biomass are easily detected by satellite sensors, and therefore MERIS data were used to map and predict Eutrophication of lake Victoria and Bosumtwi. As Eutrophication process is taking place, Inherent Optical Properties (IOP) of water changes accordingly. It is these IOPs which can be related to their respective concentration using bio optical models. GSM01 (Garver- Siegel- Maritorena) model was modified by removing band six of MERIS (centered at 620 nm) to exclude Phycocyanin pigments from derived Chlorophyll a concentration. This separation was possible because a Cyanobacterium which is determined by Phycocyanin pigments with maximum absorption at 620 nm. A simplified analytical model was derived to retrieve absorption coefficient due to Phycocyanin pigments separated at 620 band and therefore Ch-a and apc were separated and mapped. This simplified model was then applied on the two research areas – the Lake Victoria and the Lake Bosumtwi. It was realized that the simplified model was successfully applied on the two research study areas and allowed for a comparison of the results. It was generally realized that results could further be improved and used for other lakes in Africa. The paper promises a greater contribution to the mapping of water quality assessment of lakes in Africa especially that this area is still very new to the Africa continent.

**Significance Of Paper**

Water quality problems in Africa are generally not good and the little said about it the better. Just as most Africa countries face huge environmental pollution as a result of poorly planned settlements, indiscriminate activities from farming and sanitation; so it is that, these pollution activities finally end up in the rivers, streams and lakes. Lakes natural purification ability is however lower compared to the rivers and streams since they are generally close systems which might be generally supplied by a groundwater. Therefore, the pollution of lakes take a greater long time to restore compared to a riverine system. The Lake Victoria and Lake Bosumtwi are all strategic lakes in Africa but due to the indiscriminate activities around the lake, they are polluted heavily and as a result of the growing pollution and urbanization, it is envisaged that if nothing is done, these one-time beautiful lakes may become dead. This means that they will not be in the capacity to support aquatic life. There is limited attempt to assess the quality of such lakes in spatially. Remote sensing approach gives a broader overview of lakes quality conditions which is more informative to decision makers and planners to see illustratively the problem that persists in such a system. Therefore, the use of remote sensing data MERIS to assess the water quality of these lakes is broadly new to these lakes and if any attempt was made then was not well documented. This research hence, provides a critical foundation to redress the current situation of these lakes.

**ABSTRACT**

In this paper we deal with the integrated use of time-series of SAR and MODIS images to derive the temporal behavior, the abundance and the distribution of the floating macrophytes in the Winam Gulf (Kenyan portion of the Lake Victoria). The proliferation of invasive plants and aquatic weeds is of growing concern. Starting from 1989, Lake Victoria has been interested by the highest infestation of water hyacinth with significant socio-economic impact on riparian populations. The information provided by satellite can play an important role in supporting a decision system for the management of the water resources allowing also an easy and inexpensive way of monitoring the environment response to any action that might be undertaken to contrast its degradation. This paper aims at assessing the capability of medium/high resolution (Wideregion and Stripmap) COSMO-SkyMed ScanSAR time series imagery to
support/supplement optical data, frequently affected by clouds, in the knowledge of temporal macrophytes growing cycles and sustain the monitor and management of the Lake Victoria waters. Aquatic weeds are a kind of water “biological pollution” and a major component of global change due to human impacts. Aquatic weed species can be defined as aquatic plants (macrophytes) not desired by the managers of the water bodies where it occurs, either when growing in abundance or when interfering with the other species. Lake Victoria was interested by the highest infestation of water hyacinth since 1989 that caused significant socio-economic impact on riparian populations. The relevance of the Lake Victoria for the economy of the region has been recognized by FAO that promoted an international project named Lake Victoria Environment Management Project (LVEMP). Even, in the framework of the TIGER-ESA initiative several projects focusing on the Lake Victoria have been funded. In this context, satellite remote sensing, offer the capability to rapidly and synoptically monitor large water ecosystem and detect vegetation cover dynamics over time.

Time series of MODIS NDVI data have been successfully applied to quantify vegetation activity and to measure vegetation dynamics even if many of these images results useless as consequence of the cloud contamination. In a previous work [1] the authors faced the objective of assessing the capability of time-series of MODIS imagery to monitor the abnormal growth of floating macrophytes and investigated the correlations with other water quality parameters. Nevertheless, MODIS data should be opportunely supported by the more precise information provided by other satellite sensors. The use of COSMO-SkyMed ScanSAR time series imagery, thanks to their spatial resolution and their capability to work also in cloudy condition, represents a valid supplement to optical data to provide information suitable for enhancing the understanding of the temporal cycles of the floating macrophytes.

A time-series of 28 Wideregion and 28 Stripmap COSMO-SkyMed ScanSAR images was used to monitor the floating vegetation extension over the water surface of the Winam Gulf from June 2010 to November 2011. The acquisition were carried out with a weekly frequency in different period of the year: May 210-July 2010; September 2010-December 2010; March 2011-May 2011. Contemporary a time series of MODIS multispectral images covering the same period was acquired at least with a twice a week frequency.

COSMO-Sky data were acquired in the framework of the “Scientific Projects” call for the COSMOSkyMed Mission advertised by ASI (Italian Space Agency). MODIS standard products were ordered directly from the LAADS website (http://ladsweb. nascom.nasa.gov/data/) and retrieved from the LAADS ftp site (ftp://ladsweb.nascom.nasa.gov/).

As regards the TERRA MODIS images, NDVI values were used to discriminate water from floating weeds and submerged vegetation or water reach in phytoplankton. This classification is a difficult task to perform by using MODIS images alone. On the contrary, COSMO-SkyMed backscattering values showed an high contrast between the water and the portion of lake interested by the floating vegetation. Using the COSMO-SkyMed data it is, thus, possible to define the optimal MODIS NDVI threshold for the floating vegetation discrimination. By a comparative statistical analysis of MODIS and COSMO-Sky data, the NDVI threshold was fixed to 0.37. Values comprised between 0.20 - 0.35 represent water reach in phytoplankton.

The analysis of the COSMO-Sky data showed that the higher contrast between floating vegetation and water is obtained using a looking angle of 27°. Under this modality it is also possible to observe other less contrasted features on the lake that could be related to the presence of sparse vegetation. Currently, research activity, including comparison with other sensor’s data (CHRIS, Landsat), are being carried out to understand if the COSMO-Sky data can be used for differentiating among different vegetation species.

A further analysis is being conducted on selected image areas to verify the capability of COSMO data to relieve the floating vegetation height in order to discriminate between different species or observe different vegetation growing stages. The information obtainable with this multi-sensor approach are of crucial importance for the comprehension of the complex mechanisms that rule the macrophyte cycle and for supporting the management and prevention of anomalous growing events.
HYPERSPECTRAL DATA FOR QUANTIFYING URANIUM CONCENTRATION IN PHOSPHATE DEPOSITS: A CASE STUDY IN JORDAN USING THE ASD SPECTORADIOMETER

Amer Alroichdi
General Director of Mapping Solutions Ltd. 28, Roberts Avenue, Manchester M14 4DA, UK.

ABSTRACT
Phosphate deposits with different Uranium concentration are spread all over the Arab world. The value of phosphate deposit per ton can vary between 50-120000 USA dollar depending on the concentration of Uranium. Low grade Uranium concentration is used cheap and used for agricultural purposes, however, high grade is expensive and used for Uranium extraction.

Traditional measurements for Uranium involve Gamma x ray measurements either from in-situ or airborne platform. Both platforms are time consuming and expensive. In addition, they do not provide quantitative value for Uranium concentration. This paper will discuss the effectiveness of using hyperspectral data to quantify the Uranium concentration in Phosphate deposit in Jordan.

70 samples were collected from different depth over 10 km². Samples were grounded and spectrally recorded using the ASD Spectroradiometer (350-2500 nm). Samples were sent to Canada for Uranium concentration analysis. The results indicated that there is a strong relationship between Uranium in phosphate deposit and spectral indices developed in the spectra domain 350-2500 nm. In addition, quantification of the Uranium concentration was feasible with accuracy up 94%. The finding indicates a high potential for upscaling the algorithm to be used with Hyperspectral camera in airborne platform.

REMOTE SENSING ESTIMATION OF SPATIAL AND TEMPORAL VARIABILITY OF ACTUAL EVAPOTRANSPIRATION OVER THE SEMI-ARID BAROTSE SUB-BASIN USING SEBS ALGORITHM

W.K. Phiri¹, I. A. Nyambe¹ J, Kabika¹, K. Banda¹, Z. Verkerdy² & T. Woldal²
1. University of Zambia, IWFM Centre, C/O School of Mines, P.O Box 32739 Lusaka, Zambia
2. Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, The Netherlands

KEY WORDS: Spatial-temporal evapotranspiration, SEBS, Barotse Sub-Basin, water resources management

ABSTRACT
Evapotranspiration is the second dominant hydrologic flux in the water balance of semi-arid areas. For this reason, the accurate measurement of its spatial and temporal dynamics in such environments is of critical importance for assessing water availability and enhancing water resources management. However, direct estimation of distributed evapotranspiration is a difficult task because of complex to interactions among the components of the land-plant-atmosphere system. Consequently, prevalent methods of estimating this phenomenon are based on point measurements. This approach, however, assumes the existence of a homogenous surface to calculate potential evapotranspiration. Yet it is a reality, not least from the catchment scale, to find different types of land cover co-existing within a few square meters. These vegetation species have different physiological features such as rooting depth, leaf area index and stomata resistance which complicates the quantification of evapotranspiration using point-based methods. This apparent weakness of point-based methods underscores the importance of employing techniques that effectively capture the spatial-temporal dynamics of ET. In this regard, application of spatial modelling techniques presents opportunities for understanding the spatial-temporal variability of actual evapotranspiration. This knowledge is critical for enhancing water resources management, especially in heterogeneous and water limited environments such as the semi-arid Barotse Sub-Basin of South-Western Zambia.

Therefore, this study applied the physically based Surface Energy Balance System (SEBS) model to determine the spatial-temporal variability of actual evapotranspiration AET over the semi-arid Barotse Sub-Basin. The model was run
using Moderate Resolution Imaging Spectro radiometer (MODIS) satellite imagery on clear-sky warm-wet, cool-dry and hot-dry days. These images were logically selected to cover these days and stretched from November 2006 to October, 2007. The Level 1B MODIS images which were initially in their native format were re-projected to Geographic Tagged file Format (Geotiff) using MODIS Re-projection Tool (MRTSwath) software. The radiance and reflectance calibration scales where extracted from the header files using the HDFview Tool. A total of twenty-four (24) images were pre-processed for the determination of bio-geophysical parameters in Integrated Land and Water Information System (ILWIS). These images were corrected for the atmospheric effect of absorption and scattering using the Simplified Method for Atmospheric Correction (SMAC) Algorithm. Further, based on sunshine data and daily actual evapotranspiration, time series monthly actual evapotranspiration was generated for further characterization of spatial-temporal variability of the fluxes. The SEBS estimated actual evapotranspiration was evaluated against the FAO Penman-Montieth potential evapotranspiration over the reference station at Sesheke. Thus a physical validity of SEBS estimated evapotranspiration was done by using potential evapotranspiration. Parametrisation of roughness terms was done with the exiting modules in the SEBS algorithm. The Land use map was extracted Global Cover Africa made and tested by ESA/ESA Globecover Project led by MEDIAS France/Postel which was made in 2006. Meteorological data was collected from both ground based station and internet sources.

Results indicate that the SEBS estimated AET on cool-dry and hot-dry days were ~58.3% and 36.6% of PET respectively. However, the average AET on warm-wet days was found to be physically inconsistent, as it was ~101.8% of PET. Nevertheless, the systematic occurrence of inconsistent AET on warm-wet days seemed to imply that SEBS modelled AET were not necessarily implausible but rather suggested that the assumptions on which the PET is based significantly differed from the surface conditions on these days. This highlighted the uncertainties of using PET to evaluate AET. The temporal variability in evaporative water use by land cover type revealed that water bodies and regularly flooded vegetation experienced higher fluxes on warm-wet days of ~6.9 and 5.9 mm \textsuperscript{d} respectively, with minimal variations on cool-dry and hot-dry days. On the other hand, lower fluxes occurred on croplands and grassland with a high variation of up to 64.1 and 71.1% between warm-wet and hot-dry days respectively. The generated monthly AET was found to be lower than PET for all the months except for January in which there was an over estimation of ~11%. On the overall, this study showed that SEBS can be successfully used to estimate spatial-temporal AET, and contribute towards improving water resources management.

SOIL PROPERTIES ASSESSMENT USING ASTER MULTISPECTRAL DATA, APPARENT ELECTRIC CONDUCTIVITY (ECA) AND STOCHASTIC MODELING IN SEMI-ARID ENVIRONMENTS OF NORTHERN TANZANIA

Michael Märker\textsuperscript{1}, Felix Bachofer\textsuperscript{1} & Geraldine Quénéhervé\textsuperscript{1}

1. Heidelberg Academy of Sciences and Humanities, Rümelinstr. 19-21, 72070 Tübingen, Germany

ABSTRACT

Semi-arid environments such as in Northern Tanzania are characterized by a variety of degradation processes due to long dry periods and short but intensive rainfall events. High potential evaporation, high run-off rates, and low water holding capacities are typical for the present soils. The area is mainly covered by semi-arid savannah, the dominating crop is maize and extensive grazing is conducted.

Soil properties and their spatial distribution play a critical role for hydrologic processes. To assess the spatial distribution of these soil properties we utilized an Electromagnetic Induction (EMI) device that induces an electromagnetic field into the soil, creating an electric current. The strength of a resulting secondary electromagnetic field is recorded as the apparent electric conductivity (ECA), measured in mS/m. ECA can provide an indirect indicator of important soil properties. Factors that influence ECA include soil salinity, clay content and cation exchange capacity (CEC), clay mineralogy, soil pore size and distribution, soil moisture content, and temperature. However, in non-saline
soils, conductivity variations are primarily a function of soil texture, moisture content, and CEC. There are few studies, related to EMI measurements, conducted in semi-arid environments.

In this study we conducted field measurements with the GSSI Profiler EMP-400. In total we recorded 12000 conductivity field points. These points were localized also with GPS. Thus, the exact location of the soil electric conductivity measurements allowed the assessment of the data together with a 20m SPOT DEM and ASTER data. Soil physical characteristics were also measured in field on typical soil profiles to get the respective calibration data, validation was done by lab analysis. We analyzed the spatial pattern of the soil ECa maps to determine relationships with soil properties, with a focus on soil texture. Therefore the conductivity was separated into three classes for sandy, silty and clay soil. The regionalization was carried out using ASTER multispectral data. We applied 10 ASTER bands in the VNIR, SWIR, TIR channels. The ASTER images were geo-referenced and were taken in the dry season in 2009/10. Moreover we derived from SPOT data (2010) a digital elevation model to carry out a detailed terrain analysis. The geo-data were finally combined and integrated using a stochastic gradient boosting to derive a continuous map on soil characteristics. In this study we tested classification and regression trees as well as advanced stochastic gradient boosting methods to generate a spatially continuous soil electric conductivity and texture map. Further research in the area was carried out using Worldview II data to derive mineral characteristics (see Bachofer et al. 2012).

10 YEARS OF TIGER – ACHIEVEMENTS IN EARTH OBSERVATION FOR WATER RESOURCE MONITORING

B. Koetz¹, D. Fernandez¹, F. Pallazo¹ & Z. Verkerdy²
¹. European Space Agency, Frascati, Italy
². ITC of the University of Twente, Netherlands

ABSTRACT

The concept of Integrated Water Resource Management (IWRM) is seen as an opportunity to mitigate the wide spread water scarcity in Africa. One blocking key component of IWRM in Africa is the limited knowledge of the available extent and quality of water resources at basin level. Earth Observation (EO) technology can help filling this information gap by assessing and monitoring water resources at the regional scale.

Specifically the wide spatial coverage of satellite images has proven of relevance for trans-boundary basins where consistent information between countries is needed for sustainable water resource management. Over its 10 years of existence the TIGER initiative has established and supported capacity building activities and development projects in over 27 African countries involving more than 150 African institutions. Within TIGER a whole portfolio of EO products relevant to IWRM, such as water reservoir inventory or catchment characterization - has been developed and demonstrated to African stakeholders. Along the development of EO information products TIGER has strongly supported capacity building in African countries required for their successful uptake and full exploitation by the water authorities and scientific institutions.

The European Space Agency (ESA) launched the TIGER initiative in 2002, responding to the urgent need for action in Africa stressed by the World Summit on Sustainable Development (WSSD) in Johannesburg. TIGER is an international endeavour that has been endorsed by the African Ministerial Council on Water (AMCOW) and is guided by a Steering Committee that includes representatives from AMCOW, African Union Commission, African Water Facility, Department of Water Affairs and Forestry of the Republic of South Africa, CSA, ESA, Ramsar Secretariat, UNESCO-IHP and the UN-Economic Commission for Africa.

Within the four major action lines of the TIGER initiative the following main goals have been achieved within the last 10 years:

Facilitating Access to EO data:

TIGER is supporting African partners with free access to spaceborne data and products. Some 4000 MERIS/AATSR, 7000 (A)SAR and 600 high resolution optical products (SPOT, KOMPSAT-2, AVNIR, PRISM) gathered in the framework of ESA
and ESA Third Party Missions have been distributed by ESA. In order to facilitate data reception, some 17 DDS (Data Dissemination System) stations have been installed at the premises of organizations involved in TIGER: to date, almost 15 TB of data have been transmitted to African users through the 2.8 Mbps dedicated telecommunication satellite channel.

**Capacity Building & Training**

Training and capacity building actions have been enforced to support African partners to advance towards an independent African capacity to make operational use of EO technology for improving IWRM. To date, some 19 training sessions have been organized focused on both the needs of the different research projects and the requirements of the water authorities. Almost 200 individuals from 26 different African countries have been involved in training or mentoring actions performed by the TIGER Capacity Building Facility (TCBF). Training and education tools have been produced and distributed by ESA to all the TIGER research teams (e.g. TIGER Training Kit).

**Development of EO Information Services**

The research and development component of TIGER has included 70 research projects submitted by African and north-south scientific teams since 2004. Through additional development projects, TIGER developed, demonstrated, validated and aims eventually to transfer robust EO information services to relevant African institutions for operations. The following portfolio of EO information services dedicated IWRM have been developed:

- Catchments characterization and base mapping
- Water quality monitoring
- Soil moisture mapping
- Water levels information services
- Water infrastructure monitoring
- Support to ground water management and exploration

**Knowledge and Information Network**

TIGER has involved more than 150 African institutions (water authorities, universities, technical centers) through projects and training activities. Six dedicated TIGER workshops (2003-11) and several TIGER side events during international symposia (such as AfricaGIS 2007, AARSE 2008, 4th-6th World Water Forum 2006/2009/2012) have been organized to raise awareness of the initiative and disseminate results. The TIGER newsletter is regularly distributed to a list of more than 1000 entries and is also made available on the TIGER Website.

The most recent TIGER activity, TIGER-NET, as first pre-operational project will develop a freely available Water Observation Information System, supporting African water authorities to build up necessary local capacity to process and exploit satellite observations for monitoring and management of their water resources. TIGER-NET will specifically prepare the ground for the uptake for the observations provided systematically on a global scale by the upcoming Sentinel 1-3 missions. The freely and open available data of the operational Sentinel missions will make an essential difference to African water authorities supporting their day-to-day planning and decision making in IWRM processes.

---

**VARIABILITY OF UPWELLING INTENSITY AND THE DYNAMICS OF THE POPULATION OF OCTOPUS, OCTOPUS VULGARIS, NEAR MBOUR**

Ousmane DIANKHA¹ & Modou THIAW²

1. Laboratoire de Physique de l’Atmosphère et de l’Océan Siméon Fonga (LPAO-SF), ESP/UCAD, Sénégal
2. Institut Sénégalais de Recherches Agricoles (ISRA), Centre de Recherches Océanographiques de Dakar Thiaroye (CRODT), Pôle de Recherches de Hann, Dakar, Sénégal, BP 2241

**ABSTRACT**

The Eastern Boundary Systems are known for their seasonal and interannual fluctuations and their key biological and socio-economical roles. The variability could have consequences for marine resources, particularly on short lived
species. The life cycle of octopus is very short and its recruitment in the waters near Mbour is usually considered highly dependent on the upwelling intensity. Therefore, fisheries management has to take into account diagnosis based not only on stocks assessment, but also on the impact of environmental variability.

The present study analysed the spatial and temporal variability of the upwelling intensity and its effects on seasonal and interannual octopus recruitment in Senegalese waters from 1996 to 2005. Senegalese coasts were divided in three areas: the first one is from 12.5 N to 13.5 N, the second from 13.5 N to 14.5 N (area of octopus catch) and the last one from 14.5 N to 16.5 N. This division was based on the temperature distribution along the Senegalese littoral. To explore the relationship between octopus recruitment (R) estimated by the Virtual Population Analysis (VPA) from the Research Centre of Oceanography Dakar-Thiaroye (Centre de Recherche Océanographique Dakar-Thiaroye in French (CRODT)) data and environmental variability, we used coastal upwelling index, CUI, and sea surface temperature, SST, derived from satellite data available at the National Oceanic Atmosphere Administration (NOAA) website.

Our results showed that upwelling intensity varied seasonally and year to year along the Senegalese coasts. From December to March, upwelling intensity is higher in the area of octopus fishing. At the interannual scale, during years when upwelling intensity was more important in this area, coincided with periods of high recruitment. Thus, marine resources were submitted to an unstable environment. Octopus recruitment varied seasonally and inter-annually. Significant correlations were found between environmental factors and recruitment. The variability in CUI and SST explained 81% of seasonal variance in recruitment. In winter, recruitment variation was controlled by upwelling intensity (36.39%), while in spring, SST explained the most part (29.57%). And the year to year variability of recruitment was mainly explained by the combined environmental factors (48.69%).

STUDYING THE MICROCLIMATIC IMPACT OF LARGE SOLAR ENERGY HARNESSING FACILITIES USING REMOTE SENSING TECHNOLOGY: RIYADH CITY AREA (KSA) CASE STUDY

Ali EL BATTAY 1 & Mohamad Ali Hakami 2
1. GIS and Remote Sensing Laboratory, Arabian Gulf University, P.O.Box 26671, Manama, Kingdom of Bahrain
2. Faculty of Geoinformation Science and Technology, Universiti Teknologi Malaysia 81310 Skudai, Malaysia


ABSTRACT
Solar energy remains the largest source of potential clean and renewable energy. Since the oil shock in the early 70s’ the solar energy market has grown on average +25 to 30% per year. However, the goal of this study is to explore the possibility of existence of a positive radiative forcing due to implementation of large scale photovoltaic solar panel farms on the microclimate. To achieve it, the first step was to conduct field work on mono crystalline - Silicone photovoltaic solar panels to extract and monitor the spectral signature daily variation using spectroradiometer and thermal camera. The albedo results obtained were then correlated with local weather conditions and compared to other type of land cover (sand, vegetation, asphalt, concrete, water etc). The second step in this study was to simulate the effect of implementing a large scale photovoltaic SP farm in nearby of Ryadh City (KSA) and its impact on solar albedo, relative humidity (RH) and land surface temperature. These parameters were chosen as microclimate indicators. A Landsat 7 ETM+ image of 2003 was used along with weather parameters to extract the Land Surface Temperature (LST) and then to replace chosen potential area to implement the solar farm with temperature values obtained from fieldwork. The result of this simulation shows an increase of LST between 15 to 25% and a significant drop of RH. In fact, the RH has decreased dramatically reaching very low values of less than 10%, extremely dry, which is critical to sensitive fauna and flora living in this arid area. Hence, even though solar energy is a clean and renewable source of energy, but implementing photovoltaic panels on large scale in sensitive or critical climate zone should be done carefully.

154
WOODY SAVANNAH TREE BIOMASS ESTIMATION IN THE GREATER KRUGER NATIONAL PARK REGION, SOUTH AFRICA, USING A MULTI-FREQUENCY POLARIMETRIC SYNTHETIC APERTURE RADAR (SAR), LIGHT DETECTION AND RANGING (LiDAR) AND OPTICAL DATA FUSION APPROACH

Laven Naidoo¹, Renaud Mathieu¹, Moses Cho¹ & Greg Asner²,
1. Ecosystem Earth Observation, Natural Resource and the Environment, CSIR, Pretoria, South Africa
2. Department of Global Ecology, Stanford University, Stanford, CA, USA

ABSTRACT

Introduction:
The sequestration of carbon in growing vegetation is understood as a significant mechanism for the removal of CO2 from the atmosphere (Viergever et al., 2008). Adverse anthropogenic activities such as deforestation and the burning of biomass can alter these carbon sinks into carbon emission sources (Viergever et al., 2008). These activities are especially prevalent in developing regions around the world such as the savannah environments of Southern Africa. With a mean net primary productivity of 7.2 tC/ha/year, savannahs account for approximately 40% of the global carbon store (House and Hall, 2001, cited in Collins et al., 2009). In these heterogeneous savannah environments, biomass estimation using remote sensing is challenging because of the complex stand structure and abundant species diversity of the vegetation (Lu, 2006). Due to its responsiveness to vegetative structure, high canopy penetration ability and general weather independence, active remote sensing sensors such as LiDAR and SAR have been widely used for studying woody biomass of trees (Popescu et al. 2011; Le Toan et al. 2011; Collins et al. 2009; Sun et al. 2011). Studies, however, are under-represented in low woody density environments such as African savannahs (Mitchard et al. 2009; Ribeiro et al. 2008), where above ground biomass is mostly below 50 T ha⁻¹. The aim of this work is to create regional scale woody biomass map products for the management of South African savannas. This aim will be achieved by experimenting with multi-frequency (RADARSAT-2 C-band and ALOS PALSAR L-band which allows for the sensing of different tree structural elements e.g. tree trunk and canopy branches) and polarized (HH, HV, VV polarizations which allows for the characterisation of the tree scattering properties) satellite SAR data, airborne LiDAR derived biomass metrics (utilised as the ground truth data) and optical textures (derived from WorldView-2 multispectral sensor) using an integrated modelling approach. The overarching research question to be answered in this study will be: “Does the fusion of multiple frequency and polarized SAR data with optical textural data products improve modelled biomass results compared to the use of the SAR data alone?”

Methodology:
The study area is the Southern Kruger National Park region which includes areas such as the Bushbuckridge communal rangelands, the Skukuza region and the Sabi Sands Wildtuin. Using ground validation, a biomass structural metric will be estimated from the 1.1m LiDAR dataset and upscale, together with the C-band RADARSAT polarized data, to large strips of land across the study area to match the spatial resolutions of the coarsest SAR dataset (ALOS PALSAR). Successful fusion of all these data products will provide a very large and representative number of samples for model calibration and validation. Multi-polarized intensities will be derived from the SAR images, compared to, and used to model the LiDAR-based biomass metric according to various scenarios (multi-polarized versus individual polarimetric variables). Bootstrapping stepwise multiple linear regressions will be implemented with the SAR polarimetric variables as the independent variables and the LiDAR derived biomass metric as the dependent variable. Model summary statistics such as coefficient of determination (R²), root mean square error (RMSE) and standard error of prediction (SEP), will be recorded to ascertain the best model and SAR variables to be used. An attempt will then be made to improve the most accurate biomass prediction model by including optical textural products, derived from the WorldView-2 imagery, as an additional independent variable. The most accurate model will then be subjected to the final mapping procedure.

Preliminary Results and Discussion:
From the preliminary results arising from the modelling of C-band RADARSAT polarimetric variables against the LiDAR biomass metric, the use of the standard deviation and means of all three polarized intensity variables (HH, HV, VV) yielded higher modelled accuracies with the HV variable contributing the most to the overall accuracy. This observation is supported by the fact that the HV polarization best reacts with the volumetric scattering mechanisms present within the tree structure.

Table 1: Models for predicting biomass using stepwise multi-linear regressions and SAR variables

<table>
<thead>
<tr>
<th>Variables selected by stepwise multiple linear regression</th>
<th>M R2</th>
<th>M RMSE</th>
<th>M SEP</th>
<th>Std R2</th>
<th>Std RMSE</th>
<th>Std SEP</th>
<th>R2 CI</th>
<th>RMSE CI</th>
<th>SEP CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH MEAN, HH STDEV</td>
<td>0.40</td>
<td>12.97</td>
<td>13.05</td>
<td>0.039</td>
<td>0.080</td>
<td>0.39</td>
<td>0.41</td>
<td>12.84</td>
<td>13.09</td>
</tr>
<tr>
<td>HV MEAN, HV STDEV</td>
<td>0.46</td>
<td>12.27</td>
<td>12.33</td>
<td>0.041</td>
<td>0.080</td>
<td>0.39</td>
<td>0.47</td>
<td>12.17</td>
<td>12.38</td>
</tr>
<tr>
<td>VV MEAN, VV STDEV</td>
<td>0.16</td>
<td>15.33</td>
<td>15.31</td>
<td>0.040</td>
<td>0.080</td>
<td>0.46</td>
<td>0.17</td>
<td>15.20</td>
<td>15.46</td>
</tr>
<tr>
<td>MEAN and STDEV of HH, HV</td>
<td>0.47</td>
<td>12.09</td>
<td>12.32</td>
<td>0.040</td>
<td>0.078</td>
<td>0.46</td>
<td>0.08</td>
<td>11.99</td>
<td>12.19</td>
</tr>
<tr>
<td>MEAN and STDEV of HV, VV</td>
<td>0.46</td>
<td>12.26</td>
<td>12.33</td>
<td>0.039</td>
<td>0.080</td>
<td>0.56</td>
<td>0.118</td>
<td>0.48</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*where M = mean; Std = standard deviation; CI = Confidence Interval

The use of C-band RADARSAT data alone in the predictive modelling of biomass could be limiting as the C-band backscatter mostly interacts with the tree canopy elements such as leaves and small branches which is not where the majority of the tree biomass lies. The inclusion of the L-band ALOS PALSAR data, of which the backscatter interacts with the tree trunks and large tree branches, and optical textural products, which could assist in determining shrub-based and coppicing biomass that is not easily picked up by the LiDAR and SAR products, could greatly improve the modelling accuracies.

References:

REVENUE OF GLOBAL ENERGY SYSTEM MODELING BASED ON REMOTE SENSING DATA WITH FOCUS ON RENEWABLE ENERGY RESOURCES

Markus Biberacher¹ & Sabine Gadocha¹
1. Research Studios Austria Forschungsgesellschaft mbH, Schillerstrasse 25, 5020 Salzburg, AUSTRIA

ABSTRACT
Our current energy system is mainly based on fossil fuels and nuclear power. The spatial context in such a system is secondary since transport infrastructure is well established, transport losses are marginal and supply and demand locations can be easily matched. That is also reflected in most system modeling approaches in terms of not paying attention to spatial correlations. A transition of our energy system towards a higher share of temporally and spatially highly disperse renewable energy resources makes it necessary to consider spatial correlations between different resources and also demand structures. Paying attention to these correlations not only decoupled in individual studies on specific sub-topics but also in the integrated system in form of a combined objective function is a raising issue and is not yet treated in many studies. Remote sensing is able to provide spatially high resolved indicator data, relevant for paying attention to the challenges of spatial and temporal disperse renewable energy resources and quantify possible impacts of their integration in the energy system.

The paper presents an approach that bridges the gap between the consideration of spatial correlations in future energy systems derived from remote sensing data and the conventional energy system modeling approach with a focus on forecasting the entire energy system development in future.

Therefore the energy system model TASES (Time And Space resolved Energy Simulation), first published in 2004, has been further developed in order to tackle all relevant geographical correlations in energy systems partly or mainly based on high intermittent and location dependent renewable energy resources. The model is a snap shot model focusing on one year with seasonal and day/night variations among the region of interest. It outlines the optimal energy system setup in terms of optimal locations for the construction of solar power plants, wind turbines or biomass power plants also with respect to an optimal transmission grid as part of the entire system. TASES works on a geographical resolution of single raster grid cells which can be defined in a flexible way, in order to achieve the best relation between revenue of a spatially high resolution consideration and system complexity.
Remote sensing data are utilized in preprocessing steps to derive relevant information on land use, solar insolation, biomass potentials, wind speed and energy demand with the desired geographical resolution as input in the TASES model approach. The results of a TASES model run are optimal locations for renewable energy installations as well as grid infrastructure in the context of the entire energy system. TASES makes it possible to figure out geographical sensitivities of individual geographical aspects on the entire energy system of the region of interest. Geographically triggered process chains (for instance suitability of single locations for solar power installations with respect to other land use competitions and respect to transmission line corridors to demand centers) in the energy system can be explored and decision strategies can be based on it. Conventional energy system planning, based on demand forecasts, price developments and technology learning curves leaving spatial aspects of the energy system aside, is linked to the consideration of impacts triggered by geographical correlations in the entire energy system using the TASES model. Pre-processed remote sensing data, in order to describe location dependent best usable renewable energy resources as well as demand structures, are the major input in such system analysis. Therefore geographical relevance in energy systems can be addressed with such system approach. The approach is suited to figure out balances between different geographical assumptions and impacts on the entire energy system (e.g. which area share is considered to be available for CSP installations).

DELINEATION OF GROUNDWATER POTENTIAL ZONES OF UPPER TUMET CATCHMENT, MENG AREA, WESTERN ETHIOPIA USING REMOTE SENSING AND GIS

Gezahen Lemecha
Oromia Water Works Design and Supervision Enterprise, Addis Ababa, Ethiopia

ABSTRACT
Low success rate of drilling productive wells is one of the challenges encountered in hard rock environment. The use of remote sensing data for the evaluation of groundwater resource in conjunction with ancillary ground information in GIS environment is becoming an effective method for the improvement of groundwater development success rate. In the present research thematic layers generated from satellite images, existing maps and field survey results were
integrated in Geographic Information System (GIS) environment to delineate the groundwater potential zones in upper Tumet catchment, Menge area, Western Ethiopia. Factor maps generated from satellite images include lineament, thermal lineament, soil moisture and vegetation anomaly and land use (lu)/land cover (lc) whereas those derived from existing maps were slope, drainage density and lithology. The zone of weathering thematic layer was generated from water point inventory data and Vertical Electrical Sounding (VES) survey interpretation results. In order to drive groundwater indicator parameters from satellite images, image pre-processing, enhancements and classifications were performed and various false color composite images were generated. Geologic and topographic maps were digitized and GIS analysis performed to drive thematic layers from existing maps. Field work was conducted for inventorizing water points, to do VES survey and to collect point information for geometric rectification and ground truth. Information for 49 water points was gathered and 13 VES surveys were done. The collected ground truth was used during image classification. Data derived from different sources were reclassified to common scale and weighted. Multi-criteria evaluation using pairwise comparison matrix was used for weighting and ranking the thematic layers. In order to arrive at the groundwater prospect map raster based GIS modeling was conducted using Weighted Linear Combination (WLC) method. The resulting groundwater prospect map has five classes; namely Excellent, Very good, Good, Moderate and Poor. The model results revealed that large part of the study area has poor groundwater potential. The resulting model was evaluated using water point inventory data and the results were found to be in good agreement with the model output.

EVAPORATION IN OPEN WATER BODIES IN AFRICA USING REMOTE SENSING

Amos T. Kabo-bah1,2, Xie Yuebo1, Robert Becht3, Webster Gumindoga4 & Mark Amo-Boateng1

1. College of Hydrology and Water Resources, Hohai University, China
2. Green Waterhut, Box UP913, KNUST, Ghana
3. Department of Water Resources, Faculty of Geo-information and Earth Observation (ITC), University of Twente, Enschede, The Netherlands
4. University of Zimbabwe, Department of Civil Engineering, P.O Box MP 167 Mt Pleasant Harare

ABSTRACT
The spatial and temporal knowledge of evaporation is critical for proper management of water resources. Evaporation is also a key requirement for water budgets during water resources modelling. The estimation of evaporation for open water bodies such as lakes is however challenged because of the complex nature of the techniques involved and large amounts of data required. Notwithstanding, the Africa region is predominately challenged by scarcity of meteorological and hydrological data which makes the reliable estimation of evaporation, a challenge. With the advent of remote sensing and open source GIS capabilities, there are reliable answers to addressing this urgent need to providing reliable estimates of evaporation.

This paper assessed the reliability of using satellite data to assess the evaporation of lakes in Zimbabwe and Kenya. The research cases of Lakes Chivero and Manyame in Zimbabwe, and Lake Naivasha of Kenya. These lakes offer multi-user services to the Urban communities in which they reside and hence serve as a good model for the rest of the lakes in Africa. The research employed the Surface Energy Balance System (SEBS) model in ILWIS Open for the derivation of evaporation products for the lakes. The evaporation products were evaluated against measured evaporation products based on meteorological measurements. The results proved comparable to the measurements with the meteorological and in addition, gave a spatial extent. The spatial-temporal distribution of evaporation is usually lacking from meteorological derived evaporation. Hence, this approach provided a clearer view of the evaporation behavior in the lakes. This study envisages a significant contribution towards the satellite remote sensing for open water bodies in Africa and further relevance of the use of the SEBS for evaporation estimation in Africa.
TOWARDS AN INTEGRATED WATER RESOURCES MANAGEMENT SYSTEM: GEOSPATIAL DATA AND LAND SURFACE MODELLING FOR ASSESSING WATER AVAILABILITY IN DIFFERENT WATER CONTEXTS (CASE STUDIES FROM MOROCCO)

A. Er-Raji1 & D. El Hadani1
1. Royal Centre for Remote Sensing (Rabat, Morocco)

KEYWORDS: IWRM, water balance, actual evapotranspiration, modeling, remote sensing.

ABSTRACT
In Morocco, establishing an Integrated Water Resource Management System is fundamental for sustainable development. With regards to its mission CRTS is carrying a numerous actions through the country to demonstrate the role of the rapidly evolving earth observation programs for collecting and disseminating water related information in cost effective and sustainable ways. In this paper, parts of the results from these actions will be presented from different applications in different water contexts.

The first case study aims at developing, in the Souss-Massa hydraulic basin, an integrated approach including the exploitation of the satellite data, the pre-existing data and the Geographical Information Systems (GIS) as sources of information and tools of analysis within the water management process. This region has continuous aquifers that are facing a severe depletion because of intensive irrigated activities. The use of multi sensors and multi-temporal satellite images (optics and radar) enables to highlight new practices on the current situation of the land use, particularly in the irrigated areas during the last decades. The land use changes analysis shows the surface expression of the groundwater over-exploitation by generating an intensive dynamic, with regards to different aspects of land use changes, in particular in terms of irrigated zones extension. These changes are of two forms, closely related to the reduction (disappearance) or the extension (appearance) of irrigated agricultural activities. In the first case, they are essentially related to the urbanization pressure, soil degradation, and groundwater overexploitation. In the second case, considered as more dominant, these changes take form of appearance of new irrigated farms where groundwater still more available. Although the general trend at the basin scale shows a continuous increase in irrigated surfaces, locally these irrigated zones are disappearing. The extension seems to be more generalized for the whole plain region and not simply limited to the upstream as it was expected.

The second case study concerns Ighrem region which is facing a critical situation with regards to potable water resources sustainability. This region has a discontinuous aquifer systems and week surface water contributions because of its arid climate. This area belongs to the Anti-Atlas Mountains considered as part of the Panafriuc chain with complex and intensive deformations and a large lithological variability; witch makes more difficult the characterization of its hydrogeologic context.

The approach was based on the integration of multi-sensors earth observation data, the existing data and the field truth in order to contribute to the groundwater prospecting process. This allows us to produce details information from lineament and lithological mapping in order to better characterize the aquifer system. In particular, radar imagery had been used for mapping zones with high recharge potential. On the other hand, the integration of these information in a quantitative approach known as Weight of Evidenced Modelling for combining evidence in support of an hypothesis. This method has been used based on key hydrogeologic predictors for groundwater prospecting: geology, geomorphology, hydrology and recharge potential. This enabled us to identify and locate the zones presenting high aquifer potentials. These zones are supposed to guide geophysical prospecting to better refine the location of productive drilling in the future.

The third case study concerns the Sebou hydraulic basin which is receiving more than 1/3 of Moroccan surface water potentialities per year. The aim of the study is to demonstrate the use of earth observation data to better characterize
the key hydrologic parameters for water balance evaluation. Actual evapotranspiration (AET) and rainfall are the elements in water balance estimation that give sound information on water availability. At this stage of the work rainfall products were taken from ground meteorological stations and the AET was estimated from remote sensing and GLDAS global meteorological data using the Surface Energy Balance System (SEBS) model. On the other hand, to better refine the calculated daily average of the evaporative fraction a detailed land use map from very high resolution imagery were used for surface parameters. Furthermore, climatological water balance estimation was done over rainfed and irrigated croplands for a specific period in 2010 and 2011.

ENVIRONMENTAL SIGNIFICANCE OF THE CLAY MINERALOGY OF THE MIOCENE TO QUATERNARY PEDOCOMPLEXES FROM LANGEBAANWEG “E” QUARRY, SOUTH AFRICA

Peter N. Eze & Michael E. Meadows
1. Department of Environmental & Geographical Science, University of Cape Town, Rondebosch 7701, South Africa

KEYWORDS: palaeosols, sediments, pedogenesis, diagenesis, stratigraphy

ABSTRACT
Mineralogical data have been very useful in understanding pedogenic pathways in the soil environment. In this study, our goal was to study the quantitative mineralogy of the complex Miocene to Quaternary palaeosols from Langebaanweg E-quarry excavation due to its regional and arguably global geo-archaeological significance. For comparison, (soil) sediments overlying and/ or underlying the palaeosols were also studied. The quantitative mineralogy of the bulk palaeosols and sediments (< 2 mm obtained from random powder preparation) was determined using powder X-ray diffraction. Minerals in the palaeosols and sediments sorted out into three groups according to their pedogenetic significance: (1) carbonates, (2) products of strong weathering and (3) detrital and slightly weathered minerals. Two main associations of minerals could be noted. Firstly, there is a highly weathered association consisting of haematite, calcite, magnesian, aragonite, talc, siderite, magnesium carbonate, anhydrite and calcite. Quartz contents are low, and feldspars are absent. We propose that this association represents a weathering crust formed during a warm and humid climatic period of the Middle Pliocene. Secondly, a less weathered association contains well crystallised clay minerals, predominantly quartz, but with little calcite. Calcite is present only when secondary cementation or admixture of rock fragments occurs. This association represents weakly to moderately weathered terrestrial or coastal sediments of Pliocene to Middle Pleistocene age. The genetic conclusions obtained accord well with results obtained by the study of vertebrate fossils in the area.

REMOTE SENSING CONTRIBUTION TO THE MODELING OF RANGELAND PRODUCTION AND BEHAVIOR, A CASE STUDY IN WEST AFRICA

Nutini Francesco, Boschetti Mirco, Cinquanta Davide, Brivio Pietro A & Bocchi Stefano. 1. CNR-IREA, Institute of Electromagnetic Sensing of Environment, Via Bassini 15, Milan, Italy 2. DI.PRO.VE., Department of Crop Science, University of Milano, Via Celoria 2, Milan, Italy

ABSTRACT
The Sahelian belt of West Africa is a semiarid region where the food security is based on traditional livelihood activities, like rainfed crop and nomadic pastoralism. This area witnessed a dramatic food crisis in the 70-80s, which was caused by prolonged drought and was locally exacerbated by socio economic instability.
Time series of satellite observations allowed identifying re-greening of the Sahelian belt that indicate no noteworthy human effect on vegetation dynamics at sub continental scale from 80s to late 90s. However, several regional/local crises related to natural resources occurred in the last decades despite the re-greening thus underlying that more detailed studies are needed.

This work has been carried out in the framework of the EU FP7 Geoland2 project as a contribution to the ECOWAS component (Economic Community Of West African States) of the AMESD (African Monitoring of the Environment for Sustainable Development) programme with the purpose to give a contribution to the monitoring of pasture production in a semi-arid region. Especially, the paper explores the possibilities to use a mechanistic crop model with the contribution of remote sensed data with goals to a) estimates the pasture production and b) estimates the seasonal vegetation development indicative of critical situations.

The software used is the generic crop model STICS, developed by INRA, that is able to simulate different types of crops. The mechanistic model allow to simulate, once calibrated and providing the necessary inputs (meteo, soil and management), the soil-plant-atmosphere relationships and the accumulation of biomass at daily time-step. The estimation of biomass is based on the well-known concept of Radiation Use Efficiency (RUE). According to RUE the vegetation growth can be evaluate by the intercepted incoming solar radiation and a number of conversion and efficiency factors.

The use of remote data from satellite is strategic in providing different types of information for the model otherwise missing: meteo data (estimation of temperature, precipitation and solar radiation), information about the management (for instance start of season) and time series of biophysical variables of interest for the modeling (evapotranspiration, fAPAR).

The satellite information were implemented into the model at different levels. First of all time series of satellite data were exploited as reference data for the calibration of the different model parameters. Secondly as input for phenological data of start/end of season (compensating the absence of local information on land management) and providing meteo data where local measurements aren’t available.

Furthermore the possibility to force the output of the model using biophysical variables from satellite is explored. The accuracy assessment of the output was carried out by a comparison between the simulated variable of Leaf Area Index (LAI) and satellite data of LAI from SPOT-VGT, to check the capability of the model to simulate the development of seasonal pasture areas.

In addition, the goodness of the simulated biomass productions were compared with biomass data measured on field in grazing areas of savannah. These ground data were made available by Centre Suivi Ecologique in Dakar, Senegal, and the NGO ACF (Action Contre la Faim) in Niger. Preliminary results provide an indication on how to use a mechanistic model in a semi-natural area with slightly human management, and on the contribution of remote data as input and forcing in order to obtain estimates of production and simulations of seasonal range land behavior.

**COMPARTIVE STUDY OF MULTI-DATA FUSION TECHNIQUES IN MAPPING GEOLOGICAL FEATURES, WADI GHWOWAIBA, NORTHWEST GULF OF SUEZ, EGYPT**

S. M. Hasan¹ & B. M. El Leithy¹

1. National Authority for Remote Sensing and Space Sciences (NARSS), Cairo, Egypt

**KEY WORDS:** Remote Sensing - ASTER-SPOT - Spectral characteristics analysis - Band ratio - Data fusion - Correlation coefficient.

**ABSTRACT**

In this study SPOT-panchromatic image with 10 m spatial resolution was fused with ASTER-band ratio images with 30 m spatial resolution. The fusion of SPOT image with ASTER band-ratio data using PC, Brovey, HPF and IHS transform
techniques proved to be excellent for both lithological and structural mapping as it preserves the spectral information of ASTER and SPOT data. By visually comparing of these data fusion, the HIS and CNT, methods produce high color distortion with respect to the original image, while it preserve a perfect spatial resolution. The PCA fusion method produce very low color distortion but it does not preserve all the spatial information. The HPF fusion method produces very low color distortion as well as preserves all the spatial information which looks sharper than the other images. This study revealed that, the HPF fusion method looks the best method comparing with the other methods in terms of the quality of spectral and spatial information. By quantitatively analyzed using the correlation coefficient (CC), The CC is ranging from 0.406 to 0.455 using HIS fusion method. While by using Brovey transform, the CC ranging from 0.955 to 0.988. Wherever, The CC between the multispectral input data and the output fused image is ranging from 0.988 to 0.996 using automatic PCA fusion technique. By using manual PCA fusion technique, the CC is ranging from 0.978 to 0.997, so there is no big different between the automatic and the manual PCA methods. The best CC between the multispectral input data and the output fused image is ranging from 0.989 to 0.999 using HPF fusion technique.

**DERIVATION OF SOIL TEXTURE MAP USING GAMMA RAY SPECTROMETRY METHOD**

Attah M. Fakeye\(^1\), Francis O. Aitsebaomo\(^1\) & Esther O. Ugoji\(^2\)

1. Nigerian Building and Road Research Institute, Km 10 Ota-Idiroko Road, Ota, Ogun State, Nigeria.
2. Faculty of Science, University of Lagos, Akoka-Lagos, Nigeria.

**KEYWORDS:** gamma ray spectrometry, soil texture, soil survey

**ABSTRACT**

Mapping soil and its properties are crucial for understanding the Earth structure, its processes and capabilities. Acquiring this information is often done through conventional methods which are challenging, expensive, tedious, time consuming and prone to high errors. Gamma ray spectrometry (radiometrics) is a relatively new soil sensing technique that can potentially address this problem by improving the mapping of soil texture and available potassium (avK). In addition, in inaccessible or urban areas, this method can be very challenging. Under favourable conditions, gamma ray spectrometry can provide estimate of topsoil characterisation. This technique is used to obtain the soil texture in the study. It is based on the computation of the gamma ray spectra acquired at a range. The soil gamma ray potassium is related to the soil texture (sand, clay and silt content). Here, we investigate the capability of combining gamma radiation to obtain empirical relationship with soil texture. Subsequently, we propose extending measurement to adjacent areas that were not covered by geophysical surveys. The use of this approach has led to the production of a 0.2m resolution soil texture map of Nong Sung District of Nakhon Ratchasima Province in Thailand, a quaternary environment with alluvial deposits covering the landscape, and characterised by farmland with low topography. Among other things, soil texture can help determine the organic content of soils and also predict the types of micro organisms involved in the degradation of Soil Organic Matter (SOM). The potassium held in soils can be cycled through soil-plant system. The microflora in this system can be determined using the Denaturing Gradient Gel Electrophosis (DGGE) method after extracting the Deoxyribo Nucleic Acid (DNA). Three plots Nong Sung (P1), Ban Nong Ta Net (P2) and Ban Moi Kwok (P3) were investigated using exploratory linear correlation analysis but mapping analysis was focussed on P1 and P3. In contrast to P2, the soils from P1 and P3 had sufficient soil texture range and parent material conditions that allowed for calibrations to be developed. Soil properties were mapped using multivariate linear regression with radiometric and location data as inputs. By regression analysis, radiometric data (γK) was associated with 51% variance in clay and validated with overall root mean square error (RMSE) of 0.8% clay. The success of γ-ray spectrometry in predicting this property relied on the strong relationship of 69% clay, 72% sand and 62% silt. The predominantly sandy loam terrain has led to an association of γK with soil texture and soil available potassium which occurred in the old alluvial deposit of gentle relief and also, the association with γU and γTh using multiple regression method. This study
concludes that for a plot with weathered soils of sufficient soil texture range, radiometrics can reliably predict clay and available potassium contents. The success of this methodology in developed and developing countries becomes imperative in recommending it as an exploration tool in environments with similar conditions in Africa.

**USING HYSPEX SWIR-320M HYPERSPECTRAL DATA FOR THE IDENTIFICATION AND MAPPING OF MINERALS AND CARBONATE ROCKS OF JURASSIC AGE IN THE ESSAOUIRA-AGADIR BASIN (ESSAOUIRA-AGADIR BASIN, WESTERN MOROCCO)**

Rachid Baissa 1,2, Kamal Labbassi 1, Patrick Launeau 2 & Brahim Ouajhain 1
1. Laboratoire de Géosciences et Environnement, Faculté des Sciences, Université Chouaïb Doukkali, BP 20, 24 000 El Jadida, Maroc
2. Laboratoire de Planétologie & Géodynamique/ UMR-CNRS 6112/, Université de Nantes, BP 92209 -44322 Nantes Cedex 3, France

**KEY WORDS:** Remote sensing, hyperspectral, spectroradiometry, geology mapping, carbonate, Normalized Difference Carbonate Index (NDCI), Essaouira-Agadir Basin, Morocco.

**ABSTRACT**

Nowadays the development of sensors for acquiring hyperspectral images has contributed greatly to the identification of different constituents of the earth’s surface and therefore to the improvement of cartographic products. Carbonate rocks are often altered by physical and chemical processes. These processes lead to the formation of new carbonate minerals with highly variable phase crystallization. Frequently, with the optical microscope, the precise identification and discrimination of these phases are beyond the resolving power of the eye, which makes mapping mineralogical microfacies difficult. It requires, first, the use of staining techniques. This work proposes to study hand specimens of the carbonate facies of Jurassic age in the Essaouira-Agadir Basin, using a regional spectral library, based on the samples were measured in situ by an ASD spectroradiomètre and completed by using hyperspectral imagery provided by the camera HySpex SWIR-320m. These images offer the possibility to identify with precision the different carbonate minerals and to allow diagenetic facies characterization. The approach is to calculate an index of carbonate, the Normalized Difference Carbonate Index (NDCI) to study the deepening of the main absorption band of carbonates and a supervised classification method based on the Spectral Angle Mapper (SAM) to study the overall shape of reflection spectra of carbonates and to map other accessory minerals. This method has allowed the development of mineralogical maps supplemented by their degrees of crystallinity.

**Acknowledgement:** This work is carried out under the Volubilis program. Action Intégrée N°: MA/07/171.

**THE ROLE OF GEOLOGIC AND GEOLOGIC STRUCTURE ON THE GROUNDWATER MODELING OF HOLY MAKKAH AND ZAMZAM WELL, KSA**

Ahmed Kotb 1, Ahmed Ali 2 & Majed Hassaballah 2
1. Al Zhar University, Cairo, Egypt,
2. Ain Shams University, Cairo Egypt,

**KEY WORDS:** Groundwater; MODFLOW; Calibration; STRM.

**ABSTRACT**

The purpose of this study is to find a solution for the groundwater system of Holy Makkah. KSA. A 3-D finite Difference Model (Visual MODFLOW- Ver. 3.1) has been used to simulate the impact of different alternative solutions in order to
select the best suitable one. The result of geophysical survey, bore holes data, hydro-geological data, STRM and satellite images were used to construct and calibrate the numerical model. The area is affected by a series of faults, Topographic situation of the study area comes as an impact of this structural setting. By considering fractures of the geologic formation, the calibration of the domain gets accelerated and results are more confident.

**MAPPING NITROGEN CONCENTRATION IN AN AFRICAN SAVANNA LANDSCAPE USING WORLDVIEW-2 MULTISPECTRAL DATA**

Fadzai M. Zengeya, Onisimo Mutanga & Amon Murwira

1. Discipline of Geography, University of KwaZulu-Natal, P. Bag X01, Scottsville 3209, Pietermaritzburg, South Africa
2. Department of Geography and Environmental Science, University of Zimbabwe, PO Box MP167, Mount Pleasant, Harare, Zimbabwe

**ABSTRACT**

Remote sensing provides an opportunity to estimate the distribution of forage quality at large spatial extents. In this regard, several studies have shown that remotely sensed data particularly hyperspectral data can be used to estimate and map plant nutrient status. Foliar nitrogen and phosphorous has been successfully linked to hyperspectral imagery particularly HyMap. Although meaningful results have been attained, the use of hyperspectral data is often (1) expensive for large scale mapping, (2) influenced by multicollinearity and finally often few of the bands are actually used in quantifying the foliar biochemicals. Thus, there is need for practical and affordable multispectral remote sensing alternatives to hyperspectral data that have potential to provide accurate and reliable estimates of forage quality across landscapes. In this study we used the new WorldView-2 multispectral imagery to estimate and map forage quality (nitrogen concentration). We specifically tested the extent to which different WorldView-2 derived vegetation indices can be used to estimate and map forage quality, i.e. nitrogen concentration using partial least squares (PLSR) regression. We also assessed the validity of the forage quality maps by testing whether cattle spatial distribution and movement patterns significantly relate with remotely sensed estimates of forage quality across a savanna landscape. Nitrogen concentration was successfully estimated and mapped ($R^2_{cv} = 0.66$, relative error = 0.13%) using partial least squares regression (PLSR). The results of this study suggest that new multispectral data with unique band settings such as WorldView-2 improves the estimation and mapping of forage quality in rangelands. Such multispectral data could provide less costly remote estimates of forage quality across rangelands in different landscapes particularly those in Africa where the cost of hyperspectral data is of great concern. In addition, our results indicate that remotely sensed forage quality distribution can be used to explain herbivore distribution, particularly cattle grazing patterns in rangelands thereby increasing the utility of remote sensing to rangeland management.
**Figure 3:** Relationship between measured and predicted nitrogen concentration using left panel (a) the standard NDVI (B821 and B659) (b) the best selected NDVI (B608 and B427) (c) best selected NDVIs (PLSR). Right panel (a) the standard SRs (B831 and B659) (b) the best selected SR (B608 and B427) (c) best selected SRs (PLSR). For each model the cross validated $R^2$ and RMSE is reported.
NEW REMOTE SENSING TOOLS FOR MINERAL EXPLORATION

Alex Fortescue
Southern Mapping Company 39 Kingfisher Drive, Fourways, Johannesburg, South Africa

ABSTRACT
This paper will provide an overview of satellite and airborne technologies utilised for geological mineral and hydrocarbon exploration. It will include an overview of the principles of airborne hyperspectral imaging. It will describe techniques through specific examples of commercial projects on the African continent which will include Satellite based analysis of chromite potential in Madagascar as well as Airborne hyperspectral imaging for detection of Acid Mine Drainage (AMD) sources, Gold and Uranium concentration mapping, hydrocarbon spill detection, alien vegetation mapping and water quality assessment in South Africa. It will include a demonstration of how multispectral satellite imagery and airborne hyperspectral imaging are being used in conjunction with innovative non seismic in situ monitoring techniques for the detection of oil and gas in Egypt and Mozambique.

1. Chromite potential mapping Using Landsat, Aster, Rapideye and SRTM satellite imagery
This example will outline a technique whereby multispectral analysis of Landsat, Aster and RapidEye imagery in conjunction with geological map data allowed for the determination of areas with a high probability to host chromite in Madagascar. It will be demonstrated how the remote sensing analysis allowed for the detection of chromite areas with a 98% accuracy based on 100 in situ field verification points and how an original exploration area of 50 000km2 was narrowed down to a manageable 5000km2 for in situ investigation.

2. AMD Source Mapping in South Africa
This example will describe how Acid Mine Drainage decants from 100 year old mines in Johannesburg is creating unprecedented environmental damage downstream. It will include a description of the basic mechanism behind Acid Mine Drainage, namely the exposure of pyrite and its chemical alteration to the mineral Jarosite and Hematite. Visual examples of how airborne hyperspectral imaging over the Krugersdorp decant site in Johannesburg will show how airborne hyperspectral imaging can not only detect where these AMD sources occur, but also infer the pH of water in the system.
3. Gold and Uranium Concentration Mapping
This example will show how gold and uranium (both opaque in the Visible near Infra-Red (VNIR) and Short Wave Infra-Red (SWIR) portions of the electromagnetic spectrum) were detected through airborne hyperspectral interpretation on old mine tailings and acid treatment plants in the Welkom region of South Africa. By using known spectra of associated minerals accurate snapshot maps of gold and uranium concentrations were mapped and verified in the field.

4. Environmental Baseline Monitoring using airborne hyperspectral imaging
This example will show how airborne hyperspectral imaging can be used on operational and greenfield mine projects to determine baseline water quality, vegetation species and hydrocarbon spill pollution. It will focus on the Mpumalanga coal fields in South Africa and include an example of asbestos detection on a chrome mine in Mpumalanga province South Africa.

Figure 1: Hyperspectral signatures for asbestos with airborne hyperspectral derived asbestos occurrence map on an operational chrome mine in Mpumalanga South Africa.
5. Remote Sensing Techniques combined with Innovative in situ monitoring for detection of oil and gas reserves

This component will focus on how thermal remote sensing indices were used to detect potential areas of oil and gas deposits. It will show how this technique was applied in the North El Maghara region in Egypt and allowed for 85% increase in the detection of wet wells.

Conclusion

The conclusion will include cost benefit analysis of traditional exploration techniques and how remote sensing driven techniques are able to significantly reduce the exploration budget for any projects. It will focus on the specific challenges associated with exploration in Africa.
MAPPING OF GROUNDWATER POTENTIAL ZONES BY USING REMOTE SENSING DATA AND GIS: APPLICATION OF LOWER CHAOUIA

M. El Moulat M.¹, A, Fekri¹, A, E. Fryar², M, Hakdaoui³ & R, Gloaguen⁴ R.
1. Department of geology, University Hassan II Mohammedia-Casablanca Faculty of Sciences Ben M’sik B.P 7955, Sidi Othmane. Casablanca, Morocco.
2. Department of Earth and Environmental Sciences, university of Kentucky, 101 Slone Building Lexington, KY 40506-0053 USA.
4. Institute for Geology, Freiberg University of Mining and Technology, 09599, Freiberg, Germany

KEYWORDS: Groundwater potential, remote sensing, GIS, Lower Chaouia, Morocco.

ABSTRACT
Geographic information system (GIS) and remote sensing data covering large and inaccessible areas within short time and high precision have been proved to be very effective tools to discern ground water potential zones. The area known as the Lower Chaouia, located on the Atlantic coast between Casablanca and Mohammedia is a sheet in where the water flows take place in a hard rock terrain especially the Precambrian Quartzite and Schist Fractured. The objective of the present study is to delineate, develop and verify a methodology for mapping groundwater potential zones. Remote sensing data and GIS were employed to locate potential zones for groundwater in Lower Chaouia by preparing various maps such as, the lineaments, drainage, soil type, slope and the lithology of the aquifer matrix. The groundwater availability of the basin is qualitatively classified into different classes (Excellent, Good, Moderate, Poor and Nil) based on its hydrogeomorphological conditions. The result of this study would reveal that the GIS techniques and remote sensing data can be used successfully in the exploration of groundwater potential zones.

MONITORING IRRIGATION CANAL REHABILITATION AND ITS IMPACTS ON CROP PRODUCTION USING AERIAL PHOTOGRAPHY AND HIGH RESOLUTION GEOEYE AND WORLDVIEW SATELLITE IMAGES: A STUDY OF THE MIDDLE AND LOWER SHABELLE REGION IN SOMALIA

Antony O. Ndubi¹, Zoltan Balint¹, Simon M. Oduori¹, Hussein Gadain¹ & Margaret Mugo¹
1. Somalia Water and Land Information Management Ngecha Road, Lake View. P.O Box 30470-00100, Nairobi, Kenya.

ABSTRACT
The Shabelle and Juba River Basins are the breadbasket of Somalia with considerable potential for irrigation development. However, lack of management of the barrages and canal systems threaten the long-term sustainability of irrigated agriculture and food security. The lack of relevant information on primary irrigation canals and their status is contributing to unguided and uncoordinated rehabilitation efforts. The Food and Agriculture Organisation of the United Nations (FAO) has for a long time been involved in programmes focusing on rehabilitating essential irrigation infrastructure and the roads. Much has been accomplished but little information is available due to difficulties in implementing a ground-based monitoring system. The FAO work has been implemented through local and international non-governmental organisation (NGOs) but there has been limited capabilities of monitoring the work done due to limitations stated above, but particularly due to lack of accessibility. The investments made by many other organizations to rehabilitate and develop irrigation
infrastructure along the Juba and Shabelle Rivers have also been based on scanty information that lacks good details for assessing and monitoring the state of infrastructure, potential production areas that rehabilitation will open up, cost of rehabilitation, among lots of other challenges. On the other hand, the situation of southern Somalia, both in terms of security, spatial expanse and accessibility makes it even more difficult and expensive to rely on conventional methods to generate the required information. FAO intends to overcome this by use of aerial photography and the high resolution GeoEye and WorldView remote sensing techniques.

The overall objective of the study was to develop an easy-to-use monitoring system for agricultural water infrastructure development and rehabilitation. Specifically, the work was intended to: (1) generate information on the condition and status of the primary canals and related infrastructure in the Juba and Shabelle River Basins; (2) generate temporal data on land cover in the Juba and Shabelle River Basins; and, (3) update the SWALIM developed Irrigation Information Management System (IIMS).

The work involved an approach to devise a monitoring system that is practical given the prevailing situation in Somalia. It takes advantage of the application of Remote Sensing techniques in the monitoring of the earth surface phenomena. The use of Remote Sensing techniques in land resources monitoring is well documented (Lillesand and Kiefer1987, Bandara 2006, Muhammad, et al, 2011). The system developed a high resolution information base to assess, plan and design irrigation infrastructure rehabilitation and development projects in the Lower Shabelle Region using aerial photographs and high resolution satellite images. The activities were based on (i) an initial processing of raw aerial photography data generated by SWALIM in the aerial photographic survey of 2008; and (ii) monitoring of the baseline information generated from the 2008 aerial photographs using High Resolution (HR) satellite images and is the basis of this paper.

The results obtained suggest that a significant amount of work has been completed, including 220 km of canals, seven reservoirs, eight market sheds and over 100 km of road rehabilitated. Subsequently, over 100 demonstration plots have been established and more than 10,000 farmers trained in basic agronomy. The achievement, also referred to as impact of irrigation canal rehabilitation work, is further underlined by preliminary reports from the Food Security and Nutrition Analysis Unit (FSNAU), a programme of the FAO, that indicated that in Gu 2009 for Afgooye, Qoryooley, Merka, and Jamaame Districts, which were the focus of the Special Framework Agreement field actions, approximately 76,800 ha of land were cropped, some 24,600 ha more than in 2008 and 47,500 ha more than 2007. The accompanying impacts of the programme included training of farmers on cropping techniques through the farmers field schools with a subsequent and significant increase in the yield of maize from 1.5 to 3.6 tons per ha for participating farmers in the demonstration plots.

INTEGRATION OF MODIS AND GRACE DATA FOR M MAPPING EVAPOTRANSPIRATION FOR THE VOLTA RIVER BASIN, WEST AFRICA

Firas Alazem¹, Amos Tiereyangn Kabo-bah²,³ & Mohammad Abdullah Alshamrani⁴

1. Saudi Geophysical Consulting Office, PO, Box 1587, Alkhobar 31952, Kingdom of Saudi Arabia
2. College of Hydrology and Water Resources, Hohai University, 1 Xikang Road, Nanjing 210098, China.
3. Green WaterHut, Box UP 913, KNUST, Kumasi, Ghana
4. General Directorate of Water in Aseer, Sheikh Yousef st, Abha 61321, Kingdom of Saudi Arabia

ABSTRACT

Measurements of evapotranspiration (ET) are important for managing the catchment yield in ungauged basins and water availability. The last decade has seen the growth in the use of remote sensing methods to estimate land surface evapotranspiration (ET). This is because this technique has proven to provide feasible spatio-temporal information over land surfaces especially for large study areas. The MODerate resolution Imaging Spectroradiometer (MODIS) data has to some extent been used extensively to map ET in most developed countries. Generally, the challenge with MODIS ET
is that, it is difficult to close the land water budget. Due to this limitation, MODIS satellite data may not be considered a reliable source of data for water budget analysis. However, the advantage of MODIS satellite in terms of its temporal and spatial coverage coupled with its free distribution to public users makes it an option for most users. Therefore to close this gap in the MODIS satellite ET estimates, a normalization of the MODIS ET was made with the Gravity Recovery and Climate Experiment (GRACE) water storage, precipitation and stream flow variations based on water budget method to minimize the water budget problems of MODIS ET estimates for the Volta Basin of West Africa. The Volta Basin which is one of the most important river basins in West Africa was used as a case study. The basin is shared by six countries (Ghana, Burkina Faso, Togo, Côte d'Ivoire, Benin and Mali). Due to the competing nature for the basin’s resources, effective water resources management is crucial for basin’s stakeholders. However, the huge loss from ET is a potential setback for the ensuring that the limited basin’s water resources could be used to meet the growing demands. The MODIS ET estimates were derived from the use of the Surface Energy Balance System (SEBS) model. The SEBS model is broadly used to map land surfaces fluxes using remote sensing data and meteorological data and integrated together in the model to derive actual ET. The SEBS model is an integrated package in the Integrated Land and Water Information System (ILWIS) Geographic Information System (GIS) and Remote Sensing software, consist of set of tools for the determination of various physical parameters. The final results showed that the MODIS ET estimates had a consistent error when compared to the average monthly ET estimates. The modified MODIS ET were found to be closely fit with the water budget, also comparing with other previous research using different satellite data yielded showed that, the GRACE data could provide a reliable way to improve the MODIS ET estimates. A further check for consistency was performed by comparing the modified MODIS ET estimates with the potential FAO Penman-Monteith ET. The results show a highly comparable spatial and temporal variation between the two methods. The study significantly indicate that SEBS model was applicable for estimating the actual evapotranspiration in the Volta Basin and that, GRACE and MODIS data sources were valuable tools for improving the water balance budgets in the basin. The application of GRACE data in water resources modeling in the basin is relatively new and hence this research provide a baseline to support future use of GRACE data for hydrological and water resources modeling in the basin.

SYSTEME WATERWARE GESTION ET OPTIMISATION DES RESSOURCES EN EAU

Salah Ben Amor¹, Ahmed Ezzine¹, Najeh Sayah¹, Mohamed Ali Amri¹ & Meriem Haffani¹
1. Centre National de la Cartographie et de la Télédétection- Tunisie

MOTS CLES: Optimisation des ressources en eau, gestion intégrée, WaterWare, SIG.

RESUME
La Tunisie avec son climat semi-aride, sa pluviométrie irrégulière et faible est aujourd'hui confrontée à l'impératif de mieux gérer les ressources hydrauliques et de les valoriser. Cependant, les moyens traditionnels se sont avérés insuffisants pour l’aménagement et la gestion des ressources en eau. Parmi les très nombreux projets s’intéressant à l’optimisation des ressources en eau, les projets SMART « Sustainable Management of scarce resources in the coastal zone » et OPTIMA « Optimisation For Sustainable Water Management » viennent appuyer le souci du Centre National de la Cartographie et de la Télédétection (CNCT) d’être un acteur actif dans cette démarche scientifique et institutionnelle. Ces projets visent à explorer des méthodes et des outils pour une approche pratique d’optimisation de l’allocation de l’eau et son utilisation durable en introduisant les objectifs environnementaux, technologiques, économiques et sociaux dans le cadre de développement durable de la gestion intégrée des ressources rares. L’approche de nature participative est basée sur des concepts d’optimisation multicitères, et de mise en place de stratégies de prise de décision. Il s’agit d’une approche assistée par ordinateur interactive. Cette approche consiste à intégrer cette méthode d’optimisation dans les processus de prise de décision tout en privilégiant la participation des détenteurs de l’information. Cette approche a l’avantage aussi de l’usage extensif d’internet pour faciliter une large participation et
de partage de l’information pour renforcer la participation de plusieurs acteurs dans le processus décisionnel. Il est capital de noter que dans ces projets, l’équipe des projets a eu recours à l’utilisation d’un modèle numérique pour décrire le changement de l’utilisation du sol et des ressources en eau. Ces modèles sont basés sur des données SIG, des systèmes experts et des modèles classiques des ressources en eau (RRM et WRM) basés sur les lois de conservation et utilisant les équations différentielles.

Les outils d’analyse incluent:

- Un système expert comportant les fonctionnalités SIG, l’analyse spatiale et une approche multi-critères ;
- Un système « WaterWare » de modélisation hydrologique des bassins versants.

Pour développer et tester la méthodologie proposée, une série d’études de cas le long de la Méditerranée (Turquie, Syrie, Liban, Jordanie, Égypte, Tunisie et Maroc) a été utilisée. Chaque étude de cas possède des objectifs, critères et contraintes spécifiques en termes d’utilisation conflictuelle de l’eau. Les résultats des études de cas sont comparés entre les différents pays méditerranéens pour identifier des conclusions générales et communes. Ces résultats ont été également comparés avec certains pays européens.

Cette méthodologie a été basée sur :

- La compilation de données SIG, hydrologiques, socio-économiques, etc… ;
- L’intégration de méthodes quantitatives basées sur la modélisation et la simulation ;
- Une étude socio-économique ;
- L’évaluation comparative d’une méthodologie commune ;
- La dissémination des résultats sur Internet.

Ce projet nous a permis de développer un outil de la gestion intégrée des ressources en eaux permettant une meilleure gestion de l’offre en termes d’apport et de la demande en termes de consommation ainsi que l’estimation des pertes au sein du système hydraulique modélisé. Plusieurs scénarios ont été ainsi générés pouvant matérialiser un outil d’aide à la décision fiable s’affranchissant des aléas climatiques (sécheresse et inondation) de plus en plus fréquents dans un pays comme la Tunisie.

**UNDERSTANDING RECENT LAND USE/COVER DYNAMICS IN THE SOURCE REGION OF THE UPPER BLUE NILE, ETHIOPIA: SYSTEMATIC AND RANDOM TRANSITIONS**

E. Teferi 1,3, W. Bewket 2, S. Uhlenbrook 1,2 & J. Wenninger 1,2

1. UNESCO-IHE Institute for Water Education, P.O. Box 3015, 2601 DA Delft, The Netherlands
2. Delft University of Technology, Department of Water Management, P.O. Box 5048, 2600 GA Delft, The Netherlands
3. Institute for Environment, Water and Development Studies, Addis Ababa University, P.O. Box 2176, Addis Ababa, Ethiopia
4. Department of Geography and Environmental Studies, Addis Ababa University, P.O. Box 2176, Addis Ababa, Ethiopia

**KEY WORDS:** Land use and land cover change; Systematic transition; Remote Sensing; Geographic Information System; Enhanced transition matrix; Swap change; Blue Nile River; Jedeb watershed

**ABSTRACT**

The objective of this paper is to quantify the long term land use and land cover change (LULCC) and identify the most systematic transitions for the period 1957-2009 in the source region of the Blue Nile River in the Jedeb watershed. The Jedeb watershed (~296 km²) comprises mountains and valley with steep slopes, typical of the landscape in high population density and high elevation zone of Mt. Choke. Black and white aerial photographs of 1957, Landsat imageries of 1972 (MSS), 1986 (TM), 1994 (TM) and 2009 (TM) were used to derive ten land use/cover classes by integrated use of Remote Sensing (RS) and Geographic Information System (GIS). Post-classification change detection...
analysis based on enhanced transition matrix was applied to detect the changes and identify systematic transitions. The results showed that 46% of the study area experienced a transition from one category to another category over the past 52 years, out of which 20% is due to a net change while 25.9% is attributable to swap change. Cultivated land constituted the predominant type of land cover followed by grassland in the whole period 1957-2009. Cultivated land and barren land showed a growth of 30 and 139%, while grassland, afro-alpine grassland, shrubs and bushes, riverine forest, wood land, marshland and Ericaceous forest declined by various proportions. The rate of afforestation and reforestation far outpaced the deforestation rates in both periods 1972-1986 and 1986-1994 whereas recent rate of deforestation (2.2% a⁻¹) exceeded the rate of change of plantation forest (0.9% a⁻¹). The most dominant signals of changes in the Jedeb watershed during the period 1957-2009 is conversion of grassland to cultivated land (14.8%) followed by the degradation of shrubs and bushes, riverine forest, and marshland to grassland which accounts for about 3.9% of the landscape. Hence, the loss of natural woody vegetation in Jedeb watershed is primarily attributed to the increased demand for fuel wood and other uses but not to the expansion of agriculture. The observed LULCC have apparently contributed to the existing high rate of soil erosion and land degradation in the watershed, which is evident from the numerous gullies in the cultivated and grazing lands. This study suggests that the existing resource use practice is clearly unsustainable. Hence, there is an urgent need for intervention of land use planning and watershed management in the area.

GROUNDWATER POTENTIAL MODELLING OF AKURE CITY, NIGERIA USING REMOTE SENSING AND GIS

A.Y.B. Anifowose¹ & O.O. Aladejana¹


KEYWORDS: Remote sensing, GIS, Analytical Hierarchy Process, Groundwater Modelling, Sensitivity Analysis, Weighted Linear Combination.

ABSTRACT

Groundwater is, no doubt, a resource needed for the sustainable development of any country. Hence, it is important that a balance is maintained between its abstraction and recharge. Remote sensing and GIS technology have proved to be efficient in the monitoring of earth resources, including groundwater. Akure is a fast-growing city which requires groundwater modelling as a component of its developmental strategy.

Geology, lineament, soil series, drainage, slope, rainfall and the land cover of the study area are the factors considered for this study. Thematic maps of lineaments, landuse/cover are produced by direct digital image processing of Landsat ETM+ of the study area. Other data such as the geology, contour, slope, rainfall, soil, and geomorphology were also obtained from respective thematic maps of the area.

All these above themes and their intangibles (individual attributes) are assigned weights and reclassified according to their relative importance to groundwater occurrence by using Analytical Hierarchy Process (AHP). Sensitivity analysis of the results to changes in weights are conducted to determine the robustness of the analysis. The Weighted Linear Combination will subsequently be used in modelling the groundwater potential of the study area.
RECONNAISSANCE DES RESERVOIRS KARSTIQUES D’EAU SOUTERRAINE DU CAUSSE MOYEN ATLASIQUE (MAROC) PAR L’UTILISATION COMBINEE DES SIG ET DE LA TELEDETECTION

Ali Essahlaoui \(^1\), My Hachem Aouragh \(^1\), Abdelhadi EL Ouali \(^1\) & Abdellah Elhmaidi \(^1\)

MOTS CLES: Causse moyen atlasique, SIG, Télédétection, M.N.T, Réservoirs karstiques.

RESUME
Les eaux souterraines d’origine karstique du causse moyen atlasique jouent un rôle décisif aussi bien pour l’alimentation en eau potable de la ville de Meknès que pour l’irrigation des régions avoisinantes. L’utilisation des Systèmes d’Information Géographique (SIG) et de la Télédétection, constitue une nouvelle approche pour la spatialisation de l’information et la mise à jour des travaux de cartographie, en vue d’aider à la prise de décision, notamment en matière de gestion et d’aménagement des territoires. Le présent travail de recherche a pour objet d’élaborer une base de données numériques, ayant un rapport avec la gestion des ressources en eaux souterraines, touchant plusieurs types plans d’information, en plus que la possibilité de cartographier à l’échelle régionale, à partir des données satellitaires et cartographiques, une carte de synthèse des principaux linéaments de la région. Un modèle numérique de terrain réalisé à partir du captage Radar, a été exploité dans un SIG, ce qui a permis l’extraction d’un ensemble de cartes thématiques plus précises, montrant l’état de surface du causse moyen atlasique.

Le traitement des images satellitaires : Landsat ETM (Enhanced Thematic Mapper) et Aster (Advanced Spaceborne Thermal Emission and Reflection Radiometer) a permis la réalisation de plusieurs cartes thématiques : carte d’occupation des sols, carte de répartition spatiale des carbonates (réservoirs karstique), carte des principaux linéaments. Ces derniers ont fait l’objet de comparaison avec le réseau de fracturation (données géologiques). Les cartes finales obtenues ont permis de bien connaître le réservoir hydrogéologique karstique.

Les ressources en eau de ces aquifères karstiques, constituent généralement un facteur essentiel du développement économique, social et durable des régions concernées. Cependant l’évaluation et la protection de ces ressources en eau, ainsi que la recherche de nouvelles ressources en eau potables est certainement un des grands défis actuels.

APPORT DE LA TELEDETECTION ET DES SIG POUR L’EVALUATION DE LA VULNERABILITE A LA POLLUTION DE LA NAPPE PHREATIQUE DU CAUSSE MOYEN ATALSIQUE DANS LA REGION D’EL HAJEB PAR LA METHODE DRASTIC

Yassin Azzi \(^1\), Ali Essahlaouvi \(^1\), Abdelhadi El Ouali \(^1\) & Abdellah El Hmaidi \(^1\)

MOTS CLES : causse moyen atlasique, El Hajeb, pollution, eau souterraine, SIG, Télédétection, DRASTIC.

RESUME
L’accroissement démographique et le développement agro-alimentaire que connaît la plaine de Meknès-Fès et la région d’El Hajeb, durant ces dernières années, ont induit l’augmentation de la demande en eau. Cette région occupe une place importante dans le territoire marocain, aussi bien par sa situation géographique que par ses potentialités hydriques (Essahlaoui, 2000) et agricoles. Ces dernières contribuent en plus d’autres activités, à la pollution des eaux de la nappe superficielle.
Les eaux souterraines eaux sont souvent menacées par la contamination par des polluants de différente nature. La prévention contre la pollution des nappes constitue une étape importante à laquelle les scientifiques consentent de plus en plus d’effort, en étudiant la vulnérabilité des nappes souterraines.

La nappe phréatique du causse moyen atlasique est située dans un réservoir carbonaté fracturé et karstifié. Le réservoir hydrogéologique présente une grande perméabilité de fracture ce qui le rend vulnérable aux pollutions anthropiques. Ces dernières années, cette région a connu une grande activité agricole et ainsi une étude qui permettra de spatialiser cette vulnérabilité trouve son intérêt dans cette région.

La vulnérabilité d’une nappe traduit la facilité avec laquelle elle peut être atteinte par une pollution provenant de la surface du sol. La méthode DRASTIC est la méthode la plus utilisée pour évaluer la vulnérabilité et la spatialiser sur de grands territoires. Les paramètres pris en considération par cette méthode (Aller, 1987) sont : la profondeur de la nappe (D), la recharge nette (R), les matériaux constituant l’aquifère (A), le type de sol (S), la topographie (T), l’impact de la zone non saturée (I) et la conductivité hydraulique (C).

L’appréciation de ce phénomène consiste à attribuer des cotes (c) variant de 1 à 10 et des poids (p) allant de 1 à 5 pour chaque paramètre. L’indice de vulnérabilité final recherché (ID), s’obtient en additionnant les produits des cotes des sept paramètres par leurs poids respectifs :

\[ ID = D_p * D_c + R_p * R_c + A_p * A_c + S_p * S_c + T_p * T_c + I_p * I_c + C_p * C_c \]

Les résultats obtenus sont présentés sous forme de cartes thématiques à savoir :

- La carte des pentes : à l’exclusion du long de l’oued Tizguite où la pente peut dépasser dans certains cas 20°, les autres terrains sont peu accidentés (moins de 10°).

- Carte des profondeurs de la nappe souterraine : cette carte montre des niveaux de faibles profondeurs (inférieurs à 30 m) surtout dans les périphériques du causse ; moyennement forte dans le centre (jusqu’à 80 m).

- Carte géologique : l’étude géologique a révélé qu’il s’agit bien d’un milieu carbonaté fracturé et karstifié favorable au développement d’une perméabilité élevée.

Plusieurs cartes thématiques ont été élaborées à partir de l’interprétation des images satellitaires Landsat ETM+ et ASTER à savoir : La carte d’occupation des sols, la carte de répartition spatiale des carbonates (réseaux karstique), et la carte des principaux linéaments. Ces cartes ont permis d’une part de cartographie les zones à forte activité agricole et d’autre part d’estimer la perméabilité du réservoir karstique à partir de la densité de la fracturation retrouvée et de spatialiser par la suite le paramètre de conductivité hydraulique (C) du réservoir.

L’élaboration de la carte de vulnérabilité de la nappe phréatique du causse moyen atlasique constitue un outil très important pour le diagnostic de la qualité des eaux de la région d’El Hajeb-Ifrane à travers une cartographie des zones touchées et/ou à risque et pour la bonne gestion des ressources en eau et sol de la région.

Références


MAPPING OF GROUNDWATER PROSPECT AND RECHARGE STRUCTURE SITES IN SAMARU ZARIA-NIGERIA

Younge, T. T.¹, Azua, S.¹ & Abu, M. R.¹
1. Department of Geomatics, Ahmadu Bello University, Zaria

KEYWORDS: Groundwater mapping, Water sustenance & security, Recharge structure, RS & GIS, Urban planning

ABSTRACT
Water is an indispensable commodity to both plant and animals. It is used at homes, offices, and in agriculture. The increase in world population has of course led to high demand for water, for domestic use and other purposes. Groundwater is the most important natural resource of the earth and is required for drinking, irrigation, and industrialization. The resource can be optimally used and sustained only when the quantity and quality of groundwater is assessed. Moreover, the problem of lack of accessibility to water combined with inadequate rainfall has called for the need to know where and how to look for water without much difficulty. The concept of integrated remote sensing (RS) and geographic information system (GIS) has proved to be an efficient tool in integrating urban planning (land use/land cover) and ground water studies. Hydro-geological studies coupled with structural/lineament have proved to be a very effective tool to discern ground water potential zones. In the present study, an attempt has been made to identify the ground water prospect sites (bore holes and wells) in samaru, sabon-gari local government area, based on the integrated technique. Maps/imageries and GPS receiver as well as ArcGIS 9.3 software are deployed to accomplish this task. Queries were performed and their results are analyzed. The groundwater prospect map is prepared considering major controlling factors, which influence the water yield. It will serve as a basis for the planning and execution of groundwater exploration in the area.

HYDROLOGICAL MODELING OF THE SUDD MARSHES IN SOUTHERN SUDAN

Mohamed E. Elshamy¹*, Doaa M. Amin¹, Eman S. Soliman² & and Karima Attia³
1. Nile Forecast Center, Planning Sector of the Ministry of Water Resources and Irrigation
2. Nile Basin Initiative Water Resources Management Project, Cairo, Egypt
3. Nile Research Institute, National Water Research Center

KEY WORD: Sudd Marshes, Hydrological model, prediction, calibration, losses, White Nile

ABSTRACT
The Sudd Marshes wetland is one of Africa’s largest tropical wetlands located in Southern Sudan in the lower plains of Bahr el Jebel (White Nile). Formed by the spillage of Nile water, the wetland supports a diversity of ecosystems with a rich flora and fauna in addition to providing livelihood for the surrounding community. However, the Sudd still requires an intensive assessment of its potential for integrated use of wetland resources to improve the livelihood of local people, reduce poverty, and conserve the ecosystem services. Hydrological and hydraulic modeling of the Sudd are key to the understanding of the behavior of the wetland and its role in shaping the ecology and the economy of the region. This has always been hindered by the difficulty to monitor water levels and areal extents of this vast area from the ground. Satellite remote sensing provides opportunities to avail information about the behavior of the wetland and this study attempts to utilize such information to calibrate a hydrological model of the wetland as an important component in building knowledge about the area. The main objective of such model is to predict the swamp area and the Sudd outflow to help evaluate the impacts of climate and land use changes over the area. The study used satellite-based estimates of the Sudd area over the period 1999-2006 to calibrate a simple hydrological model of the swamps.
Other inputs to the model included rainfall over the swamps, evapotranspiration from swamp vegetation, inflows estimated at Mongalla from levels measured at Juba, and outflows estimated as the difference between White Nile flows at Malakal and Sobat flows at Hillet Doleib (estimated from a hydrological model). Flow datasets were generally limited and had no overlap with the obtained series of areal extents and thus records had to be completed using several methods. Rainfall over the Sudd area was found to have a minor effect on the annual amount of losses. The inflow at Mongalla was found to be the most controlling factor of the areal extents of, and therefore the losses from, the Sudd. Model performance was inadequate due to several issues that had to be addressed. These include: calibration of satellite rainfall estimates using available raingauges, ground truthing of estimated areas, and inclusion of inter-annual variability of evapotranspiration (using global datasets or satellite-based algorithms like SEBAL and METRIC), and probably revising model structure. A more complicated swamp model (including hydrodynamic features) may be needed to improve the study results. However, data limitations have to be overcome before increasing model complexity.

A MULTI-SCALE MULTI-MODEL APPROACH TO ESTIMATE SUSTAINABLE BIO-ENERGY POTENTIALS

Markus Tum, Georg Kindermann, Ian McCallum, Markus Niklaus, Christina Eisfelder & Kurt Günther

1. Deutsches Zentrum für Luft- und Raumfahrt (DLR), Deutsches Fernerkundungsdatenzentrum (DFD), Oberpfaffenhofen, D-82234 Weßling, Germany
2. International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria

ABSTRACT

In frame of the EU FP7 project EnerGEO (Earth Observation for Monitoring and Assessment of the Environmental Impact of Energy Use) sustainable energy potentials for agricultural and forest areas were estimated by applying three different model approaches. First, the EPIC (Environmental Policy Including Climate) – a yield forecast model – was used to estimate grain yields. Second, the Global Forest Model (G4M) was applied to estimate global woody biomass harvests and stock. Both models were driven on a global scale. Third, the Biosphere Energy Transfer Hydrology (BETHY/DLR) model was applied to assess both: agricultural and forest biomass increases on a regional scale with the extension to grassland. For BETHY/DLR, test areas were Europe, Kazakhstan, Pakistan and the southern part of Africa, including South Africa, Namibia, Botswana and Zimbabwe.

To estimate sustainable energy potentials a two-step approach was developed. First the model outputs need to be transferred to straw content (agriculture) or above ground woody biomass harvests (forest) by using conversion factors on e.g. yield to straw and above to below ground biomass. This intermediate calculation is needed because of two reasons, first: BETHY/DLR’s output is given in values of Net Primary Productivity [tons carbon per unit time and per unit area] and EPIC’s in yield [tons drymatter per unit time and per unit areas]. Secondly our approach considers a sustainable use of renewable energy sources. We assume that only the straw content of a crop can be used for energy generation, but not the grain itself. In addition part (80%) of the straw will be used for other purposes as e.g. cross-compliance (soil fertilization). For forests we assume that only the annual increment of above ground woody biomass will be used for energy purposes, meaning: only this equivalent amount of wood can be harvested from a stand. In a second step lower heating values, giving specific energy potentials per kilogram biomass, are used to transfer the data. For agricultural areas technical potentials are estimated since use competitions for straw are taken into account, whereas for the forest areas only theoretical-sustainable potentials are estimated.

In order to archive comparable results the study was performed for the period 2000 to 2007. On a global scale energy potentials of 400 EJ for forests could be estimated. Case study analysis which we conducted for instance for South Africa and Germany showed good agreements to other regional studies. For Germany we found energy potentials of
156 PJ for 2006 and 217 PJ for 2007, compared to 112 PJ to 186 PJ reported in literature. For South Africa we calculated 461 PJ for 2003, compared with 546 PJ as reported in an independent study. Since biomass is a raw material estimation of biomass increase and potentially available energy is of great interest when discussing the renewable energy debate. With our multi-scale multi-model approach we see a contribution to this debate and the potential in forecasting biomass availability which can be used for energy generation, without competing with food supply. With our approach to use models, driven on different scales (global to regional/local) it is in principle possible to zoom to any region of the world to estimate bio-energy potentials.
LINEAMENTS MAPPING AND STRUCTURAL ANALYSIS OF SOUTHERN JENEIN BLOCK (SOUTHERN TUNISIA PLATFORM), USING REMOTE SENSING DATA AND GEOGRAPHIC INFORMATION SYSTEM TECHNIQUES

Rochdi Chaabouni¹ And Samir Bouaziz¹
1. Laboratory of "Water- Energy- Environment" (AD-10-02), Department of Geology, National engineering School, University of Sfax, P. Box 1173. W. 3038 Sfax, Tunisia.

KEYS WORDS: Southern Jenein Block, structural analysis, remote sensing, GIS, lineament mapping

ABSTRACT

Accurate geological and lineament mapping is a critical task for structural analysis and tectonic interpretation in the Jenein Block located in the southern Tunisia platform. It is considered as petroleum area. Efforts in structural mapping and tectonic interpretation in the Southern Jenein Block are hindered by difficult access to the outcropping features, where some of the formation and structure are buried under the sand of the "grand Erg oriental". This study involves the use Landsat images, Spot and Digital elevation model (DEMs) extracted from Shuttle Radar Topography Mission (SRTM) for lineament mapping which is subject for structural analysis. The obtained lineament results allowed determining two major directions of faults: the main lineament direction was 035°-065° (NE-SW) whereas the secondary lineament direction was 110°-130° (NW-SE). These structures originated of the tilted blocks delimited by fracture and folding of the Upper Cretaceous series (i.e., Senonian). An extensive structural analysis has been carried out to precise kinematic, geodynamic in term of stress tensor in this domain considered for longtime as a stable platform.

The Results will be compared with subsurface data to investigation measurement used as basic data for more fracture analysis to characterize the petroleum reservoir in study area.

VULNERABILITE DES SOLS A L'EROSION DANS LA REGION DE LA KARA AU TOGO

JOHNSON, Dodé¹ & OLOUKOI, Joseph¹
1. Regional Centre for Training in Aerospace Surveys (RECTAS) Ile-Ife, Nigeria.

RESUME

Il s'agit de proposer pour la région de la Kara située sur le socle granito-gneissique au Nord-est du Togo soumise à la dégradation du milieu, des outils et éléments d'analyse de l'érosion des sols.

Les particularités rencontrées dans la zone concernent aussi bien le milieu naturel que les activités humaines. La relative longueur de la saison sèche (parfois jusqu'à 5 mois écologiquement secs) et la concentration du cumul pluviométrique (3/4 du cumul total annuel sur 4 mois) au cours de l'année constituent des contraintes importantes pour la stabilité des sols. L'action anthropique est caractérisée non seulement par une longue exploitation agricole de ces sols à faible taux d’humus, mais également par la forte densité rurale à vocation agricole de la population, ce qui exerce une pression intense en réduisant les jachères et abaisse le taux d’humus. Ces conditions entretiennent deux grands problèmes : celui de l’érosion dans un secteur à relief et à forte densité rurale et celui de sources d’information géographique nécessaire à la gestion de cet environnement.
Plusieurs sources de données ont été utilisées pour cette étude. Les données radar SRTM ont permis l’élaboration d’un modèle numérique de terrain (MNT) et le calcul de certains produits dérivés, essentiellement la carte des pentes et celle de l’indice topographique. La carte de l’indice de brillance (IB = \(\sqrt{\text{TM3}^2 + \text{TM4}^2}\)) est très utile pour l’identification des sols nus et celle de l’occupation du sol ont été élaborées. L’indice topographique qui est un indice dérivé du modèle hydrologique TOPMODEL développe le concept d’aires contributives variables selon lequel, les différentes zones (matrices de pixels) d’un bassin versant ne contribuent pas de la même manière aux flux d’eau. L’indice prend en compte la pente locale (\(\beta\)), la surface spécifique (\(a\)) (l’aire contributive / la longueur du côté d’un pixel) : \(i = \ln\left(\frac{a}{\tan\beta}\right)\). Le potentiel de saturation augmente avec la valeur de cet indice.

La figure 2, une carte binaire est le résultat du seuillage effectué sur le calcul de l’indice de brillance Elle porte sur les valeurs les plus élevées (plus de 85% de la valeur maximale) et fait ressortir l’occupation humaine de la zone. Même si la différence entre les sols nus d’origine humaine (agriculture, habitats, utilisations diverses) et les zones d’affleurement naturel rocheux n’a pu être identifiée, l’agglomération de ces pixels "blancs" à proximité des voies de communication est un indicateur de l’emprise humaine.

La figure 3 se rapporte à l’indice topographique. La distribution de cet indice dans la zone d’étude est intrinsèquement liée à celle des pentes. En d’autres termes, les zones de départ des sédiments (ou zones probablement érodées) correspondent aux zones à fort relief et vice versa. Cette répartition montre également que les sols à tendance moyenne à la saturation, représentés par les indices topographiques de 5 à 7, se répartissent sur l’ensemble de la zone.
Les sols qui tendent à une forte saturation en eau (indices topographiques 8 à 10) correspondent aux secteurs humides à proximité des cours d’eau. Au total, les zones d’accumulation de sable correspondent aux secteurs ayant des fortes valeurs d’indices topographiques (> à 6). La proximité remarquable des zones à forte brillance (sols nus et affleurements rocheux) révélées par le calcul d’indice de brillance souligne qu’en plus de la pente topographique, l’absence de végétation est un facteur important de la dégradation des terres, notamment entre Pya et Niamtougou. La superposition de la carte de matériaux d’altération à celle de l’indice topographique situe les matériaux d’altération ferrallitique et kaolinique dans les zones à indice topographique bas notamment au sud de Farende et de Pagouda. Cette étude offre des pistes nouvelles de réflexion concernant l’érosion des sols dans la région de Kara, notamment pour une meilleure identification et hiérarchisation des surfaces plus vulnérables. Des possibilités de prévisions du phénomène existent également par l’utilisation des données multidate.

**SHORELINE DYNAMICS OF THE OPA DAM, OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA**

D. Ishaya¹ & A.Y.B. Anifowose²

1. Regional Centre for Training in Aerospace Surveys, Obafemi Awolowo University Campus, Ile-Ife, Nigeria.
2. Department of Remote Sensing and GIS, Federal University of Technology, P.M.B. 704, Akure, Nigeria.

**KEYWORDS:** Bathymetry, Change detection, Reservoir

**ABSTRACT**

Small reservoirs are mainly utilized for domestic purposes, livestock watering, fishing and irrigation, in spite of their importance in water resource planning and management. Two aspects of reservoir dynamics were studied: shoreline changes and bathymetric map production as baseline data for future studies. Landsat imageries covering the study area were acquired for the periods of 1986, 1996 and 2005 for the purpose of determining the extent of shoreline changes during the period. The Normalized Difference Water Index (NDWI) map of the reservoir was generated in ArcGIS environment; then the shoreline of the reservoir for each of the periods under consideration was extracted from the NDWI using slicing and reclass operations in ArcGIS. Shoreline for each year was overlaid and shoreline change detection map of the reservoir was subsequently produced.

A simple, less costly method with good enough accuracy was applied for rapid bathymetric survey and map generation (as developed by ITC, Enschede, The Netherlands). Transect lines and points were generated from IKONOS satellite imagery and uploaded on to handheld GPS for navigation, while observation was carried out at each of the transect points generated using dual-frequency GPS. The location coordinates as well as the depth at each of the transect points using handheld depth finder was determined and recorded. Interpolation analysis operation was performed to produce interpolated surface which was then used for modelling the reservoir bed. Further interpretation and analysis were performed based on the result obtained from the shoreline change detection and the bathymetric map.

**ETUDE CARTOGRAPHIQUE ET EXTRACTION DES LINEAMENTS PAR TELEDETECTION SPATIALE ET MORPHOSTRUCTURALE DANS LA REGION D’IMILCHIL-TOUNFITE (HAUT ATLAS CENTRAL, MAROC)**

M.E. El Alaoui El Moujahid¹, H. Ibouh¹, A. Ait Atta¹ & S. Er-raki²

1. Université Cadi Ayyad, Faculté des Sciences et Techniques, Laboratoire Géo-Sciences et Environnement, Bd A. Khattabi, BP 549, 40000 Guéliz Marrakech, Maroc.
2. Université Cadi Ayyad, Faculté des Sciences et Techniques, Laboratoire LP2M2E, Bd A. Khattabi, BP 549, 40000 Guéliz Marrakech, Maroc.
**MOTS CLES:** Télédétection, Morphostructurale, Linéaments, Landsat ETM+, fracturation ; Imilchil-Tounfite ; Haut Atlas central ; Maroc.

**RESUME**

Le secteur d’étude est la région d’Imilchil-Tounfite, elle est située géographiquement entre la province Errachidia et Béni Mellal, à 120 km à vol d’oiseaux de cette dernière ville. Géologiquement, le secteur d'études est situé dans le Haut Atlas central et précisément la zone des rides à cœur magmatique jurassique L’objectif principal de la présente étude est l’extraction et l’étude de réseaux des fractures et de linéaments dans la région d’Imilchi-Tounfite. L’approche méthodologique utilisée est la combinaison entre la télédétection spatiale et la morphostructurale. Les traitements utilisées en télédétection correspondent à des opérations de rehaussement et de combinaisons de bandes (ACP, Composition colorée, Filtre directionnel ou non directionnels ......) appliqués aux images Landsat ETM+ qui ont été géo-référenciées selon la projection conique conforme et calée selon le Datum Merchich .

**IMAGE INTERPRETATION AND PROCESSING OF NIGERIASAT OF PARTS OF JOS PLATEAU FOR GEOLOGICAL MAPPING**

Nwusulu Andrew Uzondu¹, Efron N. GAJERE¹ & Alaga Abayomi Taofik¹

¹. National Centre for Remote Sensing Jos, National Space Research and Development Agency

**ABSTRACT**

Delineation of geological features such as rock types and structures is not an easy task through conventional field traverses. Satellite images have useful Geological applications in this aspect as it provide synoptic coverage and access to inaccessible areas. The Geological set-up of a region which is usually the result of complex processes can be generated from an interpretation and digital image processing of an Earth Observation satellite image. Recognition of geological features on images is based on the interpretation of surface expression of the underlying Geology; landform, drainage, and linearments. One of the most important and reliable surface effects of the geological substratum is landform. Thus, Satellite image interpretation and processing was applied in the geological mapping of part of Jos...
Plateau, Plateau State, Nigeria using Nigeriasat-1. The area of study is located within longitude 8.30’ to longitude 9° east and latitude 9°30’ to 10° north. The study was mainly through structural, lithological and topographic analyses of Nigerian Sat 1 image of the study area which form part of the objective of the interpretation and processing. Other data used are SRTM, and existing topographic and geological map: Naraguta sheet 168 map.

Simple digital image processing techniques, which involve supervised and unsupervised Classification, linear / edge enhancement and high – pass filtering, were applied on the image to enhance various lithological units, edges of linear features and physiography of the image. The ILWIS and ERDAS imagine image processing and GIS software packages were used. Image classification was used to classify the image into unique characters comprising of pixels with similar spectral characteristics into unique clusters according to some statistically determined criteria (Jahne, 1991). Image filtering was performed to enhance ‘sharpness’ of the satellite image for better visual interpretation, to reduce noise in the image prior to a multi-band image classification when classifying large areas and to detect line features or edges in the satellite image to aid structural interpretation. This was followed by computer aided visual interpretation of geological features. The digitalization of the contours from the topographic map was carried out and the SRTM data was processed.

The processing led to the generation of drainage pattern map, (from existing topographic sheet and the image), fractures/lineaments map, and classified image map, digital elevation model from the SRTM and contours and geological thematic maps. All the thematic layers were integrated together with other ancillary information following fieldwork (ground truthing). The (lineament/fracture, Ring dykes) structural analyses indicated that the area has numerous long and short fractures. The structural trends of fractures are Southeast – Northwest, north-south and Northeast–southwest. The most prominent structural trends are northeast – southwest and northwest – southeast. The structural trends are related to the regional tectonic stress of the area, which is north – south, northeast – southwest and northwest – southeast. High lineament frequencies are obtained in areas where basement rocks outcrop or are closer to the surface (i.e. areas with thin overburden) whereas low lineament frequencies are characteristic of areas with deeply buried basement rocks. From field investigation, locations in the southeast of the study area with low fracture density correspond with areas covered by soil and highly weathered thick overburden.

The drainage pattern of the area extracted from the image and existing topographic map give a great deal of information concerning the parent rock materials. The dentritic pattern is indicative of lithological, structural and topographic homogeneity. It is also indicative of crystalline rock, which is typical of the geology of the area that consists mainly of crystalline rocks. Also, the drainage texture of the area is coarse. It is characteristic of resistant, permeable bedrock materials and coarse permeable soil material, such as the coarse grained porphyritic biotite, the major rock type of the study area. The geology generated from the integration of various thematic layers show that the area is underlain by Younger Granite rocks of Jurassic age, basement complex rocks; Older Granites (porphyritic granite) and undifferentiated rocks, Newer basalt and Dolerite dykes.

The interpretation and digital image processing of Nigeriasat-1 image with other ancillary data has shown that satellite image indispensable for geological applications like other earth observation satellites. Interpretation of landform, drainage, geological structures, and image classification will generate a base map for further detailed geological mapping.

ASSESSMENT OF VEGETATION DYNAMICS IN RELATION TO WATER QUANTITY IN LAKE VICTORIA: A CASE OF MARA RIVER BASIN IN TANZANIA

M. Hagai
Ardhi University, Dr es salaam, Tanzania

ABSTRACT
Assessment of vegetation dynamics in relation to water quantity is important to livelihoods of people living in the environments of Mara River Basin (MRB) and to all people depending in one or another on the water of Lake Victoria
Mara River (MR) being one of the catchment area for LV needs sustainable strategic management and protection since it is not only socio-economically valuable to Tanzania but to East Africa sub-region as well as Africa in general. MRB and LV are experiencing increasing water use, land cover, land degradation due to rise of population of people, livestock, mining, agricultural activities to the extent of threatening the extinction of the environment surrounding the Lake Victoria Basin (LVB) and the ecosystem in the area in general. Despite of the role played by Lake Victoria Commission (LVBC) and the World Wild Fund (WWF), which are institutions responsible for overseeing activities in the LVB, with the view of protecting the ecosystem in the area, the rate of discharge of groundwater to LV from its catchment areas has been declining with time, thereby threatening extinction of the LV. This study seeks to establish a relationship between vegetation cover changes with ground water discharge from MR flowing into LV over a period of 24 years, from 1986 to 2010.

The methodology used includes Remote Sensing by processing analyzing of Land sat TM Images of the years 1986, 1994, 2002, and 2010 thereby generating land cover maps and establishing vegetation dynamics using image differencing technique in GIS environment. Results indicate that there is a general decline of vegetation and ground water flowing into LV with time from MRB over the study period, indicating a positive correlation between vegetation dynamics and ground water quantity flowing into the LV.

It is being recommended that the government should endeavor to develop policies to control excessive use of MRB wetlands and dry lands such that the flow of ground water from MR to LV may be sustained.

QUALITE CHIMIQUE ET APTITUDE A L’IRRIGATION DES EAUX DE LA NAPPE DES SABLES QUATERNAIRES DE THIAROYE (DAKAR, SENEGAL)

Ousmane Coly Diouf¹, Seynabou Cissé Faye¹, Mathias Diédhiou¹, Ibrahima Mall¹, Sérigne Faye¹ & Stefan Wohnlich²

1. Department of geology, Faculty of sciences and techniques, University Cheikh Anta Diop of Dakar, B.P. 5005, Dakar-Fann, Senegal.
2. Ruhr University of Bochum, Department of Applied Geology, Universitaets str. 150, D-44801 Bochum, Germany.

MOTS CLES : Dakar, nappe de Thiaroye, hydrochimie, irrigation

RESUME
La nappe de Thiaroye, située à l’ouest du Sénégal, joue un rôle important dans l’alimentation en eau potable des populations et dans l’irrigation. Ses caractéristiques chimiques peuvent influencer les rendements agricoles dont dépendent les maraîchers de la zone.

Ainsi, la caractérisation physico-chimique de la nappe a montré que les eaux sont fortement minéralisées avec des conductivités électriques moyennes de 1400 µS.cm⁻¹. Ces eaux présentent également de fortes teneurs en nitrates pouvant atteindre 900 mg.l⁻¹ ce qui les rendent impropre à la consommation humaine.

L’étude de l’aptitude des eaux à l’irrigation sur la base de la méthode de Rive SIDE, montre que les eaux souterraines présentent un risque élevé de salinisation puisque 70 % des points échantillonnés se retrouvent dans les classes C2S1 et C3S1 (qualité moyenne à médiocre).
ASSESSMENT OF POTENTIAL RECHARGE ZONE IN THE DIASS AQUIFER SYSTEM (SENEGAL) BY USE OF OPTICAL REMOTE SENSING AND GIS TOOLS

Madioune D H1,2, Faye S1, Faye A1, Dassargues A2 & Pirard E2
1. Geology Department, Faculty of Sciences and Techniques, Cheikh Anta Diop University, PO Box 5005 Dakar-Sénégal
2. ArGenCo Department, Faculty of Engineering, Liege University, B.52/3 Sart-Tilman, B-4000, Liege – Belgium

KEY WORDS: Diass, Paleocene, Maastrichtian, recharge/discharge, ASTER, DEM, MODIS, EVI

ABSTRACT
Dakar, the Capital city of Senegal, concentrates about 21% (2.5 Millions inhabitants) of the total population and large proportion of the industrial activities. Drinking water supply is mainly ensured by 20% of surface water from the Guiers Lake (250 km distant from the capital) and 80% of groundwater resources. Among these groundwater resources, the Diass aquifer system contributes up to 100.000 m3/d. This high pumping rate is the consequence of the growing water demand induced by the rapid demographic growth. The system is located at the Western part of Senegal between Dakar and Thiès. The geological setting is represented by four major faults oriented NE-SW which configure the system into a horst where maastrichtian sands outcrops and two Paleocene karstic limestones compartments. Hydraulically, these formations bear important groundwater resources with high yield where continuous and increasing pumping occurs to meet water demand for the capital city. As consequence of this pumping, a generalized and significant drop of the water levels is observed in the system. In order to ensure sustainability of the aquifer system with regards to demand and water quality deterioration derived saline intrusion, evaluation of groundwater recharge is needed for management purpose. A detailed study is carried out through collaboration between Liege and Dakar Universities with the aims of evaluating potential recharge. It is devoted to the use of the optical remote sensing data being used with GIS and conventional hydrogeologic techniques to better understand the system functioning and to evaluate the potential recharge and discharge zones requested for any water balance investigation. Results will be used as input data for modelling work and simulating response to stress and climatic conditions. From the stereoscopic pairs 3N and 3B of ASTER L1A images of April 2006, a Digital Elevation Model (DEM) with 15 m resolution, +10 m accuracy and 6.5 m precision was generated using PCI Geomatica OrthoEngine V9.0 software. While being helped of the functionalities available in ArcGis 9.3; basins identification, drainage network, slopes maps were derived from the DEM. From the MODIS “Enhanced Vegetation Index” images obtained for the periods 15th November 2008 – 25th June 2009 representing the dry period before the rainy season, the potential discharge areas of the aquifer due to evapotranspiration are assessed using the vegetation activity and by calculating the Standard Deviation of the Enhanced Vegetation Index. Surface features such as soil type, land cover, fault, lithology, slope, drainage network and discharge zone due to evapotranspiration where used to evaluate potential recharge zone of the Quaternary superficial aquifer of the Diass region.
APPORT DE LA TELEDETECTION ET DES SIG POUR L’EVALUATION DE LA VULNERABILITE A LA POLLUTION DE LA NAPPE PHREATIQUE DU CAUSSE MOYEN ATALSIQUE DANS LA REGION D’EL HAJEB PAR LA METHODE DRASTIC

Yassin Azzi\(^1\), Ali Essahlaoui\(^1\), Abdelhadi El Ouali\(^1\) & Abdellah El Hmaidi\(^1\)


RESUME

L’accroissement démographique et le développement agro-alimentaire que connaît la plaine de Meknès-Fès et la région d’El Hajeb, durant ces dernières années, ont induit l’augmentation de la demande en eau. Cette région ocupe une place importante dans le territoire marocain, aussi bien par sa situation géographique que par ses potentialités hydriques (Essahlaoui, 2000) et agricoles. Ces dernières contribuent en plus d’autres activités, à la pollution des eaux de la nappe superficielle. Les eaux souterraines eaux sont souvent menacées par la contamination par des polluants de différente nature. La prévention contre la pollution des nappes constitue une étape importante à laquelle les scientifiques consentent de plus en plus d’effort, en étudiant la vulnérabilité des nappes souterraines. La nappe phréatique du causse moyen atlasique est située dans un réservoir carbonaté fracturé et karstifié. Le réservoir hydrogéologique présente une grande perméabilité de fracture ce qui le rend vulnérable aux pollutions anthropiques. Ces dernières années, cette région a connu une grande activité agricole et ainsi une étude qui permettra de spatialiser cette vulnérabilité trouve son intérêt dans cette région. La vulnérabilité d’une nappe traduit la facilité avec laquelle elle peut être atteinte par une pollution provenant de la surface du sol. La méthode DRASTIC est la méthode la plus utilisée pour évaluer la vulnérabilité et la spatialiser sur de grands territoires. Les paramètres pris en considération par cette méthode (Aller, 1987) sont : la profondeur de la nappe (D), la recharge nette (R), les matériaux constituant l’aquifère (A), le type de sol (S), la topographie (T), l’impact de la zone non saturée (I) et la conductivité hydraulique (C). L’appréciation de ce phénomène consiste à attribuer des cotes (c) variant de 1 à 10 et des poids (p) allant de 1 à 5 pour chaque paramètre. L’indice de vulnérabilité final recherché (ID), s’obtient en additionnant les produits des cotes des sept paramètres par leurs poids respectifs :

\[ ID = D_p * D_c + R_p * R_c + A_p * A_c + S_p * S_c + T_p * T_c + I_p * I_c + C_p * C_c \]

Les résultats obtenus sont présentés sous forme de cartes thématiques à savoir :

- La carte des pentes : à l’exclusion du long de l’oued Tizguite où la pente peut dépasser dans certains cas 20°, les autres terrains sont peu accidentés (moins de 10°).
- Carte des profondeurs de la nappe souterraine : cette carte montre des niveaux de faibles profondeurs (inférieurs à 30 m) surtout dans les périphériques du causse ; moyennement forte dans le centre (jusqu’à 80 m).
- Carte géologique : l’étude géologique a révélé qu’il s’agit bien d’un milieu carbonaté fracturé et karstifié favorable au développement d’une perméabilité élevée.
ANALYSIS OF THE PERFORMANCES OF RENEWABLE ENERGY CONVERSION OF A HYBRID POWER SYSTEM

Fazia Baghdadi1, Kamal Mohammedi2
1. University Mouloud Mammeri, UMMT, Tizi-Ouzou, Algeria,
2. L.E.M.I, University M’hamed Bougarra Boumerdes, UMBB, Boumerdes, Algeria.

KEYWORDS: Renewable energy resources, Modeling and simulation, Wind energy, Solar energy, hybrid systems.

ABSTRACT
Our energetic future has to be based on no polluting energies with long –term resources. Renewable energies are the best candidate but with intermittent production. The goal of this work is to evaluate performance of stand –alone power system, producing electricity, coupling a photovoltaic field and a wind turbine, diesel generator and a storage system made of batteries. First, the system is sized according to the electric demand and the availability of renewable energy resources. Then, each component of the hybrid power system is modeled in order to maximize the renewable energy to total energy ratio and to analyze the energy management in the system that affect the correct operation. Using Hybrid Power System can improve the exploitation of the renewable resource. The combination of several energy sources (wind turbines, photovoltaic panels etc.) in a Hybrid Power System can be very attractive for most of the remote areas, in terms of cost and availability.

EVALUATING THE POTENTIAL OF SUMBANDILASAT IMAGERY IN LAND USE AND LAND COVER CLASSIFICATION

Paida Mhangara1, John Odindi2, Nicky Knox1 & Nokuthula Wistebaar1
1. South National Space Agency (SANSA), Hartebeeshoek, South Africa.
2. University of KwaZulu-Natal, School of Environmental Studies, Pietermaritzburg, South Africa.

ABSTRACT
Sumbandilasat imagery is a valuable source of historical information for land use and covers classification and change detection. Sumbandilasat is a South African low orbit micro earth observation satellite that was launched on 17 September 2009. Currently in safe mode, the satellite captured a total of 1 296 images around the globe between 04 April 2010 and 07 June 2011. At design, Sumbandilasat had six spectral bands: blue, xanthophyll, green, red, red-edge and near-infrared. The blue, green and xanthophyll sensors of the satellite have however been dysfunctional ever since the satellite went into orbit leaving the red, red-edge and near infrared. The satellite has many potential applications which include environmental monitoring, urban and environmental planning, mining, water resource assessment, agricultural planning, and mapping of human settlements. Sumbandilasat has already provided useful disaster management information such as the flooding in Namibia, post disaster assessment of the Tsunami in Japan and fire scar mapping in the Kruger National Park, South Africa.

Urban and regional planners constantly require spatial information to support government decision making and policy formulation that advance a number of socio-economic imperatives. The loss of the blue, xanthophyll, green spectral bands during the commissioning phase, the absence of radiometric calibration parameters, and the slow progress in geometric calibration retarded the widespread application of Sumbandilasat imagery. Despite this setback the red, red-edge and NIR bands of the satellite are considerably useful in most remote sensing applications such as vegetation monitoring, urban mapping, change detection studies and other land use and land cover applications. The objective of this study was thus to demonstrate the value of Sumbandilasat multispectral imagery for land use and land cover classification.
A minimum distance classifier was used to classify an orthorectified Sumbandilasat image of East London, South Africa using PCI Geomatica software. The algorithm performs a supervised multispectral classification based on Euclidean distance. Five land use and land cover classes were selected for classification: Built-Up Areas, Water, Forest, Bare Soil, and Grasslands. The Red, Red-Edge and NearInfrared Sumbandilasat bands were used for the classification whilst the Transformed Divergence method was used to compute the class separability. An accuracy assessment was done using independently selected reference point to validate the accuracy of the classification. The results show the value of Sumbandilasat imagery in land use and land cover classification. The Transformed Divergence Separability Measure indicates a very high average class separability of 1.95. An average separability measure of 1.95 points to the fact that the built-up areas, forest, water, bare soil, and grassland can be discriminated effectively using the red, red-edge and near infrared bands of Sumbandilasat imagery. A separability measure of 2.0 clearly indicates that water can be differentiated effectively from the selected land use and land cover classes. This result is significant because water is a critical and scarce resource in South African and many parts of the world. South Africa’s water resources include marine and inland fresh water resources that include dams and rivers. Sumbandilasat imagery archive thus provides a historical source of information to quantify and monitor water resource. The transformed divergence measures also indicate very high separability of above 1.94 of forest from other land use and land cover classes implemented in this study. Built-up environments have traditionally posed a challenge to classify using remote sensing, in this study some spectral confusion existed between built-up areas and bare soil as indicated by a separability of 1.61. The classification results proved that sufficiently high accuracies can be achieved in the classification of urbanized built-up areas. An overall accuracy of 94.68% and a Kappa Coefficient of 0.95 indicate that Sumbandilasat can be used reliably to map land use and land cover using the red, red-edge and near-infrared bands. This study demonstrates that Sumbandilasat imagery can be used successfully for derive historical land use and land cover information as shown by high accuracies achieved in this study. The study also shows that simple methodologies such as the minimum distance classifier can be used to produce reliable results and circumvent issues related to the multivariate normal distribution assumption in land cover classification. This study indicates that water, forest, built-up areas, and bare soil can be separated effectively from each other using Sumbandilasat. The transformed divergence analysis revealed that water and forests can easily be classified using Sumbandilasat Imagery. The spectral confusion evident between built-up areas and bare soil is not unique to Sumbandilasat, but is a traditional remote sensing problem that arises due to the spectral similarity between the two classes. Built-up areas and bare soil can be improved by using a Digital Surface Model (DSM) which was not applied in this study. The very high accuracies achieved in this study reveals that Sumbandilasat Imagery can be used profitably for the mapping of built-up areas such as urban areas, human settlement and other fundamental regional planning applications. This study also proves the value of Sumbandilasat imagery in the identification and quantification of water and forest resources.

REMOTE SENSING FOR WATER QUALITY MONITORING OF LAKES: A CASE STUDY OF LAKE NASSER, EGYPT

Ali El Battay¹ & Alaa El-Sadek²

1. GIS and Remote Sensing Laboratory, Arabian Gulf University, P.O.Box 26671, Manama, Kingdom of Bahrain.
2. Water Resources Management Program, Arabian Gulf University, P.O.Box 26671, Manama, Kingdom of Bahrain.


ABSTRACT
Most applications using remote sensing tend to assess fresh water quality via regression models between in situ data and spectral bands. Suspended Sediment (Turbidity), Chlorophyll and Temperature are common parameters derived
from RS and recurrently used in WQI and/or TDML indicators. In this study a series of ETM+ Landsat images was used over the northern part of Lake Nasser (Egypt) to (i) assess the accuracy of an existing RS derived water quality model and to (ii) produce temporal and spatial pattern changes in the above mentioned parameters.

The results obtained were compared to field measurements reflecting limnologie dynamic of this part of Lake Nasser. The results showed a good response of the used model to describe the qualitative spatio-temporal variation, however, quantitatively; it needs to be recalibrated to fit the study area. Overall, using RS water quality generated models offer a huge potential to monitor effectively a large water body such as Lake Nasser and retrieve significant water quality/pollution related parameters.

SERVIR–AFRICA INTEGRATED HYDROLOGIC MODELING; - CREST
Eric Kabuchanga
Technology Developer, RCMRD/SERVIR-Africa

KEY WORDS: CREST, Model, Floods

ABSTRACT
SERVIR-Africa a platform developed by National Aeronautics and Space Administration (NASA) the US Agency for International Development (USAID) based at the Regional Centre for Mapping of Resources for Development (RCMRD) is a regional visualization and monitoring for our changing environment. The platform aims at addressing a wide range of thematic issues affecting the African continent among them disasters mostly floods followed by drought. SERVIR-Africa integrates remotely sensed data with predictive models and field-based data to monitor ecological processes to provide vital information for disaster response. The Coupled Routing and Excess STorage model (CREST, jointly developed by the University of Oklahoma and NASA SERVIR) is a distributed hydrological model developed to simulate the spatial and temporal variation of land surface, and subsurface water fluxes and storages by cell-to-cell simulation.

This paper looks at application of CREST model by SERVIR-Africa to provide Knowledge of the spatiotemporal distribution of water over the landscape of paramount importance for sustainable management of water resources and for mitigating water-related natural hazards such as flooding.

MODELISATION INTEGREE DU BASSIN VERSANT DE BOUREGREG A TRAVERS UNE APPROCHE SPATIALISEEE

A. Fadli1, h. Rhinane1, A. Kaoukaya1 & Y. Kharchaf1
1. Laboratoire Géosciences, Faculté des Sciences Ain Chock, Université Hassan II, Km 8, Route d’El Jadida, Casablanca, Maroc

MOTS-CLES : Modélisation, Hydrologie, Sédiments, Nutriments, SIG, SWAT

RESUME
La gestion rationnelle des ressources en eau est un souci majeur dans les pays arides ou semi-arides où la pression sur cette ressource vitale ne cesse d’augmenter. En effet, en plus de la rareté et de l’irrégularité de la pluie, ces régions sont confrontées à des problèmes d’érosion, de pollution et de l’utilisation irrationnelle des ressources existantes. Le but de ce travail est de présenter une approche spatialisée basée sur le couplage des systèmes d’information géographique (SIG), de la télédétection et des modèles hydrologiques pour la modélisation du bassin versant de

9th AARSE International Conference, El Jadida, Morocco, October 29-November 2, 2012
Earth Observation & Geo-information Sciences for Environment and Development in Africa: Global Vision and Local Action Synergy
REMOTE SENSING TECHNIQUES IN UPDATE GEOLOGIC AND GEOMORPHOLOGIC MAPPING OF JABAL AL UWAYNAT, SOUTHEASTERN LIBYA.

Eddaw Ali Elhatmi
Libyan Petroleum Institute, Tripoli, Libya.

KET WORDS: Landsat Enhanced Thematic Mapper Imagery; Update Geomorphologic and Geologic Mapping Using Remote Sensing Techniques

ABSTRACT
The Jabal AL Uwaynat area occupies 710.62 square kilometers and is situated between latitudes 21° 45’N and 22° 00’N and longitudes 24° 45’E and 25° 00’E. The eastern parts of the area border on the Arab Republic of Egypt and the Democratic Republic of the Sudan. Jabal AL Uwaynat is roughly circular with a diameter of about 22.5 km; it rises to about 1000 m. above the plain. The massif is composed of outcrops of alkaline rocks which are deeply weathered and form very large well-rounded blocks.

Ten colors composite images obtained by the superimposition of the data of three Landsat Enhanced Thematic Mapper (ETM) Bands after dynamic enhancement processing (Histogram Equalization Contrast Stretching) facilitate interpretation of the Jabal AL Uwaynat terrain features information contained in the original Landsat (ETM 7,4,2) data. New information is obtained from these ten colors composite images even though it is compared with small scale geological data such as the geological map of Jabal AL Uwaynat region. In this regard the map of IRC (2007), scale 1:250,000 and Hunting (1974), scale 1:100,000. Quaternary Landforms and Ring Complex Terrain Features in Jabal AL Uwaynata, both of them coinciding with the differentiation observed on the Landsat ETM 7,4,2.

Such differentiations have often induced by such geomorphic features as variations in pattern, spectral reflection, different rock types and variations in moisture content, grain size, their thickness and porosity, of Quaternary deposits. Based on this interpretation, new update geomorphic and geologic maps were undertaken, and were missed in previous maps. Another technique has been accomplished to identify terrain features of Jabal AL Uwaynat region using band ratioing technique. Terrain features of the study area have been identified by band ratioing technique from reflectance bands of Landsat ETM image. Twelve band ratios have been created and each ratio has revealed the terrain features. Single color - composite combinations of three ratios has separated subtle differences between different terrain features uniquely. This study has been on the basis of visual interpretation. Band ratioing technique has been identified terrain features.
EVALUATION DE LA VULNERABILITE A LA DESERTIFICATION DES SOLS DU BASSIN VERSANT DU SROU (MOYEN ATLAS - MAROC) A L’AIDE DE LA TELEDETECTION ET DES SIG

K. El bougdaoui 1, M. Badraoui 2, H. Ezzine 3, M. Zahraoui 4,
1 INSTITUT AGRONOMIQUE ET VETERINAIRE HASSAN II, MADINAT AL IRFANE, B.P. 6202, RABAT-MAROC
2 DIRECTEUR DE L’INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE (INRA), RABAT-MAROC
3 CENTRE ROYAL DE TELEDETECTION SPATIALE, SECTEUR 21 ANGLE AV ALLAL FASSI ET AV ASSANAWBAR HAY RIAD, RABAT-MAROC
4 UNIVERSITE MOHAMMED V, FACULTE DES SCIENCES, DEPARTEMENT DE GEOLOGIE, AV. IBN BATTOUTA B.P. 1024, RABAT-MAROC

MOTS CLES: SOL, BASSIN VERSANT, SROU, CARTOGRAPHIE, DESERTIFICATION, MEDALUS, SIG.

RESUME
La dégradation des sols concerne plusieurs régions au Maroc. La désertification en est un processus typique dans les régions arides et semi-arides. Le présent travail est une contribution à une meilleure caractérisation du phénomène dans le bassin versant du Srou (moyen Atlas, Maroc) à l’aide de la télédétection, dans un système d’information à référence spatiale. Le travail se base sur la méthodologie définie par le projet Medalus (Mediterranean Desertification and Land Use) adapté aux conditions des milieux méditerranéens. L’approche méthodologique traite la sensibilité à la désertification due à l’effet des sols, la végétation, le régime climatique et la gestion des sols. Le rôle de la télédétection dans ce contexte est de permettre par le biais de la carte d’occupation des sols, extraite de l’imagerie satellitaire Landsat ETM+, d’évaluer l’indice de qualité de végétation. L’analyse, la combinaison des données et la modélisation ont été opérées dans un Système d’Information Géographique (SIG). Les valeurs de vulnérabilité attribuées aux différents facteurs sont combinées dans un modèle permettant d’aboutir à un indice de désertification et d’élaborer une carte de vulnérabilité. Cette carte permet d’orienter l’intervention par ordre de priorité, suivant la situation des zones à risque de sensibilité à la désertification et d’entreprendre des actions adéquates concernant la gestion de l’environnement.

APPLICATION OF GIS AND RS IN FLOOD MODELING IN AFRICA – A REVIEW

Amos T. Kabo-bah 1, Kwaku A. Adjei 2, Donald T. Rwasoka 3, Mark Amo-Boateng 1, Chenai E. Madamombe 4 & Webster Gumindoga 5
1College of Hydrology and Water Resources, Hohai University, 1 Xikang Road, Nanjing, China
2Kwame Nkrumah University of Science and Technology, PMB, Kumasi Ghana
3Upper Manyame Subcatchment Council, Box 1892, Harare, Zimbabwe
4Digby Wells Environmental, Fern Isle, Section 5< 359 Pretoria Avenue Randburg, 2125, Republic of South Africa
5University of Zimbabwe, Dept of Civil Engineering, Box MP 167, Harare, Zimbabwe

KEYWORDS: GIS, remote sensing, flood modeling, Africa.

ABSTRACT
Frequent flooding is one of the key natural disasters affecting most countries in Africa. Flooding results in the loss of agricultural produce, properties and sometimes lives. There have been dotted research efforts around Africa in a bid to understand flooding dynamics for flood; forecasting, mitigation, monitoring and management. However, these dotted advances in flood research are not well known by most professionals in the region due to the fact that all these efforts have not been well documented for
Africa. Also, flood events usually require collaborative efforts of different stakeholders in a country and a basin to ensure that appropriate strategies are put in place both scientifically and socially. In view of this, this review paper focuses on the documentation of the recent GIS and RS application in flood modelling. The goal of this review paper is to also provide a comprehensive guide to stakeholders in flood monitoring and management, and also give them the opportunity to learn of all the available techniques related to GIS, remote sensing and software applicable for the Africa regions. Through this, stakeholders can save time in learning, sharing and developing better strategies for the management of floods because of reliable reference information presented in this paper. Therefore, with this review paper as a referenced document on flood modelling in Africa, it is anticipated that stakeholders will be better be informed and hence make necessary advance plans to mitigate floods and in some instances plan adaptation strategies for affected communities in Africa.

Justification
Most African countries on yearly basis experience some floods. These flood events usually lead to loss of lives, property and destruction of the ecological system in several parts in Africa. Governments, Non-Governmental Organisations (NGOs) and Civil Society Organisations (CSOs) have attempted to prevent floods over the past decades. However, the lack of required technology and exposure of requisite planning tools usually lead them to repeating the same mistakes, and hence in the end are not capable of preventing the floods from the communities (or countries). Notwithstanding, some stakeholders in Africa have developed GIS models that are good at understanding floods in both the climatic and the social dimension trends. These available tools are somehow scattered and difficult for all countries and communities to know about them and hence use them. This means that, the documentation of such available tools in Africa can provide a knowledge-box for sharing, collaborating and enhancing skills for better monitoring and management of floods in Africa. In view of this, this paper hopes to fill in a significant gap by reviewing the recent trends in flood modelling in Africa.

COMBINING MULTISCALE REMOTE SENSING WITH EXPERIMENTAL MEASUREMENTS FOR INVESTIGATING GULLY EROSION DEVELOPMENT IN THE SOUSS BASIN, MOROCCO

Sebastian d'Oleire-Oltmanns¹, Irene Marzolf¹, Klaus Daniel Peter², Johannes B. Ries², Hassan Ghafrani³ & Ali Aït Hssaïne³

¹Remote Sensing & GIS Research Group, Department of Physical Geography, Goethe University Frankfurt am Main, Germany
²Physical Geography, University of Trier, Germany
³Department of Geography, Ibn Zohr University Agadir, Morocco

KEYWORDS: gully erosion; UAV; Quickbird; multiscale; rainfall simulation; land-use change.

ABSTRACT
Gully erosion leads to significant loss of land particularly in semi-arid landscapes, where climate conditions and precipitation regimes encourage soil erosion processes through low vegetation cover and recurrent heavy rainfall events. Non-sustainable land-use on often marginal land and poor soils are additional factors for high gully erosion risk. The region around the city of Taroudannt, Souss-Massa-Drâa, Morocco, is one of the most important areas for agro-industrial production of citrus fruit and vegetables in Morocco, and at the same time heavily affected by gully erosion. The large sedimentary fans originating in the High Atlas, which provide the most important land resource for the intensification of agricultural areas, are in their distal part heavily dissected by gullies and badland areas. These erosion processes threaten fields, plantations and greenhouses as well as settlement structures.

In order to gain profound understanding of gully erosion, two main points are considered to be important: (1) the spatial distribution and development of the gullies and (2) the analysis of the erosive processes occurring. This article
presents the combination of (a) an integrative multiscale remote sensing approach and (b) erosion process analysis via rainfall simulation. The combined approach endeavours to transfer experimental point measurement data (rainfall simulation on micro-plots) into area-wide understanding of gully erosion based on the integrated remote sensing approach using different scales. The local scale uses small-format aerial photographs (SFAPs) which are acquired using an unmanned aerial vehicle (UAV). The regional scale is based on Quickbird satellite data. The very recent methodology of UAV-derived small-format aerial photographs offers high potential for very detailed analysis of gully development, while the usage of Quickbird satellite data allows the area-wide mapping of gullies within the study area. The site-specific experimental measurements (i.e. rainfall simulation and infiltration experiments) investigate the dependency of soil erosion and runoff rates from soil characteristics, soil crusting, vegetation cover, topography and other controlling factors.

As a result the combined analysis of the current gully distribution based on remote sensing data as one part of the overall surface morphology and the findings from the experimental measurements may improve the process understanding and therefore provide a good basis for future development of avoidance strategies of gully erosion. First results indicate that erosion rates and gully erosion development is highest on former badland areas that have been levelled with bulldozers in order to provide additional land for agriculture. Old gully systems that seem to have reached a rather stable state are thus rejuvenated and sediment loss on the levelled areas is accelerated.

This work is embedded in the international research project AGASouss – Assessment of gully erosion in agro-industrial landscapes of the Souss Basin, Morocco between the Goethe University Frankfurt (Germany), University of Trier (Germany) and Ibn Zohr University Agadir (Morocco). Funding is granted by the German Research Foundation (Deutsche Forschungsgemeinschaft/DFG) under research contracts MA 2549/3 and Ri 835/5 and gratefully acknowledged.

Conference participation is funded by the Austrian Science Fund (FWF) through the Doctoral College GIScience (DK W 1237-N23) and gratefully acknowledged.

SIMULATING FUTURE FLOOD INCIDENCE IN ACCRA FOR DISASTER RISK MANAGEMENT

Sovoe, S.
Environmental Protection Agency, Ghana.

KEYWORDS: Flash, Alluvial, Urban, Flood, Risk

ABSTRACT
The twenty first century will experience rapid urbanization as a result of increasing population and industrialization especially in the developing countries including Ghana. As many more land areas are being converted into settlements, roads, industries, coupled with haphazard development and climate change, the incidence of flash, alluvial and urban flood hazards will be exacerbated. Mitigating impacts of this will require adequate knowledge of the frequency, extent, depth and velocity of these floods for risk assessment to enable informed decision making by policy makers. In Ghana disaster risk management is a huge task since the information required for risk management is completely non-existent. It is against this background that this research aimed at developing a comprehensive flood risk management strategies to mitigate the impact of flood hazard in the city of Accra. High spatial resolution (0.5m - 1m) satellite data will be used to map and generate the first elements at risk database of the city. Probability distribution function that fits the flood events in the city will be established. I will use ILWIS, HEC-HMS and HEC-RAS to develop flood hazard map and risk curve for the city. Flood risk management options will be evaluated and the appropriate recommendations highlighted for policy makers.
INTERPRETING ENVIRONMENTAL CHANGES IN ARID TUNISIA – A LANDSAT REMOTE SENSING APPROACH

Bouajila ESSIFI¹ & Mohamed OUESSAR¹

1. Remote Sensing & GIS Research Unit, Eremology & Combating Desertification Laboratory, Institut des Régions Arides (Arid Land Research Institute) 4119 Medenine, Tunisia.

ABSTRACT
Desertification, land degradation and drought are problems of global dimensions. Understanding of the Land Degradation process in the context of climate change has been one of the major objectives of the national action plan for combating desertification in arid Tunisia. Proved as an effective means for landscape change detection over extended areas, we used in the present work a collection of remotely sensed data to monitor ground cover and assess desertification dynamics in Tataouine province (southeastern Tunisia). Landsat scenes, acquired from Thematic Mapper sensor between 1985 and 2011, estimate vegetation temporal patterns and soil properties. Image analysis was performed for two test dates (2nd April 1985 and 25th March 2011) by comparing typical selected areas, based on spectral indices of greenness and brightness. Punctual Land Cover/Land Use categories were classified for each date. Through mapping of land degradation risks in arid Tunisia, this paper overviews the state-of-the-art of desertification assessments on both the national and local levels by means of earth observation data. The applied methods highlighted a strong correlation of vegetation indices which was able to consistently trace extreme drought events. We conclude that image analysis is a superior choice for detecting landscape, and that inspecting the impact of climate change or human activities on vegetation dynamics seems to be an important research issue to assess land condition, especially in arid lands.

GIS AND REMOTE SENSING FOR DROUGHT MONITORING IN AFRICA – A CASE OF GHANA AND ZIMBABWE

Amos T. Kabo-bah¹, Webster Gumindoga², Raymond Aabeyir³, Donald Rwasoka⁴ & Justice O. Odoi⁵

¹Green WaterHut, Box UP913, Kumasi, Ghana
²University of Zimbabwe, Dept of Civil Engineering, Box MP 167, Harare, Zimbabwe
³Department of Environment and Resource Studies, UDS, Wa Campus, P. O. Box 520, Ghana
⁴Upper Manyame Subcatchment Council, Box 1892, Harare, Zimbabwe.
⁵Environmental Specialist, Agency for International Development, P.O. Box OS1455, Osu-Accra, Ghana

KEYWORDS: Drought, monitoring, TAMSAT, NOAA-AVHRR, framework, Ghana, Zimbabwe

ABSTRACT
Climate change impacts on agro-ecological environments presents several challenges to food security. One of these adverse effects is drought. Prolonged drought affects crop production, yield and subsequent household income. Droughts effects become severe as a destruction of the forest and wood lands. It is unlikely that droughts will be completely written out the face of Africa in the coming decades as weather conditions and rainfall patterns become more variable.

In view of providing a long term mechanism in drought management, this research developed a methodology for analyzing drought conditions. The methodology used satellite data (NOAAAVHRR images) and Tropical Applications of Meteorology using SATellite (TAMSAT) rainfall data and land use generated maps for the period of 2000-2010. The datasets were weighted based on Multi-Criteria Approach and developed into an index for evaluating the drought conditions in Africa. Two countries in Africa - Ghana and Zimbabwe were purposively selected for this study. The drought index maps produced were evaluated against FAO and World Food Programme (WFP) drought indices for Africa. The results were found to be comparable to that FAO and WFP drought indices and presented better basis for
zoning into national needs compared to the continental based maps produced by FAO and WFP. The results from this study show a plausible reliability for use in other African countries, and can easily be upscaled into a decision support system for drought monitoring and management in Africa.

Justification
Droughts are some of the huge challenges affecting most parts of Africa. Perennial drought conditions are not only affecting adequate potable water supply but also support for food production. African agriculture that is largely rain-fed is adversely affected by drought. There are some available continental scale drought indices developed by international development agencies. However, these continental scale based indices to a large extent do not allow for zeroing in on in-country spatial variation of drought. The challenge with continental based index maps is that, one country can only be represented on two scales of assessment of drought – high and low. This becomes difficult to differentiate within a country, the different variation of drought conditions. Due to this, it becomes difficult to design specific tailored programmes to specific towns, cities and remote rural areas that are worse hit by the drought in a country. Therefore, the ability to use GIS and remote sensing techniques to derive country-based drought indices become imperative to provide the necessary details for the various towns and cities within a country. This research therefore seeks to contribute meaningfully towards a framework and an index for identifying and mapping drought conditions in Ghana and Zimbabwe which will be replicable in other African countries.

SPATIAL AND TEMPORAL ANALYSIS OF RECENT DROUGHT YEARS USING VEGETATION TEMPERATURE CONDITION INDEX DERIVED FROM MODIS. THE CASE OF SOMALI REGIONAL STATE IN ETHIOPIA

Elias F. Mekuria, Mario Caetano, Jorge Mateu & Edzer Pebesma
1. Former student at ISEGI, New University of Lisbon, Portugal between 2010-2012 Addis Ababa, Ethiopia.
2. Associate Researcher at Portuguese Geographic Institute. Invited Professor at New University of Lisbon, Portugal
3. Associate professor at University Jaume I of Castellón, Spain.

ABSTRACT
The semiarid and arid area of the eastern part of Ethiopia, majority of it is Somali regional state, have suffered a series of droughts and famines in the years 1999/2000, 2003/2004, 2007 and 2011. Absence/decline of rainfall in two of the rainy seasons locally called Dihra (October to December) and Gu (April to June) as being the major fact behind drought, lack of appropriate monitoring techniques aggravates the situation. In this region where the numbers of meteorological stations are not sufficient enough to monitor the onset and extent of drought, remotely sensed data presents fast and economical way of information.

In our study, the drought monitoring approach is developed using Vegetation Temperature Condition Index (VTCl) that integrate Normalized Difference Vegetation index (NDVI) and Land surface Temperature (LST) for the year 2000-2011, which are derived from Terra-MODIS level-3 products of MOD11A2 and MOD13A2 respectively. Many authors argued that plotting the NDVI and LST as scatter plot could demonstrate the condition of soil in response to the amount of water available. The empirical concept of NDVI/LST to derive soil moisture conditions often results in a triangular shape if an area is large enough to provide wide range of NDVI values from bare soil to fully vegetated surfaces and the soil moisture from wet to dry condition. This basic idea is the bases for determining the scatter space to monitor the soil moisture content. Among the various methods for determination, we used each year maximum value composite of LST and NDVI products. The warm edge is determined by using the each year maximum value for each rainy season on composite LST and NDVI products, while the wet edge is determined by using the each year maximum–minimum value composite LST products.
From the NDVI versus LST scatter plot, we extract VTCI values to map the variability and trend of the drought years. VTCI values that are less than 0.4 indicates drier condition while values greater than 0.4 illustrates wetter condition. Accordingly, the year 2003 was found to be the driest year (more than 90% of the region affected by drought) and the season that showed increasing intensity of drought being Dihra season.

The correlation ($r > 0.7$) between rainfall and VTCI across the major meteorological stations suggested that the index could be used as good indicator of drought as rainfall does. It was also observed that eastern and southern regions will experience more severe drought in the coming year (Figure 1.) Moreover, VTCI value for the month October from 2000-2011 showed high intensity of drought condition throughout the time series (Figure 2.) In addition, it was evident that majority of the sparse vegetation and shrub land are highly variable and as expected bare soil region is consistently dry.

![Figure 1. Areas affected by drought in the Somali regional state for the past 11 years.](image)

![Figure 2. Areas affected by drought for the past 10 years.](image)
REMOTE MONITORING OF LU/LCC AND ITS RELATIONSHIP TO THE LD IN SEMI-ARID ZONE BY USING OBIA TECHNOLOGY

Abdelnasir Ibrahim Ali1 & Elmar Csaplovics1
1 Technische Universität Dresden, Institute of Photogrammetry and Remote Sensing, Germany

ABSTRACT
Monitoring of the land use and land cover change (LU/LCC) and its relation to the land degradation (LD) at spatial and temporal scale is a paramount issue and more needed, in semi arid, for conserving and managing the ecosystem balance, which it in turn saves the sustainability of land use and land cover resources. Therefore the research aimed to map and monitors the dynamic linkage between LU/LC and LD for 37 years in semi arid region. Accordingly, Elgetien Locality is located in White Nile State of the Sudan was selected as study area. Specifically, it is located in latitude 14º 43’ and longitude 32º 17’, on the eastern bank of White Nile, to south of the Khartoum capital. Remote sensing technology and ancillary data were used for analyzing satellite imageries, which they were of different sensors namely MSS 1973, TM 1986, ASTER 2009 and TM 2010. At first the study depended on vegetation degradation and sand dunes formation and accumulation as biophysical indicators in determining and identifying the land degradation by soil adjusted and atmospheric resistant index (SARVI) and Topsoil grain size index (GSI) respectively. Then the object based image analysis (OBIA) was used, for analysing the images by supporting of ground truth. Therefore multiresolution segmentation was used, to divide the imageries into different segments, using appropriate values, 30, 0.3/0.7 and 0.5/0.5 as scale parameter, colour/shape and compactness/smoothness respectively. And classification process was done using fuzzy logic classifier, after determining appropriate object features for separability, namely layer value and Texture after Haralick. Then change detection matrix was done for detecting the changes in LU/LCC and LD. Furthermore Pearson Correlation matrix (PCM) and scatter dots matrix were used for finding the correlation between LU/LCC and LD. The results showed that there was an interexchangeable dynamic occurred between LU/LC and LD during 1973-1986; whereas a large area of natural range land (NRL) estimated with 35.3 Km2 plus small areas (3.8 Km2) of different LU/LC changed into severe degraded land (SDL). In contrast a large area of SDL estimated with 36 Km2 changed into NRL and plus small areas (5 Km2) of SDL changed to different LU/LC. During 1986-2009 the results showed that a large area of the NRL, 43.5 Km2 changed into SDL, and in addition to small areas (2.2 Km2) of LU/LC changed into SDL and conversely a large area of SDL about 29.7 Km2 changed to NRL and small area (8.5) of SDL changed into LU/LD. The above interexchangeable relation led to the increasing and decreasing change in both LU/LCC and LD. The results showed the correlation of those changes; whereas the FML revealed moderate positive correlation with SDL e and NRL equal 0.651** and 0.632** as well as it showed moderate negative correlation with semi-bare land (SBL) and dense wood (DWL) equal -0.654** and -0.668** respectively. And the residential area showed strong positive correlation with SBL equals 0.837** and while it showed moderate negative correlation with NRL equals -0.684. Those results may help in conservation the ecosystem and re sustainable management of LU and LC resources.

A CASE STUDY OF FIRE SCAR MAPPING USING IMAGERY FROM THE SUMBANDILA MICRO-SATELLITE

Nichola M. Knox1, Paida Mangara1, Thuli Wistebaar1 & Hugo de Lemos1
1 South African National Space Agency – Earth Observation; P.O. Box 484; Silverton; Pretoria; 0127; South Africa

ABSTRACT
Sumbandila Satellite (SSAT) is a low earth observation (LEO) multispectral imaging micro-satellite. The satellite was commissioned by the South African Department of Science and Technology (DST), and was built in a partnership
between the University of Stellenbosch and SunSpace. The multispectral scanner was designed to have six spectral bands which were chosen to optimise the image content for a wide range of applications, but with a special emphasis on food security. Two multi-spectral CCD detectors were constructed to collect the six spectral bands in the blue, xanthophyll, green, red, red-edge and near infrared (NIR) region of the spectrum (Mostert, et al. 2008).

The micro-satellite was launched on the 17th September 2009 from the Russian Baikonur cosmodrome. One of the CCD detectors was damaged during launch. As a result images acquired from SSAT only contain 3 spectral bands in the red, red-edge and NIR region. Globally 1909 images of 6.25m spatial resolution were acquired between 12 November 2009 and 28 July 2011, of these 1128 were usable (no clouds or low cloud cover). Although most areas were only imaged on a single occasion by the satellite, a few locations were targeted to have multiple image acquisitions within a short time frame. One of these areas was located on the border between the Kruger National Park and the neighbouring settlements, located in the Limpopo province of South Africa.

Although the images do not overlap entirely, a small region coincides on three images acquired on the 1st and 16th of August, and the 5th September 2010 (Julian Days: 213, 228 and 248 respectively). This time of year coincides with the primary fire season in the region. Fire as both a management tool and a natural occurrence is an important driver of the savanna landscape structure, which results in the heterogeneous structural landscape seen in this savanna region.

Accurate maps of fire mapping provide important input not only to managers of national parks and nature reserves in the region, but also to disaster management centres and in litigation cases for compensation. In this case study the effectiveness of SSAT imagery with its high spectral resolution is compared against Moderate Resolution Imaging Spectroradiometer (MODIS) fire scar maps derived on the same days. MODIS fire scar maps are the industry standard tool in earth observation for generating landscape fire scar maps. For this reason in this study we compare the SSAT derived fire scar maps to maps derived from MODIS imagery. The produced fire scar classifications are compared based upon the total fire scar areas classified, the number of individual scars identified, and based upon a visual assessment the success of the classifications.

For all six images (subseted overlapping regions in 3 SSAT and 3 MODIS images) supervised classification was performed using a Maximum Likelihood classification. Classification on the SSAT images was modified to include the use of Bayesian probabilities to discriminate between fire scars and water bodies. The figures (1A-C) below provides a glimpse of the results derived from one of the classifications of the MODIS and SSAT for Julian day 218.

In general the three bands of the SSAT image are well suited to classify burn scars, providing a better representation of the actual burn scars when compared to the coarser resolution MODIS classifications. The greatest weakness in the SSAT classification process of the burn scar mapping is the difficulty in spectrally unmixing between water and the darker burn scars.
MAPPING OF HYDROCARBON CONTAMINATED SOIL USING GIS AND GEOSTATISTICS

F.O. Akinluyi\textsuperscript{1}, and M.O. Olorufemi\textsuperscript{2}
\textsuperscript{1}Department of Remote Sensing and GIS, Federal University of Technology, Akure, Nigeria
\textsuperscript{2}Department of Geology, Obafemi Awolowo University, Ile-Ife, Nigeria

KEYWORDS: Environment, Soil, Pollution, Mapping, Prediction, Kriging, BME

ABSTRACT
The objectives of this study were to use the spatial pattern of soil physico-chemical properties of Total Hydrocarbon Content (THC) and the Electrical Conductivity (EC) to determine the optimal method for delineating hydrocarbon polluted soil. Eleven (11) THC and twenty-eight (28) related (R=0.62) EC measurements were used. The THC values ranged from 0 – 16 ppm. Ordinary kriging was evaluated by carrying out cross validation using the Root Mean Square
Error (RMSE) which ranged between 3.82 and 5.45. Uncertainty assessment of the mapped prediction of Bayesian Maximum Entropy (BME) using both hard and soft data was carried out by computing the standard deviation and it varied between 0 and 8. Soft data were generated from regression model between THC and a covariate EC and their uncertainties were derived using probability density function. 10 simulations were made from the soft data. Each of these 10 simulated soft data was combined with 11 THC measurements to form the simulated data. Semivariogram of the 10 simulated data set was modelled using Power model for prediction by Ordinary kriging. Both estimation methods exhibited high concentration level where hydrocarbon impact was high at the extreme western side and variable distribution geometry at other locations in the area. The high BME estimated standard deviation was attributed to the relatively weak correlation between THC and EC used to generate the soft data and measurement error. The results obtained demonstrated the usefulness of the BME method in areas with limited data points.

VALIDATION OF THE PROTOTYPE SYSTEM FOR HOTSPOT DETECTION AND MONITORING OF THE AFRICAN SUB-SAHARA REGION: A CASE STUDY OF THE HORN OF AFRICA REGION

Anthony M. Mwangudza¹, Andrew O. Nyawade², Rosa Loizzo¹, Marzo Cosimo¹
1. Italian Space Agency (Broglio Space Centre – Malindi), Kenya, 2. Ministry of State for Defence, Kenya,

ABSTRACT

The Italian Space Agency has recently installed a fire detection and monitoring facility at its San Marco Project (Broglio Space Centre - BSC) facility in Malindi, Kenya. This is an interactive prototype processing system of Meteosat Second Generation (MSG) data for hotspot detection (FIRE) adapted for Sub-Saharan Africa. The FIRE system implements a processing chain that routinely receives MSG data through the EUMECAST Channel, extracts and transforms the SEVIRI data into geocoded Reflectance, Radiance and Temperature images. The Temperature images at 3.9 m and 10.8 m are used to detect local thermal anomalies (hotspots). The time delay between the MSG data acquisition and the hotspot detection is about 30 min.

All the detected hotspots are archived in a POSTGRES database with POSTGIS extensions. The system can be accessed remotely to visualize in Near Real Time, all the hotspots detected on the last acquired image. The database archives the hotspots’ geographical coordinates, temperature and radiance. Users can also visualize all the latest hotspots detected more than 2 times (high probability of fires) in the last three hours, or select the ones having a certain repetition number selected by the user in a given time range. All the hotspots can be displayed as a layer on a simple geographical map with a graphical user interface built on OPENLAYERS library. Cloud cover can also be displayed to support statistical weather conditions evaluation. It is also possible to visualize the hotspot on Google Earth System in order to obtain more geographical or thematic information about the site and the area affected by the hotspot. All the hotspots acquired on the Sub-Saharan Africa region from May 2011 to date are being archived in a database. Analysis and validation of the data for countries in the Horn of Africa region, namely Kenya, Tanzania, Uganda and Somalia has been done for the period from May to December 2011. Comparison of these data has also been done for the same period and locations based on other fire detection systems utilizing MODIS imagery. The results indicate that there is fair hotspot locations’ coincidence occurrence between the two systems. In particular both systems fairly agree both in spectral and temporal resolutions of those locations with the highest probability of fires like active volcanic areas. However due to differences in the sensors availability over these regions and the view angle for SEVIRI and MODIS, both systems exhibit nominal qualities which can be exploited for operational use.

In addition to validation using other fire detection systems based on MODIS imagery, it is necessary that ground truth data be primarily incorporated in the validation process. The FIRE system should also be made accessible to the scientific community, civil authorities and the general public via a web portal. Focal points can then be selected to provide the ground truth data and subsequently employ the system in environmental monitoring and disaster management.
EARLY WARNING AND RISK REDUCTION USING EXPORTABLE SATELLITE-BASED TECHNOLOGIES: THE EXPERIENCE OF THE ITALIAN PILOT PROJECT OPERA

G. Boni¹, L. Candela², F. Castelli³, R. Rudari¹, C. Versace⁴ & F. Siccardi¹
1. CIMA Research Foundation, Savona, Italy
2. Italian Space Agency, Matera, Italy
3. DICEA, Univ. Of Florence, Italy
4. ACROTEC s.r.l., Savona, Italy

ABSTRACT
The OPERA project - civil protection from floods (www.operaproject.it) - is a pilot project of the Italian Space Agency, designed in collaboration with the National Civil Protection Department and implemented by a group of research institutes and companies of national relevance. One of the objectives of the project was to verify the potential of the Cosmo-SkyMed Italian satellite system for monitoring of ground effects of the floods and damage assessment during the emergency management phase. This activity focused on the analysis of the possibilities of the system to operate in areas characterized by data scarcity and poor cartographic information.

During the operational demonstration phase of the project, which lasted from November 2009 to November 2011, the project team performed several activations of the system in different areas of the world affected by floods (Albania, Thailand, Japan, Pakistan among others). During each activation, the team started from scratch, without ancillary information in advance, investigating the possibility of creating in any case realistic event and damage assessment scenarios.

Special attention was paid in respect of the timing of production and delivery of flood and damage maps, according to end-user requirements, end user represented by the manager of the emergency phase. Requirements in this case defined in collaboration with the real end-user, represented by the National Department of Civil Protection.

The results showed that the OPERA system can quickly create and deliver products to be extremely useful in the management of flood emergencies, thanks to the connections between technical experts, data providers, satellite operator and end user. The validity of the products was also tested in the context of emergency management in Pakistan in 2010.

In conclusion, the system is proposed as a good example of efficient system of rapid mapping for emergencies. This presentation discusses the philosophy of the OPERA project and its main findings in terms of products and procedures.

REMEDIAL POTENTIAL OF SOKOTO ROCK PHOSPHATE IN HEAVY-METAL CONTAMINATED COCOA SOIL IN NIGERIA

Aikpokpodion P.E¹, Lajide L.² & Aiyesanmi A.F²
¹Cocoa Research Institute of Nigeria, P.M.B 5244, Ibadan, Nigeria.
²Federal University of Technology. Akure, Nigeria

KEYWORDS: Cocoa, Remediation, Rock Phosphate, Heavy Metal.

ABSTRACT
The continuous use of copper – based fungicide over the years for black pod disease control has led to heavy-metal accumulation in cocoa soils due to its non biodegradable nature. Reports have shown that, many cocoa plantations in Nigeria are already contaminated with copper and lead (Pb). Considering the limited, available forest, it is therefore, necessary for the existing heavy-metal contaminated cocoa soils to undergo soil remediation in order to reduce the bioavailability of metals for plant uptake and ultimately minimize the risk of heavy metal toxicological effects in consumers of cocoa products. A research work was carried out to evaluate the potential of rock phosphate in immobilizing and transforming heavy metals from bioavailable to non bioavailable form in soil solution in a Greenhouse...
experiment in which polypropylene pots were filled with 2.5kg heavy-metal contaminated soil collected from a cocoa plantation in Idanre, Ondo State, Nigeria. The soil samples were thoroughly mixed with Sokoto rock phosphate at the rate of 20g, 40g and 60g phosphate per kg soil. The experiment was in a completely randomized block design replicated thrice. The incubation was done one month ahead planting and kept in wet state in order to allow the rock phosphate to solubilise which will enable complex formation between phosphate and heavy metals. At six months after planting, the seedlings were removed and processed according to standard procedure. Seedlings’ leaves were analyzed for copper and lead using Atomic absorption spectrophotometer. Result showed that, copper available for cocoa uptake in soil was reduced by 19%, 35% and 42% due to application of 20g, 40g and 60g phosphate per kg soil respectively while, lead was reduced by 12%, 23% and 25% by the application of 20g, 40g and 60g phosphate respectively. It was also shown that, application of Sokoto rock phosphate at the rate of 20g, 40g and 60g phosphate per kg soil led to 80%, 69% and 85% reduction of copper in foliar tissue respectively while same phosphate rate reduced lead (Pb) in foliar tissue by 88%, 89% and 77% respectively. The findings showed that, Sokoto rock phosphate which is readily available is a potential candidate for the remediation of heavy metal contaminated cocoa soils.

THE ROLE OF TRADITIONAL KNOWLEDGE (INDIGENOUS) IN THE MANAGEMENT OF GEOHARZARDS AROUND THE MOUNT CAMEROON AREA OF SOUTH WEST CAMEROON

Athanasius Fuashi Nkwatoh, Samnel Ayonghe Ndonwi, Sabastain Iyassa Musua

KEYWORDS: Geohazards, Mount Cameroon, Epassa Motto, Traditional Believes

ABSTRACT
The study assessed the Role of Traditional knowledge and Local Perceptions in the Management of Geohazards in the Mount Cameroon area of South west Cameroon. This was carried out within a period of eight months (March – October 2008). The study in order to achieve its assigned task, made use of one set of questionnaires divided into four sections (ABC and D) and a selection of Participatory Rural Appraisal (PRA) tools (Semi Structured Interviews, Focus Group Discussions, Ranking and Triangulation). Beside the use of the above toolboxes, purposive sampling was used to select zones, villages and the administrative jurisdictions of each of the zones visited for data collection. Findings revealed that the Mount Cameroon area is inhabited by a multiplicity of ethnic groups with the major dominant one being the indigenous Bakweri group from Fako Division on which they rely on for their traditional inspiration in the event of any geohazard. 55% of the population, who are Bakwerians and earlier settlers, perceive and believe that volcanic eruptions and their associated consequences are spiritual resulting from the anger of the Gods “Epassa Motto” or the death of a Bakweri Chief. This believe further holds that geohazard can be stopped by the offering of physical and spiritual sacrifices to the Gods on the Mountain. In the event of geo-hazards, the populations around the study area in the first place rely on the traditional council for instructions and action. The traditional Council on its part, forms vigilant groups to keep watch, carries out night patrols and report evolving events to the council for further action. Assistance is also received from the Government (Cameroon Development Cooperation (CDC), Del Mounte) Neighboring villagers, Red Cross, Nigerian Consulate, NGOs and other National and International institutions/organizations inform of food, shelter, water transportation, medication, finances and religious fellowshipping that nurtures the body and soul. Conclusively, in the event of any disaster in the study area, assistance to affected persons is usually characterised by poor coordination as a result of the absence of a well coordinated frame work to facilitate communication amongst stake holders established at the National, Regional/Provincial and community base levels.
BIO-DETECTION OF OIL PIPELINE LEAKS USING REMOTE SENSING TECHNIQUE

Dr. Emengini & Ebele Josephine

1. Department of Surveying and Geoinformatics, Faculty of Environmental Sciences, Nnamdi Azikiwe University, P.M.B. 5025, Awka, Anambra State, Nigeria

KEYWORDS: Remote sensing, Spectral reflectance, Oil pollution, Pipeline leaks, Plant stress.

ABSTRACT

Leak from oil pipeline is one of the major sources of oil pollution and a threat to man and his environment. To control this menace, frequent, accurate and spatially-comprehensive monitoring and detection of oil leaks is required. Remote sensing technologies have this potential by using plant spectral properties. To investigate this, ornamental fountain grass (pennisetum alopecuroides) and deciduous shrub called forsythia (forsythia suspensa) grown in pots were contaminated with refined oil at low, medium, and high levels. Plant heights and spectral measurements were undertaken every week and visual stress symptoms observed. Field portable GER 1500 spectroradiometer was used for all reflectance measurements. Results show a general increase and decrease of the reflectance spectra in the visible and the near infrared regions of the spectrum, respectively. The red region was most sensitive to oil pollution at all levels for both plant species. Based on the ratio of change in plant height, both plants were significantly affected by oil pollution. Visible stress symptoms observed include: chlorosis, dryness, and growth impairment in all the levels of pollution in both plants. This indicates that by detecting plant stress, remote sensing has potential for detection of oil pollution. It suggests further research that may focus in testing the robustness of this approach across species and scales.

REMOTE SENSING AND LOCAL EARTHQUAKE TOMOGRAPHY FOR UNDERSTANDING COMPLEX EARTHQUAKE ACTIVITY IN THE AGADIR REGION (MOROCCO)

Y. Timoulali & S. Radi

1 CNRST-MARWAN, Rabat, Morocco
2 Faculté des Sciences et Techniques, Université Sultan Moulay Slimane, Beni Mellal

ABSTRACT

The 1960 Agadir earthquake (Mw 6.0) constitute the most damaging earthquake in recent history of Morocco. With the expansion of seismic networks during the last two decades in Morocco, new seismic data have been collected in this region and used in this study to investigate the lithosphere structure. The present study has two main goals: 1) the use of the remote sensing techniques to detect and map the surface geological structures and faults; 2) the use of the local earthquake tomography for imaging the lithosphere (subsurface) and detect the deep structures and faults.

For the remote sensing techniques we use an ETM+ Landsat7 image and The SRTM 90m image as a MNT. The supervised classification and directional filter convolution (Moore techniques) are used to define geological map, surface structures and faults. With the seismological techniques (local earthquake tomography), we use a linearized inversion procedure comprising the following steps: 1) finding the minimal 1-D model and simultaneous relocation of hypocenters and 2) determination of local velocity structure. For the digital mapping and 3D visualization of surface structure with the depth structure modelling, we use GMT (Generic Mapping Tools) and ESRI Arc GIS software with Arc Map and Arc Scene applications.

The 3D velocity model show that the total crust thickness varies from 30 to 40 km in the Agadir region and confirm the modest crustal tectonic shortening and thickening in the High Atlas Mountains of Morocco. The inferred geological structure reconstructed by the calculated image illustrates the existence of fault-related folding in this region. The preferred directions of the major surface faults detected by remote sensing coincide with the deep faults detected by tomography. The resulting tomographic image show a high velocity anomaly that could be associated with the location
of deep active fault (from 10 to 30 km) which is associated with the fold structure and may represent brittle and competent parts of the crust which sustain seismogenic stress along the faults, probably more with the compression along the south Atlas thrust front. Finally, a new geological structures map comprising the deep structures is constructed from the new local velocity model.

APPORTS DE LA GEOMATIQUE POUR LA MODELISATION DU RISQUE GLISSEMENTS DE TERRAIN, CAS DU BASSIN VERSANT DE L’OUED LARBAA NORD-TAZA.

Mesrar, H., 1, sadiki, A. 1, faleh, A. 2, Chaauaan, J. 2 & Lakhouaja, H. 2

2. L. E. G. A. C. Département de Géographie, Faculté des Lettres, Saiss-Fes, Maroc

MOTS CLES : Glissements de terrains, modélisation, valeurs informative, vulnérabilité, SIG

RESUME
Le risque de déplacements en masse de volumes considérables de matériaux menace aussi bien les hommes que les biens. Ils provoquent le basculement des champs de culture et la diminution des espaces agricoles utiles. Ils sont responsables de la destruction des maisons, des infrastructures routières et des ouvrages d’arts. Ils induisent des coûts très élevés de réaménagement. Ils perturbent parfois la dynamique fluviatile lorsqu’ils déposent une quantité considérable de matériaux dans les lits des oueds. Cette morphodynamique accélérée constitue une contrainte qui pèse lourdement dans le domaine de l’aménagement du territoire et s’oppose au développement durable.

Les versants du Rif oriental, notamment ceux du bassin versant de l’oued Larbaa au nord de Taza, présentent un aspect chaotique et bousouflé reflétant leur vulnérabilité, leur fragilité et leur sensibilité aux différentes causes du déclenchement des glissements de terrains et à certaines actions anthropiques inadéquates qui contribuent au déclenchement de ce processus érosif. Les mouvements de terrains inventoriés dans la zone d’étude ont des dimensions très variables qui vont des petits arrachements pélliculaires enlevant la couverture pédologique sur une surface restreinte aux grands glissements rotationnels profonds. Les causes principales sont des événements pluviométriques exceptionnels qui s’abattent sur un terrain présentant une certaine vulnérabilité liée à une combinaison de facteurs de prédisposition. Les années 2008 et 2009 relativement pluvieuses ont connu le déclenchement de nombreux glissements de terrain et la réactivation d’autres.

Cette étude porte sur la modélisation du risque des mouvements de terrains dans le bassin versant de l’oued Larbaa au nord de Taza. La méthodologie adoptée se compose de deux techniques, une pour évaluer la susceptibilité des terrains aux mouvements de masse et l’autre pour estimer la vulnérabilité des enjeux exposés à l’aléa.

La susceptibilité des terrains aux mouvements de masse a été évaluée par une technique statistique basée sur la comparaison des glissements de terrain qui se sont produit dans le passé avec six facteurs de prédisposition, déterminés par la collecte de données de terrain et la télédétection. L’algorithme mathématique utilisé appelé “valeur informative” (VI) est le calcul de rapports des surfaces affectées par ce processus géomorphologique dans chaque classe des différents facteurs de prédisposition et leur comparaison avec le rapport total de la surface mise en mouvement par rapport à la surface totale de la zone d’étude. La technique permet de quantifier spatialement la corrélation entre les glissements de terrains existants et les facteurs de prédisposition des versants à l’instabilité.

La vulnérabilité des enjeux exposés à ce risque a été estimée par une méthode basée sur des indices qui quantifient les pertes selon quatre critères, les préjudices corporels, les dommages structurels, les pertes fonctionnelles et la méconnaissance de l’aléa par les populations. Ces indices ont été représentés cartographiquement. La vulnérabilité totale est obtenue par la superposition des quatre cartes et la sommation des indices de perte.
La confrontation des cartes synthétiques de ces deux techniques fournit une carte de risque sur laquelle sont identifiées les zones où les manifestations extrêmes de l’aléa peuvent constituer un risque pour les populations et les biens et présente aussi une évaluation des dégâts potentiels peuvent s’avérer désastreux. La carte résultante tente d’apporter des éléments de réponse pour comprendre et essayer de maîtriser ce risque. Elle constitue un document de base pour lutter efficacement contre ce phénomène.

L’application de cette méthode a été possible par le biais du Système d’Information Géographique qui a permis la cartographie, l’intégration, le traitement et l’analyse des principaux facteurs de prédisposition et toutes les caractéristiques spatiales de la vulnérabilité aux glissements de terrains. C’est une méthode basée sur un modèle conceptuel qui permet d’hierarchiser un terrain en polygones et chaque polygone porte la signature de son degré de vulnérabilité.

**APPLICATION D’UN SIG POUR L’ÉVALUATION DES CARACTÉRISTIQUES MORPHOMETRIQUES DES BASSINS VERSANTS : L’EXEMPLE DE YOPOUGON A ABIDJAN EN AFRIQUE DE L’OUEST**

Koffi a. Stephane¹ & ait fora a.²
¹Université Ibn Tofail de Kénitra, Laboratoire de Géosciences Appliquées
²Université Ibn Tofail de Kénitra, Département de Géologie

**KEY WORDS:** Floods, Geohazard, Watershed, Geomorphometry, GIS

**ABSTRACT**
Climate change in the world in general and Côte d’Ivoire in particular are the cause of many disasters such as droughts and floods. The floods have negative effects on people and their different living environments. In the case of floods, they cause geohazards are landslides, mudslides and other weather. These floods also cause significant property damage, deaths and water pollution, anything which results from increasing urbanization, uncontrolled and unreliable which makes it more and more areas are vulnerable to these phenomena of floods. This causes damage to the people whose socio-economic cost is even more important that these events are violent and more frequent. The floods usually originate from the vicinity of a river that leaves his bed during the long rains. However, heavy rainfall can cause flooding by runoff from areas far away from any major rivers. The consequences can be just as severe, and the stakes are high. Yet knowledge about this type of flooding remains modest, as the variety and unpredictability of events are great. In the ten municipalities of the District of Abidjan, Côte d’Ivoire, the last years were marked negatively by this type of flooding in several neighborhoods. These phenomena have caused property damage, displacement of populations and even deaths in neighborhoods generally defined as precarious. The main victims are women, children and the elderly. This study will highlight the importance of physical characteristics of a region like Abidjan in Cote d’Ivoire (West Africa), geology, topography and rainfall data in modeling the phenomenon flooding. This study will highlight the importance of geomorphology of a region like Abidjan in Cote d’Ivoire (West Africa. The use of GIS technology, which has become an important tool for decision support for a good and better predictive and preventive management of floods risks.

**LES CHANGEMENTS D’ECHELLES POUR LA PERCEPTION DE L’INSTABILITE DES TERRAINS DU CAP BON : APPROCHE GEOMATIQUE.**

Romdhan Haddad¹ & Med Chedly Rabia²
¹Département de Géologie, Bizerte Tunisie.
²Département de Géographie, Manouba Tunisie.

**MOTS CLES:** Cap bon, Instabilité des terrains, changements d’échelles et Géomatiques.
RESUME
Dans la présente recherche, l'aléa d'instabilité des terrains, au niveau de la presqu'île du Cap bon, est approché de façon systémique basée, en plus des travaux de terrain, sur les outils de Géomatiques (SIG, Télédétection et cartographie numérique).
Par ailleurs, en plus des différents facteurs, la question d'échelle semble être déterminante dans l'appréhension de ce phénomène.
La méthodologie suivie lors de cette étude, en plus d’une homogénéisation et la mise en place d’une véritable base de données, a concerné les calculs mathématiques et empiriques de l’indice d’instabilité à trois échelles différentes.
L’analyse spatiale, notamment les opérations de Buffering et d’union, ont permis de restituer les résultats sous forme de cartes numériques l’aléa d’instabilité au niveau de la région d’étude à trois résolutions différentes directement utilisables par les décideurs et qui pourraient être mises à jour en fonction de nouvelles informations. Des zones, considérées comme théoriquement stables, semblent ne pas l’être et doivent ainsi prises en compte lors de la réalisation des plans d’aménagement.
Enfin, un essai de validation des résultats a été abordé. Il confirme, globalement, les résultats atteints par l’approche systémique.

ASSESSING AND MODELLING FLOOD DISASTER USING REMOTE SENSING AND GIS TECHNIQUES: A CASE STUDY OF IBADAN CITY, NIGERIA.

P.C. Nwilo¹, Isi I. Ikuhoria², M.S. Keita², S. Fabiyi², A.E. Adzande³, E. Adagbasà³, G. Yesuf³, O. O. Ige Olumide³ & D.N. Oloyinka³
¹ Office of the Surveyor General of the Federation (OSGOF), No.8, Yamuri Street, Abuja, Nigeria
² Regional Centre for Training in Aerospace Surveys (RECTAS), OAU Campus, Ile-Ife, Nigeria
³ Department of Surveying and Geoinformatics, University of Lagos, Akoka, Lagos, Nigeria

KEYWORDS: Assessing, Modelling, Flood, Remote Sensing, GIS, Ibadan

ABSTRACT
Flood is one of the major environmental disasters in many part of the world. The devastating flood occurrence and its multidimensional impact on the people have been of great concern in Nigeria. Ibadan city in the south-western part of the country is prone to flood disaster. The occurrence of flood event in the city has shown a repetitive pattern over 50 years, with a high possibility of reoccurrence. On 26th August 2011, after a heavy rainfall that lasted for fourteen hours and the partial failure of the Eleyele dam gravity spill way, a flood disaster occurred along Ona river. It was characterised as the worst in thirty years while over 80 lives were lost, buildings and infrastructures were submerged or destroyed during the flood disaster.
This paper is a practical attempt in the use of remote sensing satellite data, field observations and GIS technology to determine the extent of the Ibadan flood disaster, determine the intensity of the flood to infrastructures and evaluate the potential of risk within the flood plain and the immediate environs.
The methodology used is an integrated risk assessment procedure that utilises detailed field investigation and extraction of flood plain and infrastructure from high resolution satellite images. The data set used include TerraSAR-X image (1m resolution) of 31 August 2011 for the extraction of the flood patterns and extent; recent Quick Bird image (60cm resolution) of January 2008 used to identify and extract the affected building foot prints, the dam and other infrastructures; a digital elevation (from SRTM data with 96m spatial resolution) covering Ibadan and environs has been used for flood plain modelling and estimating vulnerable areas. The field observations were carried out using hand held GPS and digital camera.
The results are presented on maps showing damaged infrastructures and terrain analysis (vulnerability), all produced using Geographic Information Systems software (ArcGIS 10.0). The acquired results are relevant and will be useful in
assessing the damaged farmlands, the destroyed dam, bridges, roads and buildings. The vulnerability maps would be invaluable for decision makers and emergency response team in the case of future occurrence of flood disasters in the study area.

Useful recommendations are made for the use of remote sensing data and GIS tool for decision making and effective flood management and planning in Ibadan and in Nigeria in general.

**HYDROLOGICAL RISK ANALYSIS WITH OPTICAL REMOTE SENSING, CHEMICAL AND ISOTOPIC DATA AND HYDROGEOLOGICAL MODELLING: CASE IN THE FLOODING AREA OF DAKAR (SENEGAL)**

Ousmane Coly Diouf¹, Seynabou Cissé Faye¹, Ndeye Maguette Dieng¹, Serigne Faye¹ & Stefan Wohnlich²

¹Department of Geology, Faculty of Science and Technology, University Cheikh Anta Diop (UCAD) Dakar
²Ruhr University of Bochum, Department of Applied Geology, Universitaets str. 150, D-44801 Bochum, Germany

**KEYWORDS:** Floods, Remote sensing, isotope chemistry, hydrogeological modeling.

**ABSTRACT**
The present study was undertaken in order to use remote sensing, geographic information systems, isotopic data and hydrogeological modelling to analyze and map flood, determine their causes but also propose solutions to fight against the floods.

The use of optical remote sensing with very high resolution has a thematic mapping including urban dynamics and the extension of floods from 1989 to 2009. Maps of the urban dynamics have to see the evolution of land use. Areas affected by flooding is located in the departments of Guédiawaye and Pikine. On the 22 district municipalities that have both; 17 were affected by the floods in 2005. In general, these floods are the result of factors such as urbanization combined with spontaneous occupation of lowland flooding, rainfall accumulations of very important events and rising groundwater level caused by a significant decrease in its pumping rate. We must also add the induced recharge caused by the scarcity of the lack of a wastewater and stormwater drainage.

Stable isotopes samples in rainwater and groundwater allowed the establishment a recharge map in 2008. This map shows high recharge in the basin of Thiaroye.

All these vectors data are used for hydrogeological modelling of the groundwater using the FEFLOW software. The predictive simulations of exploitation of the groundwater as a solution to fight against floods at rates of 19 000 m³.j⁻¹ and 9 000 m³.j⁻¹ respectively for infrabasaltique and Thiaroye aquifer cause a decline in groundwater levels of 2 m Pz7 (Guédiawaye); 1.72 m Pz4 (Pikine) 1.45 m Pz21 (Yeumbeul). These results show that the pumping is an effective way to fold the piezometric levels.

**TELEDETECTION, SIG ET MODELISATION DE L’EROSION HYDRIQUE DANS LE BASSIN VERSANT DE L’OUED AMZAZ, RIF CENTRAL**

Chaaquan J.¹, Faleh A.¹ Sadiki A.², Mesrar H.² & Lakhouaja H.¹

²Département de Géologie, Faculté des Sciences Dhar Mahraz, B.P. 1796 Atlas Fès.

**MOTS CLES :** Maroc, Rif, érosion, télédétection, SIG, EPM, Equation de Gavrilovic

**RESUME**
Le bassin versant de l’oued Amzaz à l’image du reste de la région rifaine connaît une érosion intense due à la conjonaison de facteurs favorables tels que l’escarpement du terrain, la prédominance des roches tendres, la brutalité des précipitations et l’insuffisance du couvert végétal. En plus de ces facteurs naturels, l’intervention de l’Homme dans ce milieu vulnérable accentue sa fragilité par le défrichement et la mise en culture de terrains en pente forte. Cette érosion très accélérée a des effets néfastes sur l’écosystème qui se manifestent par :
- La diminution des ressources en eau superficielle et l’altération de leur qualité.
- La dégradation des sols et la perte de leur fertilité.
- L’envasement du barrage Al Wahda en aval


Pour atteindre ce but, il a fallu cartographier et intégrer dans un SIG tous les paramètres nécessaires à l’application du modèle empirique de Gavrilovic EPM "Erosion Potential method" et l’application des techniques d’analyse spatiale pour évaluer les pertes en sols et estimer le poids de chaque facteur et de leurs effets combinés d’une part et de démêler leur interdépendance d’autre part.

Les paramètres utilisés ont été étudiés grâce à la télédétection et aux données collectées sur le terrain puis intégrés dans le SIG. Ces paramètres sont :
- Les facteurs permanents de l’érosion hydrique (lithologie, pente…) et les facteurs dynamiques (climat, hydrologie de surface, utilisation des sols…),


L’intégration dans le SIG du modèle de Gavrilovic a permis d’hiérarchiser les différentes zones du bassin versant en produisant une carte synthétique de répartition des degrés de sensibilité à l’érosion et de déterminer le taux d’érosion par le ruissellement en nappe (10 483 m$^3$/Km$^2$/an en moyenne). L’analyse des résultats de ce modèle a permis d’établir les facteurs causaux décisifs qui contrôlent l’érosion hydrique et qui sont par ordre d’importance, les précipitations, la pente, l’érodibilité des sols et la densité du couvert végétale.
URBAN FLOOD MENACE IN A RAPIDLY GROWING CITY OF IBADAN, NIGERIA

Fashae¹, Olutoyin A, Adepoju² Adewale and Adedeji² & Oluwatola I

¹Department of Geography, University of Ibadan, Nigeria.
²Africa Regional Center for Space Science and technology Education in English (ARCSSTEE)

ABSTRACT
Flooding is a global phenomenon that has continued to constitute a major threat to cities and indeed nations across the world. At present, over 7500 people have been displaced by flooding in China while cities such as California, Mississippi, Sydney. Floods belong to one of the most threatening natural hazards for human lives and property. Ibadan which is located in the south-western part of Oyo state is the largest city in West Africa and one of the fastest growing cities in Nigeria with estimated population of about 3.5 million. Ibadan, to mention just a few, have at different times, faced the menace of flooding, this can be attributed mainly to rapid mindless urbanisation, encroaching upon and filling up natural drainage channels and water bodies, where value urban land are used for buildings on floodplains.

GIS have been recognized as a powerful means to integrate and analyze data from various sources in the context of comprehensive floodplain management. These tools, based on GIS, are very appropriate for a participatory approach to flood policy formulation and floodplain management because they help communicate with the public in a scientifically accurate and yet rather simple manner. This study exploits the integrated approach of Remote Sensing by using high resolution imagery, Digital Elevation Model and GIS techniques. Buildings were digitised, so as to analyse the building foot prints that were affected by the flood of the period and GPS receivers during fieldwork with the goal of mapping areas vulnerable to flood hazard in Ibadan.

The result showed that from the heavy rainfall of about 1850mm accompanied by wind gusts of 65km/hr in August 26th 2011, all the eleven Local Governments Areas (LGAs) within the Ibadan region experienced flooding, where nine LGAs which incidentally falls into Ibadan central local government areas, the most urbanized and densely built up areas of Ibadan. Out of 287,679 buildings in Ibadan, about 20,000 buildings were on the flood plain of Rivers Ona, Omi and Ogunpa, the major rivers in Ibadan. Conclusively, it was evident from the study that urbanization contributed significantly to the ravaging extent of the flood in Ibadan of the period.

THE FLOOD HAZARD ASSESSMENT OF KADUNA METROPOLIS

Youngu, T. T.¹ & Anoze, D. S.¹

1. Department of Geomatics, Ahmadu Bello University, Zaria, Kaduna State. Nigeria

KEYWORDS: Flood probability, Flood hazard management, Mapping, GIS and Rainfall forecasting

ABSTRACT
The hazard and damage caused by flooding cannot be overemphasized in terms of loss of life, property, displacement of people and disruption of socio-economic activities as well as the loss of valuable agricultural land due to the problems associated with flood plains such as excessive rainfall and dam failures. Several areas along the coast of the Atlantic Ocean and along Major River valleys are affected by floods every year of which, urban flooding is gradually becoming a serious ecological problem in Nigeria. To gain better understanding of the flood problem especially for planning purposes, flood hazard maps are often required. A combination of data records on flood plains such as land...
use/cover, river/flood stage, and digital elevation models are used to predict future flood stages and likely impacts. GIS and results of analysis of flood stage data using a combination of digital elevation model and land use/land cover data as well as rainfall data were used to map out the areas that are prone to flood hazard and forecast flood in Kaduna Metropolis. Areas under high risk due to flooding were also determined. The study revealed that most of the areas lying close to the River Kaduna’s flood plain are under severe threat to flooding in as much as some suggestions are proffered.

**NEAR REAL TIME FLOOD WATER MAPPING**

Fritz Policelli, G. Robert Brakenridge, Dan Slayback, Shahid Habib

Fritz Policelli – NASA GSFC, Greenbelt MD USA

G. Robert Brakenridge – Dartmouth Flood Observatory, Boulder CO USA

Dan Slayback – SSAI/ NASA GSFC, Greenbelt MD USA

Shahid Habib – NASA GSFC, Greenbelt MD USA

**ABSTRACT**

Since the beginning of operation of the MODIS instrument on the NASA Terra satellite at the end of 1999, an exceptionally useful sensor and public data stream have been available for many applications including the rapid and precise characterization of terrestrial surface water changes. One practical application of such capability is the near-real time mapping of river flood inundation.

With the launch of the MODIS sensor aboard the NASA Aqua satellite in 2002, the two MODIS sensors provide nearly global daylight acquisitions twice daily of calibrated multispectral optical radiance and reflectance values at three spatial resolutions: 250 m, 500 m, and 1000 m. The primary obstacles to using these data for surface water characterization are: 1) cloud cover obstruction, and 2) the lack of higher spatial resolution. Other properties of these data are, however, exceptionally useful: including the wide area, frequent-repeat coverage (twice daily, on a global basis), and the precise geolocation information provided by the well-characterized orbital geometry (positional accuracies of the image pixels are at a nominal +/- 50 m with reference to a global datum and geoid).

We have developed a surface water mapping methodology based on using only bands 1 (620-672 nm) and 2 (841-890 nm) of the MODIS instruments. These are the two bands at 250 m, and the use of only these bands maximizes the resulting map detail. In this regard, most water bodies are strong absorbers of incoming solar radiation at the band 2 wavelength: it could be used alone, via a thresholding procedure, to separate water (dark, low radiance or reflectance pixels) from land (much brighter pixels)

Some previous water mapping procedures have in fact used such single band data from this and other sensors that include similar wavelength channels. Adding the second channel of data (band 1), however, allows a band ratio approach which permits sediment-laden water, often relatively light at band 2 wavelengths, to still be discriminated, and, as well, provides some removal of error by reducing the number of cloud shadow pixels that would otherwise be misclassified as water.

The most desirable outcome of a water mapping algorithm for flood surveillance is complete coverage from one image: because floods are a dynamic phenomenon, and surface water extent can change over a few hours of time. On the other hand, cloud cover commonly obscures significant land areas during flooding, so that accumulating data from more than one image is necessary in order to expand spatial coverage. Also, cloud shadow removal can be facilitated by combining data from at least two images (cloud shadows that vary in location can be distinguished from surface water present in both images). Our procedure provides a
flexible approach in which raster image processing of at least four MODIS images is the initial input, and then, once the water area data are translated into GIS vector format (water polygons), accumulation of water area can be extended over several days, or more, in time: in the case when cloud cover is heavy and only relatively small areas of the ground surface are captured in even four images.

The resulting GIS files, outlining surface water, are then best used in comparison to other data obtained through identical processing but on dates prior to flooding and when surface water was at approximate mean conditions. This constitutes a change detection approach, but occurs within the GIS environment: one flood water layer, perhaps colored red, can be displayed below a normal water layer, perhaps colored light blue. All areas of visible red then represent defined parcels of land that are under water in the flood image and were not in the comparison scene.

In our mapping, we normally superimpose these GIS water layers over reference map information, such as shaded relief and cultural feature files such as cities and towns, and over all of these layers we superimpose a layer showing the persistent cloud cover.

Because of the importance of having the latest information for disaster management applications, we have developed a prototype, automated, global system to implement the processes described above. We draw on near real time data from the recently implemented NASA MODIS LANCE system to provide MODIS based flood maps with a latency time of less than six hours.

We expect to focus our future work in this area toward addressing issues of false indications of flooding caused by cloud and terrain shadow, evaluating the prototype products with partners, and investigating the addition of satellite radar data and higher resolution optical data sources as available.

CONTRIBUTION DE LA TELEDETECTION ET DES SYSTEMES D’INFORMATIONS GEOGRAPHIQUES (SIG) AU TRAITEMENT (FIXATION) DE LA DUNE VIVE DE OURSI. BURKINA FASO

Padonou Nourou Moucharaf 1 & Bouland Patrick 2

1-Institut Panafricain pour le Développement (IPD/AOS) 01 B.P 5975 Ouagadougou 01 Burkina Faso
2- GDTA Toulouse (France)

MOTS-CLES: Télédétection, SIG, dune vive, changement climatique, images satellite, traitement, Burkina Faso.

RESUME
Les possibilités offertes par la télédétection et les SIG permettent de nos jours de mieux appréhender les problèmes de l’environnement dus aux changements climatiques en général et à la désertification en particulier. La présente étude a pour objet majeur de montrer la performance de ces outils et leur complémentarité pour l’analyse du suivi de la dynamique d’une vive en pleine expansion dans un milieu sahélien, dans le but de sa stabilisation. Confrontée depuis plusieurs décennies à une crise pluviométrique et à une démographie galopante de la population et du bétail, la partie Nord du Burkina est soumise aux effets de la sécheresse et de la désertification qui ont pour conséquences une forte mortalité des strates arbustives et l’installation des cordons dunaire.

L’objectif principal de la présente étude est donc d’élaborer une approche méthodologique et opérationnelle qui puisse permettre, à partir de la télédétection et des SIG, d’appréhender et de maîtriser les informations spatiales et géoréférencées relatives aux paramètres de dénudation, de remobilisation et de progression du front d’un ancien cordon dunaire afin de procéder à son traitement et sa fixation, car elle menace dangereusement les habitations et la mare pérenne du village de Oursi. Ces informations pourront

**ETUDE DES IMPACTS ECOLOGIQUES DU DYNAMISME SPATIO-TEMPOREL DES HABITATS NATURELS SUR LA FAUNE MENACEE DU COMPLEXE ZONES HUMIDES MAHAVAVY-KINKONY (CZHMK), MADAGASCAR**

Rado H. Andriamasimanana
LOT IIN 83 DM Analamahitsy Carrière, Antananarivo 101, Madagascar

**MOTS CLES:** habitat naturel, faune menacée, changement, menace, impact, prédiction

**RESUME**
Cette recherche menée dans le CZHMK a pour but d’évaluer les impacts écologiques du changement des habitats naturels sur sa faune présentant une importance internationale. Des outils technologiques tels que SIG, télédétection ainsi que celui de priorisation combinés avec les études bibliographiques et les travaux de terrains ont été utilisés pour (1) identifier les habitats naturels prioritaires pour la faune menacée du site, (2) évaluer leur changement entre 1950 et 2005, (3) déceler ses causes, (4) prédire leur changement en 2050 et (5) évaluer les impacts du changement. Ce changement des habitats naturels s’est déroulé au cours des temps mais il n’est pas assez important au niveau global du site pour transformer radicalement les occupations du sol. Toutefois, la diminution des phragmites du lac Kinkony de la forêt de Tsiombikibo ainsi celle de Marofandroboka est menaçante pour les espèces qui en dépendent.

**DISET: A SPACE-BASED, SAHELIAN DESERTIFICATION MONITORING PROJECT**

Salu, B. O. & Akinyede, J. O.

1. African Regional Center for Space Science & Technology Education-English (ARCSSTEE-E)

**ABSTRACT**

Desertification has been a serious problem in the Sahel region of Africa for a few decades now. This has resulted in various studies to seek ways mitigating this problem.

The Space Research and Development (SR&D) unit of ARCSSTEE is undertaking research in this major problematic area in collaboration with several Nigerian Universities through the use of a Distributed Sensor Network with data collection proposed to be via the ESA-supported HUMSAT constellation.

This work presents the use of Satellite based data gathering and an inexpensive sensor array to track movement of sand using visibility as an effective metric along with other parameters (wind speed, direction temperature etc). The development of cluster computing capability to analyze collected data is also discussed.

The ability to monitor sandstorms, for example, using visibility, wind speed, direction etc gives a clear ground-truth picture of how much sand is deposited in an area over time. This information is invaluable for combating desertification (e.g. targeted tree planting and also for policy makers, farmers etc).

Finally, collaboration and participation is sought from interested Governments, Agencies, Universities and Research institutes within the sub-region.

**MULTI-SATELLITES DATA FOR ANALYSIS OF DROUGHT EVENTS IN A NORTH AFRICA SEMI-ARID REGION**


1. CESBIO (CNRS/IRD/UPS/CNES), 18 avenue. Edouard Belin, bpi 2801, 31401 Toulouse cedex 9, France,
2. INAT, 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène TUNISIE
3. Vienna University of Technology, Gusshausstrasse 27-29, 1040 Vienna, Austria

**KEYWORDS:** Semi-arid region, Soil moisture, SPOT VEGETATION time series, Vegetation Anomaly index, Moisture Anomaly Index.

**ABSTRACT**

In semi-arid regions, and northern Africa in particular, the scarcity of rainfall and the occurrence of long periods of drought, represent one of the main environmental factors having a negative effect on agricultural productivity. This is
the case in Central Tunisia, where the monitoring of agricultural and water resources is of prime importance. The climate in this region is semi-arid, with an average annual rainfall of approximately 300 mm per year, characterised by a rainy season lasting from October to May. The mean annual potential evapotranspiration (Penman) is close to 1600 mm. The landscape is mainly flat. The vegetation in this area is dominated by agriculture (cereals, olive and fruit trees and market garden). Crops are various and their rotation is typical of semi-arid regions. Vegetation cover and soil moisture are key parameters in this objective. Remote sensing has shown in the last decades a high potential to estimate these surface parameters.

This study is based on two satellite products: SPOT-VEGETATION NDVI data and ERS and ASCAT/METOP moisture products proposed by Vienna University of Technology (TU Wien) (Wagner et al., 1999). A validation of soil moisture products is realized over the studied site using ground measurements (Thetaprobe continuous measurements), inter-comparison with other satellite products and precipitation levels. Based on long time series of satellite products, two anomaly indices have been proposed.

In order to estimate the state of stress of the vegetation cover, an index referred to as the Vegetation Anomaly Index (VAI) is proposed from SPOT-VGT time series. A positive VAI indicates good vegetation dynamics, whereas a negative VAI indicates the presence of vegetation stress. This index is highly correlated to precipitation, and is found to have a maximum correlation with the 4-month cumulative precipitation (CP3). In fact, vegetation response to precipitation has a time lag, and the impact of water deficits on vegetation is cumulative especially in arid regions. We observe high correlations occurred particularly in the middle of the growing season for annual agriculture, but are much lower during greenup and senescence. The VAI index can be operationally applied in order to estimate quantitatively the effect of drought on vegetation cover.

Based on SWI (Soil Water Index) products, representing root-zone soil moisture content in the first meter of the soil, we propose a simple Moisture Anomaly Index, which can provide a quantitative visualization of drought periods. This index is compared with and validated, using the SPI precipitation index. A high degree of correlation is observed between the two indices. The Moisture Anomaly Index could be a very useful tool in regions without precipitation networks. It could be also particularly complementary to precipitation indices in arid and semi-arid regions characterised with limited rainfall events and a high evaporation.

**ASSESSMENT AND MONITORING OF LAND DEGRADATION AND NATURAL HABITAT CONSERVATION IN IGAD REGION**

**Muyambi Fortunate**

IGAD Climate Prediction and Applications Centre, African Monitoring of Environment for Sustainable Development, P.O Box 10304-00100 GPO, Nairobi, Kenya

**KEY WORDS:** Land degradation model, Natural Habitat Vulnerability Assessment model

**ABSTRACT**

The objective of the project was to assess and monitor Land Degradation and Natural Habitat conservation. This is therefore a key to policy formulation and decision making in addressing food insecurity, poverty, and sustainable natural habitats conservation and crucial in planning and implementing adequate mitigation measures in Uganda. Using GIS and remote sensing, a land degradation model was developed using vegetation cover type and condition, Rainfall erosivity, Soil erodibility, Topography (Slope and slope length) and Population density parameters to assess the Land Degradation and land degradation Index Maps (LDIM) were produced indicating the risk of land degradation at
low resolution and high resolution over selected areas ("hot spots"). The model identifies extent and severity of land degradation at the national levels. Natural Habitat vulnerability model was developed by carrying out land cover change analysis for selected natural habitats using high-resolution images. The vulnerability model was then developed using the following parameters: Population pressure, Agricultural pressure and Accessibility pressure to the Protected Areas.

Biography
Holds a Bachelor’s Degree in Forestry, Msc in Environment and Natural Resources Management. Works for IGAD-Climate Prediction and Applications Centre- African Monitoring of Environment for Sustainable Development (AMESD Project) as GIS and Remote Sensing Specialist. He won award in 2008 at ESRI UC for the best GIS user. He is the Current Chairman for Society for Conservation GIS Uganda Chapter.

ON-LINE LARGE-SCALE FOREST FIRE MONITORING IN RUSSIA BASED ON DIRECT ACQUISITION OF DIFFERENT TYPES OF SATELLITE DATA

Targulyan Oganes¹, Gershenzon Vladimir¹ Gershenzon Olga & Farutin Ilya¹
¹ RDC ScanEx, 119021, Russia, Moscow

ABSTRACT
ScanEx Research & Development Center (RDC) created an infrastructure (ground stations network) to acquire and process remote sensing data from different satellites: Terra, Aqua, Landsat, IRS-P5/P6, SPOT 4/5, FORMOSAT-2, EROS A/B, RADARSAT-1/2, ENVISAT-1, UK-DMC2.

ScanEx performs large-scale projects in collaboration with government agencies to monitor forests fires. During 2010-2011 ScanEx conducted daily monitoring of wild fires in Russia, detecting and registering thermal anomalies using data from Terra, Aqua, Landsat and SPOT satellites. An automated fire recognition system detects fires in MODIS temperature bands (both Terra and Aqua satellites) twice a day. To further assess the extent of fires, and fire propagation, optical images with medium to high spatial resolution were used (Landsat 5, SPOT 4/5, Formosat-2 data). Compared to MODIS Terra/Aqua data high resolution images with infrared channels help to detect more fires with better precision. Additionally it helps to separate real fires from hot spots associated with different sources (e.g. gas flaring, metallurgical works, etc). Detailed SPOT 4/5 data were used to analyze burnt areas and to assess damage caused by fire.

Satellite data along with other information about fire situation in Russia was daily updated and published via free-access Internet web-portal (geoportal) “Kosmosnimki – Fires”. This geoportal implements an automated algorithm to cluster separate fires in bigger sections. Such approach allows tracking the dynamics of the fires, to assess their strength and area, and the total burnt area for a specific period.

Additionally technology for monitoring of low-intensity fires using infrared band from high-resolution sensors, e.g. SPOT, was developed. This technology was applied for peat bog fires monitoring. It results in possibility to detect a fire, when the peat is not burning yet, but smoldering. The outcomes were used to ensure prompt extinguishing at an early stage and to organize and plan further satellite control of peat bogs.

The drawback of optical infrared sensors is the inability to detect fires and to assess the damaged areas through thick clouds. As the 2010-2011 Russian fires satellite imagery analysis results revealed, the space
radars with synthetic aperture (SAR) can be an operational supplement to the optical multispectral equipment, widely applied for monitoring of fire situations.

An experimental work was performed on operational mapping of forest areas, affected by fires based on the method of using images acquired by multispectral optical and radar satellite imaging equipment. The purpose of this work was to assess the possibilities of quick detection and delineation of burnt areas based on multi-polarized images of space SAR detectors, backed up by the multi-temporal optical images used as a reference for verification of the obtained results.

A burnt area caused by the forest fires that occurred in August 2010 in the Mariy El Republic was used as a test region. The Canadian MDA Geospatial Services provided the image from RADARSAT-2 satellite, acquired on 19.08.2010 in Fine QuadPol mode, and the ScanEx Center acquired and processed with own assets a series of color optical images of SPOT 4, 5 and Landsat-5 satellites for this test region in June-September 2010.

The results of this experiment showed the capability of detecting forest fire burnt areas based on multi-polarized RADARSAT-2 radar images. The probability of correct detection of burnt areas based on SAR images depends on the fire type (crown or ground fire), vegetation class, soil and vegetation moistening level, and viewing angles. Burnt areas and configuration assessment results based on SAR images match the respective parameters of burnt areas, received from optical imagery data with acceptable accuracy.

Conclusions: Joint application of multi-temporal optical and radar images enable increasing the probability of correct detection and operability of assessments of the burnt areas of forests. Multi-polarized radar imagery can be applied for operational assessment of fire situation around major industrial, military and scientific targets in case of cloudy weather preventing optical imagery.

**TELEDETECTION ET ETUDE DIACHRONIQUE DES INCENDIES DE FORETS DANS LA PROVINCE DE CHAOUENE**

Lakhouaja H.¹, Faleh A.¹, Sadiki A.², Chaaouan J¹ & Mesrar H.²

¹ - L. E. G. A.C. Faculté des Lettres Saiss Fès, Maroc.
² - Département de Géologie, Faculté des Sciences Dhar El Mahraz.

**MOTS-CLÉS :** incendies - Télédétection - image satellite - forêts - chaouène - risque - NDVI.

**RESUME**

L'incendie est un des problèmes majeurs de la dégradation de la forêt marocaine, C'est la première cause du rétrécissement de sa superficie. Ce phénomène pèse lourdement sur l'économie locale et régionale. Il a en plus des répercussions néfastes sur l'environnement comme la diminution de la biodiversité, l'enlèvement de la protection des sols et leur exposition à l'érosion ainsi que la dégradation des ressources sylvo-pastorales.

Les méthodes classiques généralement utilisées au Maroc pour le suivi et la gestion des incendies ne sont pas toujours satisfaisantes vu la complexité et la diversité des écosystèmes forestiers. Il est donc nécessaire de faire appelle à de nouvelles techniques qui permettent de cerner tous les paramètres du problème aussi bien spatialement que dans le temps.
L'éventail des possibilités offertes par la télédétection dans ce domaine est extrêmement riche. La disposition de l'information presque en temps réel des déclenchements des feux et de leur propagation pour une intervention de lutte rapide et efficace. La couverture spatiale des images satellites permet une cartographie de toutes les zones impliquées. la périodicité de l’acquisition des données l’étude diachronique du phénomène.

Dans cette étude, nous proposons une technique beaucoup plus performante et plus efficace basée sur l’exploitation des images satellites multi dates et multi capteurs sur une période assez longue pour la détection des changements dans le temps et dans l’espace grâce à l’indice de végétation normalisé (NDVI), dans la province de chaouène. La méthodologie adoptée met en relation les résultats de la télédétection avec les données collectées sur le terrain afin d’atteindre deux objectifs distincts : d’abord améliorer la cartographie pour le suivi des surfaces forestières incendiées, ensuite analyser l’évolution de ce phénomène pour une gestion optimale.
A NEW APPROACH FOR DETECTING AND MONITORING SAHARAN DUSTS

Filomena Sannazzaro¹, Rosita Corrado¹, Carolina Filizzola², Francesco Marchese², Giuseppe Mazzeo²,
Rossana Paciello², Nicola Pergola¹,² & Valerio Tramutoli¹,²

¹- University of Basilicata, Department of Engineering and Physics of the Environment, via dell’Ateneo Lucano
²- National Research Council, Institute of Methodologies for Environmental Analysis (IMAA), c/da S.Loja-85050 Tito Scalo (PZ), Italy

ABSTRACT

Saharan dust has been particularly studied for its relevant climatological implications and for damage mitigation purposes. To this aim, an early detection (Mei et al., 2008), as close as possible to dust sources over deserts and semi-desert regions, would be required, but it is made difficult by the relatively similar mineral composition (and spectral signatures) of airborne and surface dust (Wald et al., 1998). Different satellite techniques have been proposed up to now devoted to detect and monitoring Saharan dust clouds with different success depending on observation conditions (day/night, land/sea, etc.) and specific aerosol properties (mainly size distribution and complex refractive index). Due to dust-cloud optical properties - which are very similar to those exhibited by low/thin meteorological clouds, as well as by cloud fringes - their discrimination is still the main problem. To this aim several satellite methods exploited the reverse absorption behaviour showed by silicate particles (in comparison with ice crystals and water droplets) at 11 and 12 μm wavelengths (split-window). However, the performance of split window methods strictly depend on local observational conditions as well as on specific aerosol properties so that, when based on fixed thresholds, they exhibit severe problems in discriminating dust from meteorological clouds (e.g., Prata, 1989; Luo et al., 2003). To overcome such limitations, a Robust Satellite Technique (RST, Tramutoli, 1998, 2007) has been proposed and already successfully applied to the study of several natural, environmental and technological hazards. In order to detect and monitoring dust storms, the RST algorithm uses the following indices:

\[
\Theta_D(r,t') = \frac{\Delta T(r,t') - \mu_D(r)}{\sigma_D(r)} \quad (1)
\]

\[
\Theta_{\text{vis}}(r,t') = \frac{\text{Vis}(r,t') - \mu_{\text{vis}}(r)}{\sigma_{\text{vis}}(r)} \quad (2)
\]

\[
\Theta_{\text{tir}}(r,t') = \frac{\text{Tir}(r,t') - \mu_{\text{tir}}(r)}{\sigma_{\text{tir}}(r)} \quad (3)
\]

Where in (1), DT(r,t') is the difference of brightness temperatures (BT11-BT12) measured at 11 and 12 μm, while \(\mu_D(r)\) and \(\sigma_D(r)\) , respectively, represent the temporal mean and temporal standard deviation of the same spectral signal difference; in (2) and (3) Vis(r,t') and Tir(r,t') are the signals acquired in the bands at 0.6 μm and 11 μm, respectively, while \(\mu_{\text{vis}}(r)\), \(\mu_{\text{tir}}(r)\), \(\sigma_{\text{vis}}(r)\) and \(\sigma_{\text{tir}}(r)\) represent the temporal mean and temporal standard deviation of the same spectral signal, respectively. Negative values of the simple RST-DUST index (1) tend to show up image pixels with “anomalous” values of the difference (BT11-BT12), indicating a possible presence of silicate dust in the air; positive values of index (2) should further highlight more reflective bodies such as dust layers and meteorological clouds, while positive values of the index (3) should help to further exclude the coldest bodies (such as meteorological clouds).

In this paper results achieved by applying RST to MSG-SEVIRI data will be presented for the case of a Saharan sand-storm affecting the North-East Africa on 13 May 2004 as well as for a sand-storm happened in Arabian Peninsula in February 2008, discussing RST performance even by comparison with results achievable in the same cases by applying other traditional techniques (see, for example, figure 1).

Preliminary results seem to confirm that RST methodology, applied for detection and monitoring of dust storm, is capable of reducing the main limitations shown by traditional satellite methods.
Figure 1: Case of a Saharan dust storm across the Centre-East Mediterranean Basin (13 May 2004).

MSG-SEVIRI visible image at 0.6 μm is used as background. Performances in dust storm detection (using MSG-SEVIRI images) between fixed-threshold algorithms (Prata, 1989; Luo et al., 2003) and RST methodology are showed. Both fixed-threshold methods seem to underestimate the presence of the dust in the air over the sea as it is visible in comparison with TOMS aerosol maps.

References

REMOTE SENSING AND GIS ASSESSMENT OF FLOOD VULNERABILITY OF NIGERIA’S CONFLUENCE TOWN (LOKOJA)

Dukiya, J. J.
Department of Urban and Regional Planning, University of Technology, P.M. B 65, Minna, Nigeria.

KEY WORDS: confluence area, flood, gis, remote sensing, urbanization, and vulnerability.

ABSTRACT
Lokoja, the Kogi state capital is located at the Niger-Benue confluence in the south central part of Nigeria and is about 170 km from the Federal Capital Territory (FCT) Abuja. The town appeared to have experience tremendous urbanization changes spatially and socio-economically since it has been made a state capital. The river bank particularly the confluence line as a resource is a potential zone of conflict between man and the environment,
hazards grow out of such conflicts when human activities in the river confluence area is not properly managed. This project therefore uses the Remote Sensing and GIS technique to assess the flood vulnerability zones of the town using the benchmark minimum and maximum water level from the year 1995 to 2005. Land-use/land-cover and flood vulnerability maps were generated from the satellite imageries of Landsat (TM/ETM) of 1987, 1992, 2001 and Nigeria Sat 1 of 2006. The ortho-photo map and the image drape generated clearly shows that development along the marine road and the new Filele mini-dual carriage road are within the floodable areas of the river confluence. The study recommended an integrated approach in managing the confluence zone. In addition, major development activities should be concentrated on the South-western part of Lokoja.

![Elevation Map of Lokoja](image)

**Figure 6:** GIS based Slope analysis and the built-up areas of Lokoja town. Source: Authors laboratory analysis.

![Image Drape of Landsat (ETM) and DTM Map of Lokoja](image)

**Figure 7.** Image drape of Landsat (ETM) and DTM map of Lokoja, Nigeria.
SPACE-BASED ASSESSMENT OF THE COMPLIANCE OF GSM OPERATORS IN ESTABLISHING BASE TRANSCEIVER STATION (BTS) IN NIGERIA USING ABUJA AS CASE STUDY

Laide Aderoju¹, Godstime James¹, Olojo Banji¹, Ademuyiwa Oyewumi¹ & Salman Khalid¹

ABSTRACT
On the 16th of May, 2001, the first call from Global System for Mobile Communications, originally called Groupe Spécial Mobile (GSM), was made in Nigeria, thereby opening communication among the teeming population in the country. Given the mode of operation of GSM technology, Base Transceiver Stations (BTS) are required for the provision of GSM services. Consequently, network of base stations were established in areas that enjoyed the GSM services all over Nigeria. However, studies have shown that exposure to GSM radiations are linked to health hazards such as fatigue, headache, decreased concentration, dizziness, local irritation, tumour induction, sperm motility, morphology and viability, cancer, especially brain tumour and leukaemia, viral and infectious diseases. Given these potential health impacts of BTS on humans, the National Environmental Standards and Regulations Enforcement Agency (NESREA) established guidelines for National Environmental Standards for Telecommunications and Broadcasting Facilities. The guidelines provided for the establishment of BTS within a minimum setback of ten (10) meters from the perimeter wall (fence) of residential/business premises, schools and hospitals. Similarly, where there is no perimeter wall (fence), the BTS must be at a minimum of twelve (12) meters from the wall of residential/business premises schools and hospitals. Consequently, the aim of this study is to test the compliance of the existing BTS within three Abuja districts; namely, Utako, Garki and Wuse areas. As a result, fieldwork was conducted to determine the coordinates of all the existing BTS within the study area using Global Positioning System (GPS) receivers. These point information were plotted on georeferenced 5 meter spatial resolution multispectral Spot satellite imagery. Subsequently, buffering geoprocessing tool was used to create buffers on the BTS locations using buffer distances of 10m, 20m, 50m and 100m to test the compliance of the BTS to NESREA established guidelines. Results from the analysis revealed that all the 119 BTS sampled in the study failed the 10m and 12m buffer zone tests. As a result, policy prescription was presented on the way forward.

DETECTING NEOTECTONIC DEFORMATION USING FREELY-AVAILABLE MULTISPECTRAL SATELLITE DATA AND GEOMORPHOMETRICS

Nasos Argyriou¹, Richard Teeuw¹ & Derek Rust¹
1. Centre for Applied Geosciences, School of earth & Environmental Sciences, University of Portsmouth, UK.

ABSTRACT
This study examines whether multispectral satellite imagery from Landsat and ASTER, as well as Digital Elevation Models (DEMs, such as SRTM and G-DEM), can be used to highlight zones of neotectonic deformation. We focus on a Mediterranean mountainous landscape, where the assessment of neotectonic deformation is often hampered by dense vegetation, steep-sided high relief and rugged, poorly-accessible terrain. The test region for this study is the island of Crete, located in the outer forearc of the Hellenic subduction zone, associated with collision of the African plate and the Eurasian plate. This tectonic setting affects the island’s landscape, with mountainous relief and geomorphological processes that are strongly influenced by neotectonic deformation of the ground surface.
A set of geoinformatic techniques, based on geomorphological / geological discrimination using Landsat ETM+ data (such as band arithmetic operations, image fusion, optimum index factor etc.) and geomorphometric analysis of ASTER DEMs (such as asymmetry factor, mountain front sinuosity, stream-length gradient index, amplitude relief), were compared with factors such as fracture patterns and drainage basin geomorphological variations. Some of the characteristic features associated with the deformation of the bedrock and the landscape of the study area were: i) tectonically active mountain fronts; ii) uplifted and tilted blocks and; iii) migration of streams.

The methodology developed in this study provides a low-cost reconnaissance tool for assessing regional tectonic regimes and zones of neotectonic activity, in mountainous, semi-arid, vegetated regions.

AUTOMATISATION DE LA PROCEDURE DE MODELISATION DES DIRECTIVES PAP/CAR, PAR UTILISATION DE L’UTILITAIRE « PAP/CAR TOOLS » ET DES OUTILS SIG, POUR L’EVALUATION DES TENDANCES ET DES FACTEURS CAUSAUX DU RISQUE DE L’EROSION HYDRIQUE CAS DU BASSIN VERSANT DE L’OUED SAHLA

Mesrar Haytam¹, Sadiki Abdelhamid¹, Faleh Ali² & Jamal Chaaouan²
1. Laboratoire L. G. R. N. Faculté des Sciences Dhar El Mahraz Fès
2. Laboratoire L. E. G. A. C. Faculté des Lettres Saïss-Fès

MOTS CLES : Erosion hydrique, PAP/CAR, PAP/CAR Tools, SIG, tendances, facteurs causaux.

ABSTRACT

Le souci de minimiser le temps de réalisation des projets de lutte contre l’érosion hydrique un fléau qui pèse lourdement sur les sols marocains particulièrement dans le Prérif, ainsi que rendre les résultats sur lequel va se basé le décideur de plus en plus fiable et pertinentes, nous a poussé à élaborés l’utilitaire « PAP/CAR Tools » qui intervient après la superposition de deux tables de donnés, l’objet est de comparer deux colonnes qui porte un minimum de 40000 enregistrements, suivant une matrice et d’afficher leur produit croisé.

L’intégration des directives du PAP/CAR dans un SIG, combinés à l’utilisation du « PAP/CAR Tools » ont permis d’apporter des éléments de réponses concernant les états érosifs, les facteurs causaux et les tendances évolutifs du risque de dégradation des sols. Et par conséquence un document de décision pour toute fin d’aménagement ou de gestion de territoire.

Situé sur le versant Atlantique du Rif, au niveau de la région de Taounate, le bassin versant de l’Oued Sahla (Fig. 1) occupent une position médian à l’intérieur de cette dernière, dans l’Oued Sahla franchie en son centre la grande voute anticlinale du Jbel Aghil par une vallée très encaissée limité au N et au NE par le bassin versant de l’Oued Sra, à l’Ouest et au NW par le bassin versant de l’Oued Amzaz, au S, c’est la confluence avec l’Oued Ouergha. Il couvre une superficie de 173.89 Km². Une altitude moyenne de 562 m avec un sommet à 1136 m et un exutoire à 193 m.

Le climat méditerranéen à étés secs et hivers pluvieux. Administrativement, la zone d’étude dépend de la région de Taza-Al Hoceima Taounate.

 Mesrar Haytam1, Sadiki Abdelhamid1, Faleh Ali2 & Jamal Chaaouan2
1. Laboratoire L. G. R. N. Faculté des Sciences Dhar El Mahraz Fès
2. Laboratoire L. E. G. A. C. Faculté des Lettres Saïss-Fès

MOTS CLES : Erosion hydrique, PAP/CAR, PAP/CAR Tools, SIG, tendances, facteurs causaux.

ABSTRACT

Le souci de minimiser le temps de réalisation des projets de lutte contre l’érosion hydrique un fléau qui pèse lourdement sur les sols marocains particulièrement dans le Prérif, ainsi que rendre les résultats sur lequel va se basé le décideur de plus en plus fiable et pertinentes, nous a poussé à élaborés l’utilitaire « PAP/CAR Tools » qui intervient après la superposition de deux tables de donnés, l’objet est de comparer deux colonnes qui porte un minimum de 40000 enregistrements, suivant une matrice et d’afficher leur produit croisé.

L’intégration des directives du PAP/CAR dans un SIG, combinés à l’utilisation du « PAP/CAR Tools » ont permis d’apporter des éléments de réponses concernant les états érosifs, les facteurs causaux et les tendances évolutifs du risque de dégradation des sols. Et par conséquence un document de décision pour toute fin d’aménagement ou de gestion de territoire.

Situé sur le versant Atlantique du Rif, au niveau de la région de Taounate, le bassin versant de l’Oued Sahla (Fig. 1) occupent une position médian à l’intérieur de cette dernière, dans l’Oued Sahla franchie en son centre la grande voute anticlinale du Jbel Aghil par une vallée très encaissée limité au N et au NE par le bassin versant de l’Oued Sra, à l’Ouest et au NW par le bassin versant de l’Oued Amzaz, au S, c’est la confluence avec l’Oued Ouergha. Il couvre une superficie de 173.89 Km². Une altitude moyenne de 562 m avec un sommet à 1136 m et un exutoire à 193 m.

Le climat méditerranéen à étés secs et hivers pluvieux. Administrativement, la zone d’étude dépend de la région de Taza-Al Hoceima Taounate.

Mesrar Haytam1, Sadiki Abdelhamid1, Faleh Ali2 & Jamal Chaaouan2
1. Laboratoire L. G. R. N. Faculté des Sciences Dhar El Mahraz Fès
2. Laboratoire L. E. G. A. C. Faculté des Lettres Saïss-Fès

MOTS CLES : Erosion hydrique, PAP/CAR, PAP/CAR Tools, SIG, tendances, facteurs causaux.
La cartographie et l’estimation de l’érosion hydrique ainsi que la définition des tendances et des facteurs causaux au moyen des matrice croisée PAP/CAR basée sur les facteurs naturels (pente, couvert végétal et lithologie) a permis d’hierarchiser le bassin versant de l’oued Sahla en parcelle en fonction du degré d’état du risque érosif. La carte de l’approche prédictive fournit des informations sur l’état actuel de la dégradation des sols en se basant sur les degrés d’influence des différents facteurs qui contrôlent l’érosion hydrique. La carte fait ressortir cinq états, 25 % des terrains présentent une faible prédisposition à l’érosion hydrique, l’érosion notable représente 30 %, 18 % pour les terrains à érosion moyenne, Les états d’érosion élevées et extrêmes représentent 17 % et 10 % respectivement.

L’approche descriptive a montré que cette dégradation se manifeste par différents processus de l’érosion hydrique. On assiste à une perte de sol de différentes manières :

- L’érosion en nappe et le décapage. C’est une érosion qui est inaperçue mais qui est la plus dangereuse car elle emporte les particules nutritives essentielles pour le développement de la végétation (76 %).
- L’érosion en rigole et ravines qui si elles apparaissent en automne dans les sols labourés après chaque averse importante sont effacées par les labours (2 %) mais si elles apparaissent sur des terrains non exploitables évoluent généralement en formes plus importantes.
- L’érosion en ravins se fait au dépend des terrains de culture et peuvent évoluer en ravinement généralisé (11 %).
- Les Bad-lands représente une surface de 6 % apparaît généralement dans les terrains abandonnés.

La superposition de la cartographie prédictive et descriptive a permis de montrer les tendances globales de l’évolution superficielle des sols du bassin versant ainsi on a pu faire sortir la coincidence de certains états très dégradés avec des formes d’érosion spectaculaires et d’autres états plus stables avec des formes d’érosion mineurs ou carrément des zones stables. Elle montre aussi les tendances aggravantes pour certaines zones ou des tendances de régression de la dégradation pour d’autre. Le traitement et l’analyse de la base de données montre que 75 % des terrain du bassin versant de l’Oued Sahla présentent des tendances à la stabilisation, à la régression ou à la limitation de l’expansion spatiale du processus d’érosion, localiser généralement en amont du barrage.
Sahla, la classe des tendances localisée à l'expansion ou à l'intensification prennent le relai avec 16 % de la surface totale, situé surtout dans la partie à l'avale du barrage, les classes des Tendance généralisée à l'expansion ou à l'intensification et Tendance de la dégradation généralisée vers une situation irréversible ne dépassent pas les 8 %, éparpillé dans la partie avale du bassin versant de l'Oued Sahla.
La méthodologie proposée peut servir comme document d'aide à la décision qui peut à la fois minimiser le coût et le temps de réalisation des projets d'aménagement et de gestion de territoire.
- La carte des états érosifs peut donner une idée sur les zones noire nécessitant une intervention urgente.
- La carte des tendances permet rendre compte du devenir de la zone, ce qui veut dire qu'à l'intérieur du même état il y a un ordre de priorité dépendamment des tendances
- L'analyse et la définition des facteurs causaux, de leur interaction et de leur répartition permet de détecté sur quel facteur on va se focalisé pour rétablir l'équilibre à la zone concerné.
Devant les tendances menaçantes de dégradation qui pèsent sur les ressources naturelles et l'infrastructure du bassin et surtout sur le barrage de Sahla et par conséquent sur la qualité de vie des habitants de point de vue économique et social, il s'avère nécessaire d'intervenir pour lutter contre l'érosion selon une approche globale et novatrice qui permettra de mettre en interaction les différentes facteurs et concilier entre les besoins importants d'une population, qui ne cesse de s’accroître et les potentialités limitées des ressources naturelles qui s'appauvrissent du fait de leur surexploitation combinée à un mauvais usage.

CONTRIBUTION DES SIG À LA GESTION DES RISQUES GEOLOGIQUES LIÉS À L’ÉROSION DANS LA VILLE D’ABIDJAN: CAS DE LA COMMUNE D’ATTECOUBE

FOFANA Ibrahima
Chargé d'Etudes au Comité National de Télédétection et Information Géographique (CNTIG)

RESUME
La croissance démographique galopante des grandes agglomérations africaines s’accompagne bien souvent d’un phénomène de développement des bidonvilles ou quartiers précaires qui s’incrustent dans le tissu urbain.
Ce phénomène est accentué par :
- le coût prohibitif des terrains,
- la crise du logement marqué par l’absence de politique de construction de logements sociaux
- la forte paupérisation de la population (50% de la population vit en dessous du seuil de pauvreté selon le Document Stratégique de Réduction de la pauvreté)
Caractérisés par des constructions anarchiques au mépris des règles d’urbanisme et de schéma directeur de la ville, des espaces situés sous des lignes de haute tension, les flancs de collines, des zones inondables etc, sont progressivement bâtis.
Ce fait expose les populations aux risques de glissement de terrain et d’inondation lorsque surviennent les saisons de pluie.
ATTECOUBE, une des 10 communes de la ville d’Abidjan et cadre de cette étude est caractérisée par un relief vigoureux, un sol présentant un détachement très élevé et qui s’éponge difficilement entre deux averses, du fait de la prédominance de sols argileux sableux. Les effondrements de maisons y sont récurrents à chaque saison de pluie, occasionnant hélas des pertes en vies humaines.
Comment gérer au mieux ces risques d’éboulement de terrain et quelles mesures prendre lors de leurs survenus à l’aide d’outils nouveaux tels que la télédétection et les SIG ; telle est la problématique que nous essayons de traiter dans cette présentation en localisant les zones d’impact et d’élaborer des cartes d’aide à la décision.
MEASURING THE EFFECTS OF GULLY EROSION IN THE OLD IMO STATE OF NIGERIA: USING EMERGING TECHNOLOGIES

Josh. U. Ogbonna
Department of Geography and Planning, Abia State University, Uturu, NIGERIA

ABSTRACT

Gully erosion has assumed an alarming dimension in the South Eastern Nigeria especially in the Old Imo State which comprises Abia, Imo, part of Anambra and Ebonyi States. The size, number and the effects of these increases are based on speculative data partly because of lack of the technologies that can synoptically expose the various impacts or lack of the will by government to embark on census of gully erosions. This paper is an attempt to use the Geographical Information System (GIS) and Remote Sensing to measure the impacts of selected gully erosion from 1984 to 2008 and a 10 year predictive period (2008 - 2018). Based on this, eight thematic maps with multiple layers were created using ILWIS 3.3 software as digitizing platform, and ArcGIS 9.2 for split, buffering and scenario creation. The classification of the 2008 landsat image of the study area showed that 20% of the entire area is degraded. It was also observed that active gully erosion was within latitude 5° 06’N and latitude 5° 52’N and consistent with three soil types - rhodic ferrasols, dystric ferrasols and gleyic cambisols. Furthermore, measurable impact of soil erosion on selected roads, rivers and agricultural lands was determined which showed that as at 1984 Orlu, Ntueke and Mgbelu Umunnekwu erosion sites were 6.58km², 4.33km², and 22.69km² respectively, but by 2008, these gully sites became 31.01km², 34.83km² and 29.55km² respectively, with an average annual erosion growth rate of 820m. This work predicted that by 2018, these sites will be 34.07km², 48.96km², and 38.75km² respectively. This study, therefore recommends an adaptation of GIS/SRS-induced procedures in impact studies on erosion as these portrayed erosion effects more vividly than other methods.

HYDROLOGICAL RISK ANALYSIS WITH OPTICAL REMOTE SENSING, CHEMICAL AND ISOTOPIC DATA AND HYDROGEOLOGICAL MODELLING: CASE IN THE FLOODING AREA OF DAKAR (SENEGAL)

Ousmane Coly DIOUF1, Seynabou Cissé FAYE1, Ndeye Maguette DIENG1, Serigne FAYE1 & Stefan WOHNLICh2.

1Department of Geology, Faculty of Science and Technology, University Cheikh Anta Diop (UCAD) Dakar
2Ruhr University of Bochum, Department of Applied Geology, Universitaets str. 150, D-44801 Bochum, Germany

KEYWORDS: Floods, Remote sensing, isotope chemistry, hydrogeological modeling.

ABSTRACT

The present study was undertaken in order to use remote sensing, geographic information systems, isotopic data and hydrogeological modelling to analyze and map flood, determine their causes but also propose solutions to fight against the floods.

The use of optical remote sensing with very high resolution has a thematic mapping including urban dynamics and the extension of floods from 1989 to 2009. Maps of the urban dynamics have to see the evolution of land use. Areas affected by flooding is located in the departments of Guédiawaye and Pikine. On the 22 district municipalities that have both; 17 were affected by the floods in 2005. In general, these floods are the result of factors such as urbanization combined with spontaneous occupation of lowland flooding, rainfall accumulations of very important events and rising groundwater level caused by a significant decrease in its pumping rate. We must also add the induced recharge caused by the scarcity of the lack of a wastewater and stormwater drainage.
Stable isotopes samples in rainwater and groundwater allowed the establishment a recharge map in 2008. This map shows high recharge in the basin of Thiaroye. All these vectors data are used for hydrogeological modelling of the groundwater using the FEFLOW software. The predictive simulations of exploitation of the groundwater as a solution to fight against floods at rates of 19 000 m$^3$.j$^{-1}$ and 9 000 m$^3$.j$^{-1}$ respectively for infrabasaltique and Thiaroye aquifer cause a decline in groundwater levels of 2 m Pz7 (Guédiawaye); 1.72 m Pz4 (Pikine) 1.45 m Pz21 (Yeumbeul). These results show that the pumping is an effective way to fold the piezometric levels.

HOW TO COPE WITH COASTAL EROSION IN MAURITANIA? GEOINFORMATION AND CARTOGRAPHY SOLUTIONS

Sidi Cheikh Mohamed Ahmed$^1$ & Ould Lehlou Sidi Mohamed$^2$

$^1$ Chercheur en Systèmes d’Information Géographique, Parc National du Banc d’Arguin, Nouakchott, Mauritanie

$^2$ Directeur des Aires Protégées et du Littoral (DAPL), Ministère Délégué auprès du Premier Ministre, chargé de l’Environnement et du Développement Durable, Nouakchott-Mauritanie

RESUME

L’érosion côtière constitue un énorme défi non seulement pour les décideurs mauritaniens, mais aussi pour toute la région ouest africaine. Il n’est plus à démontrer les pertes économiques considérables engendrées par le recul des plages partout en Afrique et surtout sur l’avenir des activités économiques dans les zones côtières. Ici en Mauritanie, les autorités publiques sont conscientes du danger que présente l’érosion et pour cela elles ont commencé à réfléchir sur la mise en place d’une stratégie nationale pour minimiser l’impact négatif de ce phénomène. Or, il y a des contraintes multiformes qui entravent la capacité du Ministère de l’environnement, l’organe national chargé de cette question, de faire face à ces risques. Parmi les obstacles rencontrés on peut citer le manque d’informations fiables sur l’emprise géographiques des zones touchées, le degré de vulnérabilité de chaque site ainsi que sur la priorité d’intervention par rapport à la multitude des brèches. Devant l’embarra de choix entre les types et emplacement des travaux de colmatage, la Direction du littoral au Ministère de l’environnement a fait recours à l’utilisation de l’imagerie satellitaire de très haute résolution spatiale. C’est ainsi que des analyses multicritères ont été appliqués en faisant intervenir l’imagerie QuickBird comme source d’information ce qui a débouché sur l’identification de deux sites prioritaires qui subissent une dégradation accélérée. Les travaux cartographiques ont été réalisés avec l’utilisation à la fois des logiciels SIG open source comme Q-GIS ainsi que Shareware comme ArcGIS et Mapinfo. Plusieurs cadres du Ministère ont participé dans cette opération par le prélèvement des coordonnées GPS des points échantillonnés et par l’intégration de données collectées dans le SIG mis en place dans ce cadre. Les résultats de ce travail ont montré tout l’intérêt d’utiliser la technologie d’acquisition de la géoinformation pour affiner la prise de décision. Les employés du Ministère ont reçu une formation pratique sur l’utilisation du SIG pour assurer la durabilité du fonctionnement du SIG conçu pour une meilleure gestion des zones littorales en Mauritanie.

ANALYSIS OF GULLY EROSION IN BENIN-CITY OF EDO STATE, NIGERIA

Aiyede, P.E$^1$ & Odunuga S.$^1$

$^1$Department of Geography, University of Lagos, Nigeria.

ABSTRACT

Erosion plays a significant role in the degradation of the environment with grave implications for the quality of livelihoods and sustainability of land resources. This paper used Remote Sensing techniques (high resolution
Ikonos satellite imagery) for gully erosion analysis at watershed level. It analyses pattern of erosion and level of soil degradation of some selected gullies in Benin City, Nigeria by investigating bank slumping and sliding in erosion gullies, determining the extent of damage, its effect and impacts on the people and environment in the study area. A combination of data layers from hydrology, hydrogeology, geology, geomorphology, soils, meteorology and land use representing human activities were used to developed erosion risk index and severity rating for the study area. The preliminary results of the morphological characteristics derived from combination of image interpretation and field exercise of the three sites (Queen Ede, Ekenwa and University of Benin gully sites) in Benin-City is shown in table1.

<table>
<thead>
<tr>
<th>Erosion Site</th>
<th>Catchment Area (ha)</th>
<th>Length (M)</th>
<th>Average Depth (M)</th>
<th>Width (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIBEN</td>
<td>300</td>
<td>180</td>
<td>2.8</td>
<td>6.0</td>
</tr>
<tr>
<td>Queen Ede</td>
<td>250</td>
<td>240</td>
<td>2.1</td>
<td>7.0</td>
</tr>
<tr>
<td>Ekenwa</td>
<td>280</td>
<td>220</td>
<td>2.6</td>
<td>7.5</td>
</tr>
</tbody>
</table>

The results of erosion site identification reveals that gully in Benin-City do not follow any specific pattern rather they are scattered all over the town. However, the menace of gulling have degraded several parts of the city creating badlands, destroying structures and constituting nuisance to the environment as shown in plate1. The trend analysis from composite imageries shows that on the average the gullies bank slumping and sliding is on the average of 0.3m per annum.

Plate1: Degraded land at University of Benin Erosion Site

The results of erosion index and severity rating shows that Benin-City is highly susceptible to erosion and that a watershed approach that combines engineering and biological approaches at watershed level will be needed to tackle the problem of erosion in Benin-City.

**TELEDETECTION ET SIG POUR LA CARTOGRAPHIE DES ZONES VULNERABLES À L’INONDATION : APPLICATION À LA ZONE BALNEAIRE DE SASSANDRA (SUD-OUEST DE LA CÔTE D’IVOIRE)**

Mahaman Bachir SALÈY¹, ², Jean Homian DANUMAH², Vano Mathunaise SOROKOBY¹, Fernand Koffi KOUAME¹, ², Boyossoro Hélène KOUADIO²; Valère Eric DJAGOUA¹, Monique BERNIER³ & Stéphane Patrick DENEAN²

1-Centre Universitaire de Recherche et d’Application en Télédétection (CURAT), Côte d’Ivoire.
2-Laboratoire des Sciences et Techniques de l’Eau et de l’Environnement (LSTEE), Côte d’Ivoire.
3-Institut National de la Recherche Scientifique, Centre-Eau, Terre et Environnement-(Canada);

**MOTS CLES :** SIG, Analyse Multicritère, Inondation, Télédétection, Sassandra, Côte d’Ivoire

**RESUME**

L’objet de cet article est l’identification et la cartographie des zones vulnérables à l’inondation. Il est basé sur l’intégration dans un système d’information géographique (SIG), de données interprétées à partir d’images TM de
Landsat, d’un modèle numérique d’altitude (MNA) et des données hydroclimatiques. L’approche méthodologique comprend : 1) l’élaboration de la carte de pente à partir du MNA, 2) le traitement numérique des images TM du capteur Landsat, 3) la cartographie thématique et l’intégration des données (cartes thématiques issues des traitements d’images, MNA, données exogènes) et analyse spatiale dans un SIG. Les principaux critères de la vulnérabilité à l’inondation considérés sont : la pluviosité, la couverture du sol, le réseau hydrographique, la pente du terrain, la fracturation et la démographie. L’analyse multicritère réalisée dans un SIG a permis d’élaborer la carte de sensibilité (pluviométrie, drainage, fracturation et la pente) ainsi que celle de la vulnérabilité du terrain à l’inondation (population, occupation du sol). Cette carte comporte quatre classes allant de la faible vulnérabilité à la très forte vulnérabilité à l’inondation. Les zones à fort et très fort risque couvrent 80 % du bassin versant de la Davo et sont situées dans la partie centrale et sud (Sassandra) de la Davo.

Cette carte de vulnérabilité à l’inondation trouve son importance dans le rôle qu’elle peut jouer dans la gestion intégrée des ressources naturelles et de l’environnement urbain, mais également, dans l’aide et à la prise de décision sur le plan sécuritaire.

**ASSESSMENT AND MONITORING OF DROUGHT IN NIGERIA USING REMOTE SENSING**

Adedeji^1^, Oluwatola I & Adepoju^2^, Adewale

Africa Regional Center for Space Science and Technology Education in English (ARCSSTEE)

**ABSTRACT**

Due to climate change and variability, drought has become a recurrent phenomenon in several countries across the globe most especially in the sub Saharan Africa. Drought is a random, low profile natural disaster that evolves slowly which requires consistent and effective monitoring and assessment. Frequent and severe drought has become one of the most important natural disasters in sub-Saharan Africa, especially in Nigeria, a highly populated country in West Africa sub region.

The primary goal of this study is to utilize AVHRR time series satellite data for 1981-2000 to develop a reporting system for the assessment and monitoring of historical drought development in Nigeria at different scales from the country level to the level of individual states using the Vegetation Condition Index (VCI). The study emphasized on the use of Geographic Information System, a rapidly developing decision making tool for spatially referenced problems and Remote sensing technology.

This research shows that there was drought in Nigeria all through the period of the study and affects 23,901 square kilometres which is about 25% of the total land area. Drought has been more persistent in the Northern part most especially the North Eastern parts of Nigeria, this was ascertained, with the dry up of Lake Chad, at the border of this region. The drought had a wider spread in 1994 affecting many states in Nigeria, including the southern part of the country.

Considering the spread and frequency of droughts in Nigeria, drought monitoring using remote sensing techniques could play an invaluable role for drought preparedness and food security.

**CHANGE DETECTION AND VEGETATION INDICES OF AMURUM FOREST RESERVE BY MEANS OF REMOTELY SENSED IMAGERY, JOS PLATEAU STATE, NIGERIA**

Gajere E.N^1^, Tiseer A.W^2^, & Karau S.D.^1^

National Centre for remote Sensing Jos Nigeria, Ahmadu Bello University Zaria Nigeria.

**ABSTRACT**

Amurum Forest Reserve was designated as a forest Reserve and an Important Bird Area because it holds two of the four endemic bird species in Nigeria. It is surrounded by four villages which depend solely on the Reserve for firewood and therefore a lot of deforestation has taken place in the past years.
In this study, archived Satellite imagery from Landsat TM and ETM were obtained which encompassed 5 time steps of 1978, 1986, 1991, 2001 and 2008 to determine changes in vegetation structure and indices of the Amurum Forest Reserve which was designated as a protected area in June 1998 and were processed. The forest was divided into three habitat types (Gallery Forest, Scrub Savannah and Rocky Outcrop). The different spectral channels as well as several vegetation indices (e.g. Normalised Differential Vegetation Index (NDVI),) were evaluated concerning their suitability.

The result showed that there was a significant difference in the vegetation index between the 5 time series (P<0.05). There was a significant decrease in the gallery forest and savannah between 1978 and 1986, 1986 and 1991, 1991 and 2001 but there was a significant increase in the gallery forest between 2001 and 2008.

In conclusion the result showed that the presence of the A.P. Leventis Ornithological Research institute in the reserve has helped in the restoration of the depleted reserve into a forest.

**DESIGN OF A PREDICTIVE DROUGHT RELATED LIVESTOCK MORTALITY INDEX FROM REMOTE SENSED DATA FOR ARID AND SEMI-ARID LANDS**

Marie Lang¹, Bernard Tychon¹, Isabelle Piccard ² & Andrew Mude³

¹ University of Liège, Department of Environmental Sciences and Management, Belgium,
² Flemish Institute for Technological Research (VITO), Belgium
³ International Livestock Research Institute (ILRI), Kenya

**ABSTRACT**

In Arid and Semi Arid Lands, poor households rely mostly on livestock as a source of livelihood (Mude et al., 2010). During drier periods, drought is the major cause of herd losses, which occur as covariate shocks affecting many households at once (Chantarat et al., 2009). In those regions, characterized by rain-fed agriculture and livestock based economy, people are highly vulnerable to extreme weather events (UN Department of Economic and Social Affairs, 2007). It is therefore vital for those households to be able to protect their assets and income with suitable risk transfer mechanisms and insurance programs.

Index-based insurance is best suited to fit this situation and the need of rural poor populations. In that case, payments are made when an objectively measured index reaches a pre-defined strike level within a pre-defined area and spatiotemporal coverage (Skees et al., 2007; Chantara et al., 2009). Pilots programs have already shown the feasibility and suitability of such risk transfer products in the case of weather risks in poor rural areas (UN Department of Economic and Social Affairs, 2007).

This study is based on the International Livestock Research Institute (ILRI, Nairobi, Kenya) Index-Based Livestock Insurance project (IBLI) (http://livestockinsurance.wordpress.com/). In the contract, a predicted mortality index was designed as a combination of cumulated values of standardized NDVI data over the coverage season. The main advantage of this contract is that it relies on easily and freely available NDVI data (MODIS, spatial resolution of 250 m per pixel).

The aim of this study is to design a general drought related livestock mortality index that could be used for livestock insurance or other livestock and forage availability studies in arid or semi-arid regions. To do so, we will first consider the same study area as for the IBLI contract and consider different improvements that could be applied to the index. In a second part of our research project, we will work on the generalization of the index.

The improvements studied here can be divided into two categories: strictly remote sensing related and combining remote sensed and proxy data. Strictly remote sensing improvements include:

- Exploitation of data from different sensors (MODIS, SPOT-VEGETATION, AVHRR ...):

The use of different sensors will first allow us to investigate the influence of the image resolution on the mortality index. The questions that will be studied are: Is it possible to improve the livestock mortality
predictive model by using higher resolution and until which resolution should we go? Can we obtain additional information by combining images with different resolutions?

Calibration of the index on different sources of data will also allow the index user to use one of the sensors as backup in case of breakdown and therefore assure the continuity of the program, which is a crucial aspect of an operational tool.

- Image quality:

  We will investigate the impact of noise and anomalies (clouds, missing values ...) in low-resolution images. We will study the question whether or not corrections could improve the quality of the index.

- Use of additional Earth Observation products:

  In this task, we will study the possibility to improve the quality of the index by the use of other remote sensed biomass indicators, such as DMP, fAPAR or LAI as well as the contribution of other agrometeorological drought indicators.

The drought related livestock mortality index will also be ameliorated by adding information from mixed sources (remote sensed and proxy data). This additional information includes field characteristics that can have an impact on drought related mortality, for example the availability and seasonal dynamic of water points. The potential of meteorological data (rainfall amount and distribution ...) will also be investigated in this study. These data could be used directly or indirectly through meteorological and agrometeorological drought indicators. While using this information to determine the best index, we will focus on maximizing the use of remote sensed data and minimizing the field work in order to make the operation time and cost effective, which is a crucial characteristic of any operational project (insurance contract, Early Warning System ...).


WILDFIRES IN MOZAMBIQUE: AN ANALYSIS OF 2002-2011 SATELLITE-DERIVED HISTORICAL DATA

Massimiliano Lorenzini¹, Joaquim Macuacua² & Danilo Cunhete³

¹ Avenida Albert Luthuli, 1128, 1o andar, Maputo, Mozambique

² Avenida Josina Machel 573 CP 288, Maputo, Mozambique Lda. Ministério de Agricultura, Direcção Nacional de Terras e Florestas

ABSTRACT

Within the framework of the “Wildfires Monitoring and Early Warning System”, SAMOQUE1, preparatory activities, the author built up a data collection of more than 900.000 wildfires observations spanning the 2002-2011 decade. The information is based on the ACTIVE FIRES dataset produced and distributed by UMD2/NASA3.
ACTIVE FIRES are derived from the processing of MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data at 500 meters resolution. Results are presented highlighting

1. Spatial and temporal patterns in wildfires distribution.

   **Spatially**, Mozambique can be divided in three regions: southern (Maputo, Gaza, Inhambane provinces) with the lowest rate of wildfires, the northern region (Cabo Delgado, Niassa and Tete provinces) with a medium rate and the central region (Sofala, Manica, Zambezia and Nampula provinces) with the highest rate.

   **Temporally**, we observed a rapid increase in wildfires occurrences in the last two years 2010-2011, while the overall monthly distribution has the following spatial pattern: wildfires in the southern region start taking place in April/May while in the rest of the country they start in June/July with the peak in the months of August and September.

2. Wildfires “hotspots”, identified through density analysis at different scales and for different years. The poster (reduced version in this document) shows three different point density maps calibrated to bandwidths resembling average administrative unit (Provinces, Districts and “postos administrativos”) size.

3. Shorter bandwidth “point density maps” allow an in-depth analysis of the demographic pressure on natural resources showing evidences in the linkage between wildfires distribution and presence of infrastructures like settlements and road network. Examples are presented about this relationship.

---

1 Sistema de Alerta e Monitoria das Queimadas
2 University of Maryland
2 National Aeronautics and Space Administration

4. Finally we show how historical data are going to be used by the Ministry of Agriculture as one of the key elements in the identification of critical areas in the daily “early warning” bulletins to be published starting May 2012.
L’ANALYSE SPATIALE MULTICRITERE APPLIQUEE A L’EVALUATION DE LA VULNERABILITE GLOBALE AUX INONDATIONS DANS LA PLAINE DU GHARB (MAROC)

A.Er-raji¹ & A. Bouidia²
1. Centre Royal de Télédétection Spatiale, Maroc
2. Centre Régional Africain des Sciences et Technologies de l'Espace en Langue Française

MOTS CLÉS : analyse multicritère, inondation, vulnérabilité, télédétection.

RESUME
Située au Nord-Ouest du pays, la région de la plaine du Gharb bénéficie de précipitations abondantes qui dépassent largement la moyenne enregistrée au niveau national. Le relief de la région est très plat et il est au-dessous du niveau de la mer dans certains compartiments. Ce contexte expose la région à de nombreux problèmes environnementaux, le plus préoccupant est celui des inondations qui résultent de l'action combinée de plusieurs facteurs. En effet, les fortes pluies, la stagnation des eaux pluviales dans de larges surfaces à cause des faibles pentes et certaines pratiques anthropiques liées à l'utilisation des sols provoquent et accentuent les effets des inondations qui deviennent de plus en plus récurrentes à cause des changements climatiques. En vue de réduire l’impact de cet aléa, nous estimons qu’une étude de la vulnérabilité s'impose avec plus d’acuité. D’ailleurs, la gestion du risque qui a longtemps porté sur le contrôle des aléas s’oriente de plus en plus vers une tentative de réduction de la vulnérabilité. L’approche que nous avons préconisée pour cette étude repose sur l’intégration des données descriptives du milieu naturel dans une méthode d’analyse spatiale multicritère. Ces données ont été extraites à partir des images satellitaires multi-capteurs puis préparées à l’aide des fonctionnalités SIG pour leur...
intégration dans le modèle utilisé (SMCE). L’étude réalisée, propose ainsi une méthode d’évaluation de la vulnérabilité basée sur les concepts de l’analyse spatiale multicritère adaptée ici à la région du Gharb et à l’aléa inondation. La carte de l’indice de vulnérabilité composite (globale) résulte de l’intégration de l’ensemble des indices représentant les différents enjeux et considérant le pouvoir de résilience dans la région.

**DEVELOPPEMENT D’UN SIG-WEB POUR LE SUIVI ET LA GESTION DES EVENEMENTS INONDABLES DANS LA PLAINE DU GHARB : APPORT DE L’IMAGERIE SATELLITAIRE OPTIQUE ET RADAR A LA CARTOGRAPHIE RAPIDE DES INONDATIONS**

A. Er-Raji, M. A. Mitach & O. El Mamoussi
1. Centre Royal de Télédétectio Spatiale, Maroc
2. Faculté des Sciences et Techniques de Tanger, Maroc

**MOTS-CLES**: inondations, cartographie rapide, SIG-Web.

**RESUME**
Il n’est pas contestable que la région du Gharb Chrarda Beni Hsen est l’une des régions économiques les plus importantes du Maroc. Cependant, son développement socio-économique futur reste centré sur la réduction de l’impact dévastateur des inondations qui deviennent de plus en plus récurrentes ces dernières décennies entant qu’expression locale des impacts des changements climatiques globaux. Nous estimons que les actions de réduction de l’impact de ces inondations passent inévitablement à travers la maîtrise de plusieurs niveaux du risque d’inondation dans la région. Les actions les plus urgentes doivent donner plus d’importances à la réduction de la vulnérabilité et à la gestion de la période de crise. La solution que nous proposons dans le cadre de ce travail nous semble incontournable pour contribuer à cet objectif à travers une meilleure organisation des interventions sur le terrain par la production rapide d’informations sur les événements inondables et la mise à disposition de ces informations aux intervenants au moment opportun. Notre contribution consiste en la mise en place d’une base de données à jour sur la région, le développement de modèles de traitements pour la cartographie rapide des inondations à partir des images optiques et radar et le développement d’un SIG-Web permettant l’accès à distance à ces informations. Cet outil d’aide à la décision pour la gestion des périodes de crise faciliterait davantage l’action des différents opérateurs sur le terrain pour optimiser les efforts et mieux orienter les interventions. D’ailleurs, l’efficacité de ces actions ne peut être atteinte sans le recourt aux nouvelles technologies de l’information pour une meilleure caractérisation du milieu, de l’aléa, des enjeux, ainsi que l’organisation des interventions.

**CARTOGRAPHIE DES RISQUES D’EROSION HYDRIQUE AUTOUR DU BARRAGE HASSAN-I (MAROC): APPROCHE GEOMATIQUE**

Soufiane Maimouni, Abderrazak El-Harti, Abderrazak Bannari, El-Mostafa Bachaoui & Abderrahman El-Ghmari
1 Equipe de Télédétection et des SIG appliqués aux Géosciences et à l’Environnement, Faculté des Sciences et Techniques, Béni-Mellal, Maroc.
2 Laboratoire de télédétection et de géomatique de l’environnement, département de géographie, Université d’Ottawa, 60 rue de l’Université, Ottawa (Ontario), Canada K1N 6N5.

**MOTS CLES**: Erosion hydrique, Télédétection, SIG, Indices spectraux, SAM, AMC, Haut Atlas marocain.

**RESUME**
Le bassin Méditerranéen est une zone de transition entre les systèmes climatiques humides du Nord et les systèmes secs et chauds du Sud. Comme une région de rencontre de ces différents courants climatiques, le Maroc pays au Nord-Ouest de l’Afrique vit depuis les 30 dernières années l’épisode la plus sec de son histoire contemporaine. Dans la plus part de ses régions, l’action conjointe des variations climatiques (températures élevées et déficit hydrique) et des activités humaines, et de leurs rétroactions sur le milieu engendre des écosystèmes vulnérables face aux risques d’érosion hydrique. Cette dernière réduit le potentiel de production des terres agricoles et présente un impact sur l’envasement des barrages. Face à cette situation, des outils ont été développés permettant l’identification et l’analyse des processus de la dégradation des sols afin de promouvoir un développement durable.


A la lumière des résultats obtenus et par référence à la réalité terrain, nous constatons que les trois approches considérées mettent en évidence leurs potentiels pour la cartographie de la dégradation des sols de façons significatives. Toutefois, l’approche des indices spectraux se distingue par sa simplicité et sa rapidité d’exploitation. Par contre, la performance des approches du SAM et de l’AMC sont étroitement liées, respectivement, au bon choix des signatures spectrales de références et à la sélection et à la pondération des critères pris en compte lors de la modélisation; ce qui rend les procédures de ces deux méthodes relativement complexes et longues.

L’ANALYSE DE GRILLE COMME ALTERNATIVE POUR LA CARTE DE VULNERABILITE EN REGION SEMI ARIDE ; CAS DE LA VILLE DE LAGHOUAT (ALGERIE)

Abdellaoui A.1, Marmi R.2 et Boughalem M.3
1. Université Paris Est Créteil, Lab’Urba France
2. Université de Constantine Algérie
3. Université de Ain Témouchent Algérie

MOTS CLES: risques urbains, Laghouat (Algérie), découpage grille, vulnérabilité, zone semi aride

RESUME

Il n’y a pas d’aléas naturels spécifiquement urbains en zones habitées caractérisées justement par la présence du facteur anthropique qui, par ses activités, par la densité, par les constructions même expose au risque, à la fois les populations, les installations et le paysage. Le passage de l’état d’aléas à celui de risque se fait alors de façon plus rapide et plus étendue à cause du caractère multi et interdisciplinaire du type génétique des aléas : souvent les aléas que l’on appelle naturels ont aussi une cause anthropique (Grecu, 2009 a, b). Dans la littérature le risque urbain, ou risque lié au territoire de la ville, classé en risques naturels, risques industriels et technogènes, risques diffus (J. Dubois-Maury, C. Chaline, 2002 ; Grecu, 2009a). Le présent travail a pour objectif d’analyser, à partir de l’imagerie satellitale et l’observation terrain, la dynamique globale de la ville de Laghouat et les facteurs de vulnérabilité afin d’élaborer la carte de la vulnérabilité à deux niveaux d’appréhension :
1. Un premier niveau global de l’ensemble des vulnérabilités à une échelle de 1/5000ieme ;
2. Un second niveau plus ciblé à la fois sur la thématique et sur l'espace.

HYPERSPECTRAL IMAGE ANALYSIS OF DIFFERENT JURASSIC LITHOLOGIES AND CARBONATE MINERAL MAPPING IN THE AGADIR BASIN, WESTERN HIGH ATLAS OF MOROCCO;

Brahim Ouajhain¹, Kamal Labbassi¹, Patrick Launeau², Rachid Baissa¹², Anne Gaudin² and Haddou Jabour³

¹Marine Geoscience Laboratory /LGMSS_URAC 45, Faculty Of Science, Box 20, 24 000 EL Jadida, Morocco
²Laboratoire de Planétologie & Géodynamique/UMR-CNRS 6112, Université de Nantes, Nantes, France.
³ONHYM, 5, Avenue My Hassan - B.P 99. Rabat - 10050 - Maroc

ABSTRACT

Hyperspectral analysis of the Agadir Basin limestones was conducted since 2007 primarily to evaluate and assess the applicability of this approach for sedimentary formations and diagenetic studies, especially in carbonates and hydroxyl/water-bearing material.

Hyperspectral imaging is a proven technology used for identifying and mapping minerals based on their reflectance. Hyspex allows direct identification and detailed analysis of carbonate minerals such as calcite, dolomite, ankerite and siderite in the visible/near infrared (VNIR); clays and sulfates, and other minerals in the short wave infrared (SWIR); The unique capability of imaging spectrometry to produce detailed maps of the spatial distribution of specific minerals (carbonates in this case), mineral assemblages, and mineral variability on the Agadir basin during the Jurassic makes it an ideal tool for enhanced geomorphic mapping and essentially the quantification of sedimentary and diagenetic geobodies.

The quantification of diagenetic and dolomitized Jurassic geobodies is of major importance for reefal reservoir modeling during the Oxfordian. For this purpose, representative minerals for the all Jurassic formations and rock quantities from different facies and environments are required, which are some time very difficult to collect from inaccessible outcrop. The quantification and evaluation of the spatial distribution of different facies and diagenetic products will be possible if hyperspectral and “Lidar scanning” are combined correctly;
REAL-TIME REMOTE SENSING FOR DISASTER LIFE CYCLE MANAGEMENT: THE MEDITERRANEAN DIALOGUE EARTH OBSERVATORY (MDEO)

Gilbert Rochon 1, Chaker El Amrani 2, Tajjedine Rachidi 3, Gulay Altay 4, Tarek el Ghazawi 5, Okan Ersoy 6, Joseph Quansah 1, Souleymane Fall 1, Chadia Affane Aji 1, Gamal Salah El Afandi 1

1. Tuskegee University, 308 Kresge Center, Tuskegee, Alabama, USA
2. Abdelmalek Essaadi U., Morocco
3. Al Akawayn U., Morocco
4. Bogazici U., Turkey
5. George Washington U., USA
6. Purdue U., USA

ABSTRACT
Biogenic and anthropogenic disasters present humanitarian, environmental, economic and potentially political crises, particularly when they occur in resource deprived regions and developing economies. The signatory countries to the International Chapter "Space and Major Disasters" realized that access to real-time data from earth observing satellites represents a useful adjunct to rapid response teams in the event of a declared disaster. The authors demonstrate the utility of such real-time remote sensing from multiple space-borne platforms, as well as from near-real-time data products, to address the full life cycle of disasters, including emergency preparedness, advance mitigation, early warning, search and rescue, damage assessment and post-disaster societal, environmental and economic recovery. A training facility based in Morocco, designed to serve the regional trained human resource need for disaster managers is presented, specifically the Mediterranean Dialogue Earth Observatory (MDEO). This facility, which has been funded through the Science for Peace program of North Atlantic Treaty Organization, is being established in collaboration with universities in the USA, Turkey and Morocco.

DEVELOPMENT OF TANZANIA FOOD SECURITY EARLY WARNING SYSTEM (TFEWS)

M. Hagai 1

1. Ardhi university

KEYWORDS: Food Security, Food Security Information and Early Warning Systems, Food Crops GIS Data Layers, Overlaying, Food Self Sufficient Ratio

ABSTRACT
The practice of food security assessment in Tanzania is based on use of food crops production data surveys of a preceding seasonal year with agro-meteorological analyses based on estimated vegetation status as reflected from NDVI computed from NOAA satellite images. Food security assessment essentially is a prediction of food availability in predefined future time framework. It helps to establish availability or deficiency of food, thereby facilitating planning and implementation of strategies to mitigate the problem of hunger. The practice of food security assessment in Tanzania, has following shortcomings: the results of prediction are unreliable due to use of coarse meteorological data, it is inefficient as it takes a lot of time to do data compilation and analysis, it is difficult and relatively expensive as it involves physical visiting of villages, districts and regions by agricultural officers to collect food crops production data. The above shortcomings can be reduced by adoption of GIS Techniques.

This paper is reporting on a research conducted to model the process of food security assessment using Geographic Information Systems (GIS) tools, it is based on representing data pertaining to pillars of food security which are food availability, food accessibility and food utilization/nutritional capacity in form of GIS layers and integrating them. The collected food security pillar data were firstly transformed into respective point layers and secondly down scaled through re-sampling and interpolation by the Inverse Distance Method creating 30 m by 30
m pixel size raster layers. Resulting layers were then integrated through logical overlaying with a population layer, creating a Food Self Sufficient Ratio layer which was classified to form a Food Security Map for Tanzania.

It is being concluded that application of GIS modeling approach is relatively faster and convenient than statistical manual methods, food security Information ought to be executed readily, so as to facilitate evidenced-based understanding of food imbalances, thereby guiding administrators in decision making with regard to designing of equitable methods of surplus food distribution to the needy or to local and/or lower levels.

---

**LA POLLUTION DE L’EAU ET SES CONSEQUENCES SUR LA SANTE PUBLIQUE DANS LA REGION DE Malkieh (Dérik), Syrie (1975-2005)**

Ahmad Abdul Karim 1, Hélène Geroyannis 2 Rachid Ragala 1

1. Ecole des Hautes Etudes en Sciences Sociales, CAMS-UMR8557, Syrie
2. Université Paris Sorbonne, CAMS-UMR8557, France

**KEYWORDS:** santé publique, pollution, environnement, SIG, télédétection, analyse diachronique

**ABSTRACT**

La pollution de l’eau a un impact direct sur la santé publique. Notre objectif est de mettre en évidence les liens de causes à effets entre les changements environnementaux et la santé de la population en Syrie du Nord-Est au cours des 3 dernières décennies, afin d’envisager une possible amélioration de la situation hydrosanitaire.

Nous étudions les interrelations entre qualité de l’eau et niveau de santé publique à partir de l’analyse de la gestion des ressources hydriques. La méthodologie mise en œuvre concerne trois domaines :

- une analyse critique des données recueillies dans les secteurs de l’environnement et de la santé ;
- un Système d’Information Géographique (SIG), en mesure de traiter les phénomènes spatiaux ;
- une analyse du paysage à l’aide de données de télédétection spatiale.

L’association d’une série d’images satellites avec des relevés de terrain a permis d’apprêhender l’espace selon différentes échelles et dates, tout en soulignant les effets des changements géo-environnementaux sur les ressources en eau en termes de quantité et de qualité. Ainsi, ont été mis en évidence les effets de différents facteurs sur la ressource, la pollution et, par voie de conséquence, sur la santé : fortes variabilités climatiques, équilibre hydrologique naturel des eaux du Tigre, gestion agricole de l’irrigation.

La zone d’étude est la vallée du Tigre, située dans la partie supérieure de la Mésopotamie, entre les latitudes 35°43′12″ et 37°22′30″ N, et les longitudes 41°36′57″ et 42°28′48″ E, d’une superficie de (1245 km²).
APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR COMPARATIVE STUDIES ON THE DISTRIBUTION OF PRIMARY HEALTH CARE CENTRES IN UGHELLI NORTH, UGHELLI SOUTH AND WARRI SOUTH LOCAL GOVERNMENT AREAS OF DELTA STATE, NIGERIA

Agaja S.A.¹, Unuoh K.²

1. Industrial Safety and Environmental Technology, Petroleum Training Institute P.M.B 20, Effurun,
2. Department of Geography, University of Ibadan, Ibadan, kunuoh@yahoo.com

KEYWORDS: Ughelli North LGA, Ughelli South LGA, Warri South LGA, Primary Health Centre, Germain GPS, Multivariate Analysis

ABSTRACT
The mapping of primary health care centres in Ughelli North, Ughelli South and Warri South Local Government Areas (LGA) of Delta State was carried out. The objective is to provide Geo-spatial information about the distribution and accessibility of the Primary Health Care Centres in the Local Government Areas. Germain GPS was used to capture the Co-ordinates of the Health Centres which was analysed using Arc Map 9.3 (ESRI) GIS software. The multivariate analysis showed that the nearest neighbour value for Warri South Local Government Rn=0.665341 which imply a clustered pattern of distribution. For Ughelli North and South LGAs Rn=0.9991144 and Rn=0.9599 respectively. This results showed randomed distribution rather than clustered. The importance of primary health care centres to the grass root dwellers are discussed.

RAPID ASSESSMENT OF FOOD SECURITY IN SUB-SAHARAN AFRICA

Amos Kabo-bah¹, Justice O. Odoi², Chenai E. Madamombe³, Donald T. Rwasoka⁴, Webster Gumindoga⁵

1. Green WaterHut, Box UP913, KNUST, Ghana,
2. Environmental Specialist, Agency for International Development, Ghana
3. Digby Wells Environmental, Fern Isle, South Africa
4. Upper Manyame Subcatchment Council, Zimbabwe
5. University of Zimbabwe, Dept of Civil Engineering, Zimbabwe

KEYWORDS: Food security, Maplecroft, rainfall, landuse, Sub-Saharan Africa

ABSTRACT
Over the years, there has been considerable progress towards global reduction of hunger and poverty. However, the progress in Sub-Saharan Africa has been quite limited. About a third of the African populations faces widespread hunger and chronic malnutrition and hence exposed to persistent threat of food crisis and famine. In most cases, the most affected are the rural livelihoods that depend heavily on rain-fed agriculture. Therefore, food security continues to be a fundamental problem across Africa. Regardless of the economic and political disturbances which sometimes worsen the availability and accessibility to food, other factors such as reliable information at country-based level has often been a challenge also. This research develops a rapid assessment food security index for Sub-Saharan Africa using rainfall and land-use change. Rainfall maps are based on derived products of Tropical Applications of Meteorology using Satellite (TAMSAT). These indices in the form of maps are done for the years 2008 - 2010. These maps
were further evaluated with Maplecroft’s food security indices for the same period. The evaluation shows the rapid assessment provided in this research provide appropriate results and presents an easier framework for country based planners, and decision makers to replicate this method in case study of Ghana and Zimbabwe.

**EVALUATION DES POTENTIALES HYDROGEOLOGIQUES DANS LE SECTEUR AURIFERE DE SABODALA ET ENVIRONS (SENEGAL): APPROCHE PAR TELEDETECTION ET SIG**

Mall, I., Faye, S., Ngom, P.M., Madioune, H., Diaw, Moctar.

**KEYWORDS:** Télédétection, aquifères de socle, Sabodala.

**ABSTRACT**

Dans les régions sub-sahariennes les problèmes de disponibilité des ressources en eau deviennent de plus en plus acquis. La région de Sabodala (Boutonnière de kédougou Kéniéba au Sénégal) est située dans la partie socle du Sénégal où l’accès aux ressources en eau souterraine pose de réels problèmes. Ces problèmes se manifestent surtout par un taux élevé d’échecs de forage et le tarissement précoce observé au niveau de certains puits villageois en fin de saison sèche. Ainsi pour pallier à ces difficultés, la recherche de zones favorables à l’implantation de forage en zone de socle cristallin doit passer nécessairement par un repérage correct des linéaments et la compréhension des différents facteurs concourant à favoriser la mise en place de nappe d’eau dans ces milieux discontinus. Cette étude est réalisée par l’application des techniques de télédétection et SIG (système d’information géographique) pour une exploration efficace des zones potentielles aquifères. Le traitement des images Landsat ETM+ par le logiciel Erdas IMAGINE 9.2 nous a permis par l’application des filtres gradient 3x3 et Sobel 7x7 de mettre en évidence les discontinuités image correspondant aux linéaments. Celles-ci seront ensuite numérisées dans le logiciel Arc GIS 9.3. La carte linéamentaire obtenue a fait l’objet d’analyse statistique sur les longueurs et densités des linéaments par le logiciel LINWIN et elle montre que les directions Nord-Sud et Est-Ouest sont dominantes dans la zone. Ainsi la carte de densité des linéaments obtenue est combinée aux données auxiliaires favorisant l’existence de nappe d’eau (pluviométrie, nature géologique des formations, topographie, et réseau de drainage). Chaque paramètre étant ainsi pondéré par un poids selon son importance à favoriser l’existence de nappe d’eau souterraine. Cependant la carte de zone potentielle aquifère ainsi obtenue présente 5 classes de potentialité aquifère allant des zones à très fort potentiel aux zones à très faibles potentiel en passant par les potentiel bon, moyen et faible. Les zones à très forts potentiels occupent 11% du secteur et se trouvent pour l’essentiel au sud de la zone et coïncident avec les zones à densité linéamentaires élevée. Par contre les zones à Très faible potentiels se situent pour l’essentiel au nord de la zone et occupent 20% du secteur. Ces résultats sont confirmés par le NDVI obtenu sur l’image Landsat 7 TM+ du mois d’Avril 2010 qui est enregistrée en pleine saison sèche et qui montre une parfaite corrélation entre les zones à forte activité végétale et les zones à très bon et bon potentiel aquifère.
ASSESSMENT OF CLIMATE CHANGE IMPACT ON FOOD SECURITY IN MOROCCO: CLIMATE AND SOCIO-ECONOMIC SCENARIOS FOR THE HORIZON 2025

Saloua Rochdane 1, Lahouari Bounoua 2, Mohamed Messouli 1
1. Department of Environmental Sciences, Faculty of Sciences Semlalia, Cadi Ayyad University, Morocco
2. Biospheric Sciences, NASA Maryland, USA.

ABSTRACT
African countries are most vulnerable to climate change and are expected to be exposed to more adverse effects in the future. It is projected that precipitation will decrease and temperature will increase in the entire Mediterranean region including northern Africa, making a climate change impact and vulnerability assessment a must. The human demand for products of photosynthesis (NPP) is a powerful measure of the aggregate impact of human action on the biosphere and an indicator of societal vulnerability to climate variability and changes. In this study we estimate the fraction of NPP-required to support human activities in Morocco, using biogeochemical relationships that match those used in satellite-based methods. This approach allowed a comparison of the rate of NPP-required to support human appropriation (NPP demand) with the rate of terrestrial production (NPP supply) as influenced by demographic, technological and climate changes. This work presents the first detailed study of vulnerability to climate change in North Africa using a spatial scale fine enough to provide decision makers guidance on regional policy given our current knowledge of impending climate change, socioeconomic statistics, technological advances and resource constraints. A unique combination of satellite, socioeconomic and field survey data were used to explore the relationship between food security and climate change in Morocco.

We have mined the UNFAO data for different products categories including vegetal foods, meat, milk, eggs, wood, paper, and fiber and estimated the NPP-required for 4 different time periods between 1995 and 2005. Compared to the 1995 baseline, the country’s 2005 appropriation for food consumption has increased for all food categories except for eggs where a small decrease has been recorded. The largest appropriation increase is observed for milk and meat where as for vegetal food it has increased by 21.57%. Summing the amount of NPP required for all products yielded a NPP demand estimate of 29.2x10-3 Pg of elemental carbon. Comparing our total values for NPP supply and demand, we find that humans appropriate approximately 324.58% of terrestrial NPP. Our results show that under A2 and B2 climate change scenarios, a projected increase in demand is going to be coupled with limitations of supply resulting from climate change impacts. This gap between supply and demand dictates that those resources need to be used more effectively. Food production in Morocco must undergo a significant transformation in order to meet the related challenges of achieving food security and responding to climate change.

TO COUPLE GPS AND GIS FOR SENSING HUMAN WATER ACTIVITIES AND DETERMINING SCHISTOSOMIASIS EXPOSURE RISK IN THE SOUROU VALLEY, RURAL BURKINA FASO

Issouf Traore 1, Ali Sie 2, Martin Kappas 1
1. Department of Geography, Göttingen University, Germany,
2. Centre de Recherche en Santé de Nouna (CRSN), Burkina Faso

KEYWORDS: GPS & GIS, Geo-visualization, Exposure risk, Human schistosomaisis, Sourou Valley, Burkina Faso

ABSTRACT
Despite human schistosomiasis (also bilharziasis) is an old water-based transmitted disease and a growing public health concern in Burkina Faso, its geographical study remains less investigated. Nowadays, GPS and GIS tools and technologies give new opportunities to get insights into human dimensions in the disease transmission process.
These tools can also help to solve the problem of geo-visualization of human water contact distribution in the contaminated water body.

The research question underlying this field study is to see if is it possible to assess the risk of schistosomiasis exposure throughout the sensing of human water activities by coupling GPS and GIS.

Specifically, this study aims to understand and highlight in the Sourou Valley:

- How are the exposure activities distributed within the population following gender and age group,
- What are the reasons driving populations to contaminated freshwater exposures,
- How are the occurrence pattern and the distribution in the water body of the exposure activities,
- Which exposure activity, at the light of the occurrence and distribution in the contaminated water body, reveal the highest or lowest risk.

To determine exposure activities distribution within the population, we interviewed 4,860 compounds in 36 settlements with a total of 51,526 inhabitants in March 2011 to know whether their members and which (gender and age group) participate to water lily bulbs gathering (A1), traditional fishing in ponds (A2) and irrigated agriculture activities (A3) or not (A0). Additionally, respondents were asked if certain members were suffering from urinary schistosomiasis infection. Further, a small sample of compounds was interviewed to understand reasons of exposures activities. Recreational swimming (A4) exposure data were collected in January (dry cool period) and April 2011 (dry warm period). A portable GPS (Garmin 60CSx) devices were tied to individuals for sensing activities occurrence patterns at the ground. We used GIS to geo-visualize the distribution of the exposure activities in the water body with help of ArcGIS 10. The frequency of break points, the occurrence speed, aquatic vegetation cover and activity duration were integrated to assess how higher or lower is the exposure risk.

Results show that 46.01%, 12.96%, 8.93%, 3.05%, 2.02%, 0.93% and 0.12% of compounds of the study area were involved in A3, A2+A3, A2, A1+A2+A3, A1+A2, A1, A1+A3, respectively; while A0 represented the rest of 25.93% of compounds. Urinary schistosomiasis cases were reported in 24.81% of the compounds, while 6.26% didn't know and 68.93% answered by negation. Data of the water activities distribution within the population reveal that A1 was mostly done by adult women, A2 by adult men, A3 and A4 mainly involved children. The onset of A4 was attributed to a raising of the daily mean air temperature, >25° C. For the other exposure activities socio-economic reasons were stressed. Activities sensing and geo-visualization data are for A1, A3 and A4. During our stay on the field we couldn’t track any A2 because of the water level in ponds. Data show that each exposure occurred with a characteristic signature at the ground (see figures a, b). The distribution in the water body is shown in red dots representing break points and green ones are points recorded while individual was moving.

In terms of environmental condition, the density of aquatic vegetation cover varied from A1 to A4, from 100% to 0% of the water body. Break points represented 93.99% (out of 1,398 total trackpoints) and accounted for 75.51%
(of a total duration of 45.33 minutes) for A1; 12.87% (272) and 13.17% (125.43) for A3; 68.88% (1,279) and 63.07% (30.22) for A4. Therefore A1 was classified at the top of the exposure risk before A4 and A3 at the bottom. This classification seems to corroborate with respondents’ statements about urinary schistosomiasis cases within their respective compounds. When grouping compounds according to number of exposure activities there were involved in, data show that reported cases decreased in frequency from A1+A2+A3, A1+A2, A1+A3, A1, A2+A3, A3, A2, to A0, that is 50%, 44.90%, 44.44%, 40%, 33.33%, 25.13%, 24.88% and 14.76% of the class total compounds, respective.

This field study clearly shows that it is possible to geo-visualized the distribution of human activities within the water body by combining GPS and GIS. It also proofs the possibility the new tools offer to medical geographers in better understanding and contributing to schistosomiasis control initiative.

RELATIONSHIP BETWEEN VECTOR BORN DISEASE AND CLIMATE, A CASE STUDY FOR THE CUTANEOUS LEISHMANIASIS

K. kahime 1, L. Bounoua 2, M. Messouli 1, A. Boumezzough 1
1. department of biology, Faculty of Sciences Semlalia, Cadi Ayyad University, Morocco
2. NASA Goddard Space Flight Center, USA

ABSTRACT

Leishmaniasis is an infectious vector borne disease transmitted by the sand-fly (phlebotominae). It’s determined by a protozoa complex group, which belongs to the Leishmania genus and includes visceral and cutaneous infections.

Morocco is among the most affected countries in the world characterized by severe cutaneous and visceral clinical forms. The increase in annual incidence of these forms and their expansion across the country are making leishmaniasis a public health problem.

The leishmanian pathogen complex (parasite-vector-reservoir) evolves in a geographical area defined by a set of bioclimatic variables that affect its dynamics and territorial extension.

Throughout this study; we establish relationships between, leishmaniasis incidence and climatic parameters, including temperature, precipitation, and vegetation in Errachidia, Morocco. We establish correlations between averages temperature and precipitation, the vegetation index and the incidence of leishmaniasis (L major) between 1990 and 2010.

MALARIA VULNERABILITY HOT SPOTS IN EAST AFRICA – EXAMINING THE UNDERLYING CAUSES FOR MALARIA RISK

Stefan Kienberger 1, Michael Hagenlocher 2 Peter Zeil 1
1. Salzburg University, Centre for Geoinformatics (Z_GIS), Austria,

ABSTRACT

Due to its high significance, Malaria is one of the best studied and understood water-related vector-borne diseases. Research efforts so far resulted in different modelling approaches, examining transmission rates and dynamic disease models. This normally includes various climatic parameters, influencing both the occurrence and the spread of the disease. Eastern Africa (comprising Kenya, Uganda, Rwanda, Burundi and Tanzania) is the focus region of the EC FP7 research project HEALTHY FUTURES (‘Health, environmental change and adaptive capacity: mapping, examining & anticipating future risks of water-related vector-borne diseases in eastern Africa’) aiming at
the identification of future distributions of Malaria (and two other vector-borne diseases) influenced by climate and global change. The model region includes areas with endemic and epidemic risk of Malaria, where significant changes in its distribution are expected with future climate change, especially in higher altitude areas of the East African highlands. In the context of the project, two African scientists will complete their PhD research and several MSc theses at universities in East Africa contribute to deliverables.

Next to climatic factors, it is acknowledged that socio-economic conditions, such as poverty, differences in education levels but also conflicts contribute to a higher risk of being affected by Malaria. Within this paper we present an approach, where the underlying causes of Malaria risk are mapped, and demonstrate how GIScience and Earth observation methodologies can contribute to monitoring of different risk factors.

To conceptualise vulnerability and risk we used a framework that was originally developed within the FP7 research project MOVE ('Methods for the Improvement of Vulnerability Assessment in Europe'). The framework integrates different approaches used in disaster risk reduction and establishes a link to climate change adaptation. For the disease and health purpose the framework was modified and adapted. Major modifications relate to ‘dimensionality’ of susceptibility and lack of resilience but also concern the wording of definitions for the health context.

Building on the conceptual framework it was envisaged to follow an integrated spatial modelling approach which identifies homogenous regions of Malaria vulnerability, independent from administrative units for the social and economic dimension. The method was developed at the Centre for Geoinformatics at the University of Salzburg and has been applied to a series of vulnerability and climate change studies in Europe and Africa. For each of the dimensions, relevant indicators were identified through literature review and expert consultation. Most of the data for the indicators derives from public global and remote sensing sources, but inherit uncertainty when leaving the global scale level towards a more sub-national/sub-district approach. However, suitable data was identified concerning population distribution, land cover, infrastructure, poverty, age groups, women of child bearing age and child related diseases. Additionally, indicators such as the access to health facilities were modelled, integrating land cover and elevation as differently weighted barriers. The final set of indicators was then weighted through a participatory expert-based Delphi exercise, providing input for the regionalisation approach to model homogenous spatial vulnerability units. Thereby, regionalisation is based on a segmentation algorithm, originally developed for object-based image analysis (OBIA) which was applied to model spatially homogenous units of vulnerability in an n-dimensional indicator space.

Hot spot maps will be more amenable to policy and decision makers dealing with vulnerability issues if packaged with other additional information to facilitate the selection of intervention options. Therefore, we demonstrate an example for a web-based tool where not only the estimated size and location, but also the structure of the hot spots can be explored in a WebGIS environment, indicating where targeted follow-up studies could be conducted and at the same time highlighting which domains should be addressed in particular within the context of climate change adaptation policies or programs.

**MONITORING REFUGEE CAMP EVOLUTION AND POPULATION DYNAMICS IN DAGAHALEY, KENYA, BASED ON VHSR SATELLITE DATA**

Petra Füreder 1, Daniel Höbling 1, Dirk Tiede 1, Peter Zeil 1, Stefan Lang 1

1. Centre for Geoinformatics (Z_GIS), University of Salzburg, Austria,

**ABSTRACT**

In the course of the severe drought at the Horn of Africa and the ongoing violent conflict in Somalia in summer 2011, more than 150,000 refugees arrived in Dadaab, Kenya, which is currently the world’s largest refugee camp complex. The enormous influx of people to the Dagahaley refugee camp, one of the three camps in Dadaab,
brought the camp registration to a halt and revealed the need for a more efficient camp monitoring. Newly arrived refugees had to settle in the outskirts of the camp. The number and spatial distribution of dwellings could not be observed on the ground due to time and security constraints. In the frame of a Cooperation Agreement (Memorandum of Understanding, MoU) with Médecins Sans Frontières (MSF), the Centre for Geoinformatics at Salzburg University monitored the camp evolution using very high spatial resolution (VHSR) satellite imagery and provided in-depth information for supporting resource planning. Information on the amount and type of different dwelling structures and their spatial distribution was extracted by semi-automated analysis of WorldView-2 imagery (8 MS bands, 0.5 m GSD) from July 2011 and December 2011. Both images were partly affected by clouds and cloud shadows. Therefore, the eastern part of the December image was replaced by an additional image from January 2012.

The semi-automated dwelling extraction relied on object-based image analysis (OBIA), which provides a methodological framework for addressing complex information classes, defined by spectral, spatial, contextual as well as hierarchical properties. Expert knowledge is represented through rulesets coded in CNL (Cognition Network Language) in eCognition 8 software, which offers a modular programming environment for (image-) object handling. Objects may be addressed individually through class modeling, a cyclic process of segmentation and classification. For the analysis of the 1\textsuperscript{st} timeslot three dwelling types were distinguished: tents, huts and dwellings with corrugated iron roof. Tents and makeshift huts could mainly be observed in the newly settled areas in the western outskirts of the camp, whereas dwellings with corrugated iron roof were the predominant dwelling type in the main part of the camp. The ruleset developed for the July image could be partly transferred to the December image. However, such clearly distinctive indicators of newly settled areas nearly have disappeared at the 2\textsuperscript{nd} timeslot, e.g. Only very few makeshift huts were still present and many dwellings with corrugated iron roof have been covered with white plastic sheeting due to the rainy season, which made a differentiation to white tents unfeasible. Therefore only one class dwelling was extracted for the 2\textsuperscript{nd} timeslot. For shaded areas in both images, even though WorldView-2 still provided appropriate information due to its high radiometric resolution, the ruleset had to be slightly adapted to extract relevant objects. Finally, minor manual refinement was performed to eliminate obvious classification errors. The analysis of the July scene revealed about 23,400 dwellings: 13,950 dwellings with corrugated iron roof, 6,650 tents and 2,800 huts. In December 21,950 dwellings were extracted. In addition to single extracted dwellings the dwelling density (dwellings/km\textsuperscript{2}) was calculated using Kernel density methods to provide easy to grasp information about the spatial distribution of dwellings. Based on the dwelling density the camp extent was derived automatically (see Fig. 1). A change analysis of dwellings aggregated on hexagonal units shows a decrease of dwellings in the western outskirts of the camp from July 2011 to December 2011. On the other hand, dwelling density increased in the main part of the camp and a minor increase of single dwellings in the eastern outskirts of the camp could be observed as well (see Fig. 1). Areas which were covered by clouds in either of the two images were excluded from the change analysis. Results have been delivered as maps in PDF-format as well as Google’s kml-files.
Figure 1. Change detection analysis based on single extracted dwellings in the Dagahaley refugee camp between July 2011 and December 2011. Blue tones indicate areas of dwelling decrease, red tones show an increase of dwellings and grey areas did not undergo a significant change. Clouds in either of the images were not taken into account for the change analysis (dashed areas). The camp extent of July 2011 is displayed in green, whereas the red outline shows the camp extent of December 2011. The WorldView-2 image in the background is a combination of the December 2011 image and the January 2012 image (eastern part) and is displayed in true colour composite.

The study shows that relevant and up-to-date information in regard to amount and spatial distribution of affected population during humanitarian crises can be provided for inaccessible areas by making use of VHSR satellite imagery. Geo-information can contribute to make humanitarian aid more efficient, timely and effective.
APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR COMPARATIVE STUDIES ON THE DISTRIBUTION OF PRIMARY HEALTH CARE CENTRES IN UGHELLI NORTH, UGHELLI SOUTH AND WARRI SOUTH LOCAL GOVERNMENT AREAS OF DELTA STATE, NIGERIA

Agaja S.A.¹, Unuoh K.²
1. Industrial Safety and Environmental Technology, Petroleum Training Institute P.M.B 20, Effurun.,
2. Department of Geography University of Ibadan, Ibadan

KEYWORDS: Ughelli North LGA, Ughelli South LGA, Warri South LGA, Primary Health Centre, Germain GPS, Multivariate Analysis

ABSTRACT
The mapping of primary health care centres in Ughelli North, Ughelli South and Warri South Local Government Areas (LGA) of Delta State was carried out. The objective is to provide Geo-spatial information about the distribution and accessibility of the Primary Health Care Centres in the Local Government Areas. Germain GPS was used to capture the Co-ordinates of the Health Centres which was analysed using Arc Map 9.3 (ESRI) GIS software. The multivariate analysis showed that the nearest neighbour value for Warri South Local Government Rn=0.665341 which imply a clustered pattern of distribution. For Ughelli North and South LGAs Rn=0.9991144 and Rn=0.9599 respectively. This results showed randomed distribution rather than clustered. The importance of primary health care centres to the grass root dwellers are discussed.
ASSESSMENT OF ADAPTATION STRATEGIES AND KNOWLEDGE ON CLIMATE CHANGE AMONG PASTORALISTS AND AGRO-PASTORALISTS IN FAFI AND DADAAB ECOSYSTEMS

Mwaura, J.1, Tura, I., Raude, J. 1
Kenya Agricultural Research Institute – Garissa.

KEYWORDS: Climate Change, Vulnerability, Adaptation, Greenhouse Gas, pastoralism, FGD

ABSTRACT
As the national premier agricultural research outfit and through sound agricultural research Kenya Agricultural Research Institute (KARI) endeavours to generate technologies, knowledge and innovations and information dissemination via six research programmes to include natural resources management, livestock and adaptive research. In line with this the baseline study assessed Adaptation strategies and Knowledge on climate change among pastoralists and agro-pastoralists in Fafi and Dadaab ecosystems. The study area is located Bura to the South, Tana River to the South West, Garissa to the West, Republic of Somalia to the East and Wajir to the North. The area; home to over half a million refugees, falls within arid and semi-arid lands (ASALs) and is incredibly vulnerable to climate change and variability. Climate change is caused by accelerated increase in greenhouse gases (GHG) concentrations in the atmosphere with Carbon dioxide, nitrous oxide and methane being the main GHGs that trap infrared radiation and contribute to the increase. The effects of the trapped gases thwart development, particularly in agriculture sector. The sector is expected to play a vital role in the attainment of targets of Vision 2030 specifically the objective of poverty reduction and food security; all of which are now threatened by the changed climate and variability. Agriculture is a carbon sink and emitter accounting for virtually 15 per cent of global carbon emissions with livestock emitting 37 per cent of Methane and 9 per cent Carbon dioxide-the latter arising from in-organic fertilizer-dependent fodder production. GHG presents fundamental challenges to the well-being of all countries, with particular adverse effects on countries with less adaptive capacity more so in arid and semi-arid regions such as Fafi and Dadaab. In these regions, climate change is likely to extend periods of drought, raise their frequency, increase stress and conflicts over resources hence exacerbating poverty. With increased poverty and most of the workforce dependent on livestock and agro-pastoralism for their livelihoods majority are prone to various adverse climate shocks. Hence, efforts to facilitate adaptation are desirable to enhance the resilience of the agricultural-livestock systems, ensure food security, and cut poverty. Methodology used in the study included desktop review, sampling, data collection, field study including River Tana and Merti aquifer management and water utilization. Data was analyzed using SPSS version 17. In all, 322 household questionnaires were administered and 300 respondents consulted through Focus Group Discussions and Key informants’ interviews. All respondents in Fafi and Dadaab were Muslims and ninety-eight per cent Somali; majority being pastoralists. Most of them had low or no education earned below KES 2,000 a month but had considerable knowledge on climate change prior to the study. Based on this knowledge, several spontaneous coping measures were in place and interest for sustainable adaptation is high. However adaptation is hampered by drought, biting poverty, invasion by Prosopis, stringent land tenure system, inadequate skills, illiteracy, lack of disaster warning preparedness and ignorance. While perception exist of a link between trees and climate change, the perception of the link between specific land management practices and climate change was limited. Given the scenario, the study founded pertinent base for further research and enhancement of apt adaptation technologies in Fafi and Dadaab ecosystems.

THE MAURITIUS NATIONAL ATLAS

Krisna Bucha1
1. Mauritius Meteorological Services

ABSTRACT
After acquiring skills for manipulation and development of marine and coastal products in the previous phases of ODINAFRICA, the current phase is developing a new multi-sectoral Atlas. The compilation of the available Geospatial datasets and information in separate layers will promote the sustainable management of marine and coastal resources, as well as reducing the risks of ocean related hazards, based on sound scientific knowledge. Moreover, it will also indicate gaps in knowledge and information base. The aim of the atlas is to feed science into decision making or link power with knowledge. ODINAFRICA is developing a marine and coastal atlas platform which will be an online mapping application based on a web Map Services, that will
optimize the mapping products to ensure that they are user friendly and address the needs of the policy makers. Some of the expected products will address the following priorities:
- Shoreline change which is a real challenge in Africa with constant erosion occurring at many places
- Marine related Hazards and disaster Management exacerbated with climate change activities
- Management of Key ecosystems especially the coral reefs and Mangroves among others
- Sustainable use of resources such as productivity of coastal waters, biodiversity status, fish stock levels

EFFECT OF LANDUSE CHANGE ON QUALITY OF URBAN WETLANDS: A CASE OF MONAVALE WETLAND IN HARARE

Florence M Murungweni
Saveteck Solutions, Zimbabwe,

KEYWORDS: AARSE, Paper Kit, style guide, formatting

ABSTRACT
This study seeks to assess the effects of land use change to the quality of urban wetlands using Aerial Photography and Geographic Information System software. In this study urban community that surrounds Monavale wetland, Birdlife Zimbabwe a non-governmental organization, Harare city council and the Department of Natural Resources were used as research subjects. A questionnaire, Geographic Information System and secondary data were used as research instruments. Aerial photographs of August 1984 and 1995, topographical maps and survey records from Surveyor-General’s Office were used to provide information on the spatial extend and various land uses within the wetland area. The study showed that about 13.4% of the wetland has been lost either to cultivation, construction or recreational activities. These activities have had detrimental effects to the wetland biodiversity. Whilst part of the wetland has been conserved, the remaining greater part is seriously being degraded by various human activities. The study recommends that the environmental organizations such as Environment Africa and Birdlife Zimbabwe should sensitize urban farmers at Monavale as well as construction companies of the impact of their developments to the wetland biodiversity and worse still to Lake Chivero, in the down stream. The study also recommends that the City of Harare, Ministry of Environment and Tourism, non-governmental organizations such as Birdlife Zimbabwe and Environment Africa as well as Monavale community work together to conserve the wetland from further degradation. Policies that have been formulated by the government of Zimbabwe in the conservation of urban wetlands need to be fully implemented if the wetland could be saved for the benefit of the people, plants, animals and the soil.

LIEN ENTRE ENNEIGEMENT ET CLIMAT A GRANDE ECHELLE SUR LE HAUT ATLAS MAROCAIN A L’AIDE DES IMAGES MODIS (PERIODE 2000-2010)

A.Marchane, L Jarlan, L.Hani, A.Boudhar
1. Faculté des Sciences et Techniques Guéliz, Marrakech, Maroc,
2. Centre d’Études Spatiales de la Biosphère, France
3. Faculté des Sciences et Techniques, Béni-Mellal, Maroc

KEYWORDS: hydrologie, télédétection, climat, semi-aride, neige, Haut Atlas

ABSTRACT
Dans les pays du sud de la Méditerranée et du Moyen Orient, l’eau est une ressource rare : 180 millions d’habitants disposent de moins de 1000 m³ d’eau par an et par habitant et 80 millions sont en situation de pénurie (moins de 500m³/habitant /an) alors que la demande a doublé depuis 50 ans. Pour de nombreux bassins versants en méditerranée semi-aride, la zone de production de l’eau est située en montagne et la présence de neige constitue un réservoir non négligeable. Malgré l’importance de la neige dans le bilan hydrique régional et comme indicateur de changement climatique, peu d’études se sont focalisées jusqu’à présent sur l’étude du lien entre l’enneigement et le climat à grande échelle. De longues séries temporelles de données satellitaires existent désormais. Dans les régions semi-arides qui ne disposent pas d’un panel opérationnel de suivi au sol (réseaux de mesures météorologiques ...), ces séries d’observation représentent un témoignage unique de l’évolution des ressources qui n’a été que peu exploité

Figure 1: Cycles annuels d’enneigement (moyenne de 15 jours) sur le Haut Atlas du Tensift pour la période 2000-2010 (produits MODIS MOD10A2)

Dans un 2ème temps, nous avons étudié le lien entre, d’une part, la dynamique atmosphérique et océanique à grande échelle vue à travers l’oscillation Nord Atlantique (NAO) et les températures de surface de l’océan atlantique (SST) et, d’autre part, la variabilité du couvert nival sur cette région. Les résultats montrent que la variabilité interannuelle est extrêmement forte en terme de cycle annuel d’enneigement, de surface enneigée maximum et de date des premières neiges. L’étude du lien entre la dynamique atmosphérique et océanique à grande échelle (NAO et SST) et la variabilité du couvert enneigé sur cette région, montrent notamment qu’une NAO en phase négative durant le mois de février est légèrement favorable à l’enneigement sur le Haut Atlas. La faiblesse de cette relation, même si son signe négatif est cohérent avec les études précédentes montrant le lien NAO-précipitations sur l’Afrique du Nord est étonnant. L’analyse de la relation entre la NAO et la température mesurée à la station d’Oukaimeden à 3200m d’altitude a permis de montrer que la phase négative de la NAO conduisait dans un même temps à un réchauffement, donc plutôt défavorable à l’enneigement. Ce double impact opposé de la NAO sur la température et les précipitations, deux facteurs régissant le déclenchement d’un événement neigeux, pourrait expliquer la faible relation obtenue entre NAO et enneigement. Enfin, nous avons montré une relation forte entre les anomalies de température de surface des océans dans les régions tropicales et équatoriales à la fin de l’été et l’enneigement sur le Haut Atlas. Ces résultats corroborent notamment de précédentes études et font des SST dans cette région de l’Atlantique un candidat potentiel intéressant pour la prévision précoce du couvert neigeux sur le Haut Atlas.

De manière générale, cette étude montre l’intérêt de l’utilisation des données de la télédétection pour caractériser l’enneigement en montagne semi-aride et permet de déterminer les facteurs synoptiques qui régissent la dynamique de cet enneigement.

OPERATIONAL AND REAL-TIME SNOW COVER ALGORITHM FOR MOUNTAIN AREAS BASED ON 250 M MODIS IMAGES

Claudia Notarnicola 1, Anke Tetzlaff 1, Martial Duguay 1, Armin Costa 1, Roberto Monsorno 1, Christian Steurer 1, Marc Zebisch 1

1. EURAC Research, Institute for Applied Remote Sensing, Bolzano/Bozen, Italy

ABSTRACT

Because of its seasonality and physical properties snow bears great importance for nature and climate as well as for the human society: it acts as insulation layer for soil and vegetation, as water retentionbody, as influencing factor for climate. Furthermore, information on distribution and variability of snow isa basic component for investigations on plant phenology, vegetation and soil moisture, climatological research and touristic information (Blöschl & Kirnbauer, 1992).
This paper presents the development and extensive validation of an algorithm for snow cover monitoring based on MODIS satellite images. Despite the availability and general performance of the MODIS MOD10 Snow Product, obvious limitations affect the monitoring of local environment and stress the need for an adapted and robust algorithm to map snow cover with the highest possible amount of spatial details. They can enable an improved determination of snow as well as more accurate depiction of the winter snowline.

The EURAC snow algorithm has two main characteristics with respect to NASA algorithm: first, it exploits the bands at 250m in order to have a snow map with improved resolution; second, thanks to a direct broadcast from EURAC receiving station (Steurer et al. 2011), the snow maps are delivered to the users in quasi real-time i.e. around 4 hours after MODIS image acquisitions. The overall algorithm is divided in three main modules. The first module is devoted to snow detection based on the 250m resolution MODIS bands and on NDVI thresholds. The second module is related to the detection of snow in forest. The third module is devoted to the cloud detection.

The snow layer is produced along with 4 quality layers dedicated to: 1. snow quality flag; 2. Cloud quality flag; 3. Input data quality flag; 4. Satellite viewing geometry quality flag.

The algorithm validation activities were carried out by using: high resolution snow maps derived from LANDSAT images and snow depth data from ground stations in selected test sites in Central Europe. A comparison of MODIS images to sixteen snow cover maps derived from LANDSAT showed an overall accuracy of 93.6%. The residual mismatch area is often linked to forest, presumably due to changes in forest areas and is therefore linked to limited abilities of MODIS to accurately detect the snow under forest especially under extreme illumination conditions.

For the comparison with ground data, snow depth measurements from 148 ground stations in Germany, Austria, Italy and Slovakia were used. In most of the areas, the overall accuracy is around 95%. It decreases to around 80% in very rugged terrain restricted to in-situ stations along Northern facing slopes, which lie in shadow in winter during the early Terra acquisition.

From the snow cover maps other information are extracted such as snow cover duration. The calculation of the snow cover duration over different years put in evidence the different behaviour of snow due to the landscape variability and meteorological conditions.

Examples of snow cover and snow cover duration map over Alpine area and Morocco mountain areas will be presented in the final paper and presentation.

### TEMPORAL ANALYSIS OF NOAA AVHRR DERIVED LOWER TROPOSPHERIC TEMPERATURE AND ITS IMPLICATIONS ON THE MICRO-CLIMATE OF ±15O PARALLEL REGION OF AFRICA

Ojigi, M. L.1, Shaba, A. H1, Mohammed, S. O.1, Nwagwu, C. J.1


**KEYWORDS:** NOAA AVHRR, LTT, Micro-Climate, ±15° Parallel Region of Africa

**ABSTRACT**

The troposphere is the lowest layer of the earth’s atmosphere where most atmosphere-to-ground measurement is carried out, and it extends to a height of about 15km above mean sea level. The air is well mixed and the temperature decreases with altitude. Air in the troposphere is heated from the ground up, and the heat spread through the troposphere rapidly because the air is slightly unstable. The troposphere comprised of upper, middle and lower layers, which due to their unstable conditions largely cause variations in pressure, temperature, humidity and density, thereby producing the earth weather. The troposphere is a region of high non-ionized gases (e.g. CO2) and water molecules, which are very effective in the absorption of carrier signals and causing delays of such signals arriving at a desired target for up to 2.5 meters. However, these delays vary with temperature, pressure, and humidity as well as spatial and physical location of the part of the earth or a remote receiver. Due to global energy imbalance caused primarily by the anthropogenic greenhouse gas forcing and climate change phenomenon, earth surface and the troposphere are all warming; hence the Earth’s total heat content is on the increase. This paper therefore attempts the temporal analysis of the Lower Tropospheric Temperature (LTT) derived from NOAA AVHRR for the period of 1979-2009 and its implications on the micro-climate of the ±15o Parallel (latitudes 15.00oN-15.00oS of the Equator) Region of Africa. The preliminary result of the study shows an absolute increase of about 1.44oK in the LTT between January 1979 and January 2009. Within the same period, the NOAA Global Precipitation Climatology Project (GPCP) Monthly Global Precipitation Data showed a decrease of about 7.33mm in precipitation values. The chain-effect of the decrease in precipitation will lead to increase in land surface temperature and reduction in the available Oxygen for man and animal in Africa and the entire earth. The study of the LTT reveals a climate
diagnostic tool that provides an overview of the average continental LTT variability and the micro-climatic variations in the equatorial belt of Africa.

MOROCCAN COMMON WHEAT YIELDS LINKAGES WITH MID-LATITUDE AND TROPICAL CLIMATE OVER THE LAST QUARTER CENTURY: POTENTIALS FOR EARLY PREDICTIONS

Jarlan L. 1,2, Abaoui J. 2, Duchemin B. 1, Mangiarotti S. 1, Ouldbba A. 2, Tourre Y. 3, Khabba S. 4, Er-Raki S. 4, Ballaghi R. 5, Mokssit A. 1, Chehbouni G. 1
1. Centre d’Etudes Spatiales de la Biosphère, Toulouse, France
2. Direction de la Météorologie Nationale, Casablanca, Morocco
3. Météo-France, Toulouse, France
4. Faculté des Sciences de Semlalia, Marrakech, Maroc
5. Institut National des Sciences Agronomiques, Rabat, Maroc

ABSTRACT

Population growth and the associated increase in feeding demand have led to an imperial need for efficient agricultural production monitoring systems. Rainfed agriculture dominates global production with 80% of arable areas and 60% of production. Over the south Mediterranean, climate is characterized by long periods of drought and a strong interannual variability in rainfall amount and distribution leading to a high year-to-year production variability. Cereals, and, in particular, the common wheat, are of great importance in national food safety over Morocco. It is important to pre-empt the importation in the event of insufficient production for internal consumption or for the storage of seeds. The seasonal forecast constitutes in these cases a tool well adapted to decision making.

Some recent studies have demonstrated that the cereals yields at the sub-continental scale could be predicted several months in advance by using the large scale climate information, in particular the ENSO indices. Nevertheless, few studies exploited the predictive information contained in the indices and climatic variables apart from the ENSO sensitive areas. Over the South Mediterranean Countries, main reason is that the effects of this global ocean-atmosphere phenomenon are probably embedded within the complex variability of the northern hemisphere climate and local specific elements such as a marked orography over Morocco. Other products take advantage of the temporal and spatial coverage of satellite imagery for the direct monitoring of vegetation conditions. This study aims to characterize the linkages between those climate signals (North Atlantic Oscillation, Sea Surface Temperature, geopotentials) and agricultural yields over Morocco and to propose statistical models for the early predictions of wheat yields at the scale of the agricultural province by comparing the classical multi-linear regression approach with support vector machines for regression.
Figure 1: Lagged correlation between wheat yields and Sea Surface Temperature (1983-2008); Example of the Settat province; Only significant correlation at the 95% level are displayed; Colorscale ranges from -0.5 (dark blue) to 0.5 (dark red).

Over the 11 agricultural provinces producing 80% of common wheat yields over Morocco, it is demonstrated here that, (1) the December North Atlantic Oscillation is negatively correlated to wheat yields probably through the influence of water and temperature stress during the early stage of the wheat cycle and (2) high yields may also be favoured by a warming of the equatorial Atlantic in late summer/early autumn (figure 1). This large scale climate information together with NDVI are used as predictors to build empirical models for early forecasting of wheat yields. Results demonstrate that the Support Vector Machines approach always outperforms the classical Multi-linear regression and that the best models obtained are able to predict the wheat yields with a reasonable accuracy from March (root-mean-square error ranging from 130 kg.ha\(^{-1}\) to 401 kg.ha\(^{-1}\) over the 11 provinces studied).

Analyse des risques d’inondation dans le Grand Tunis

Jalel Dallel 1
1. GREVACHOT 01/UR/02-12,

KEYWORDS: Evénements extrêmes, vulnérable, dégâts socio-économiques et environnementaux, Grand Tunis, etc

ABSTRACT

Toute inondation possède une ou plusieurs origines naturelles découlant de phénomènes météorologiques ou autres. En général, elle apparaît lorsque de grandes quantités d’eaux exceptionnelles tombent et s’écoulent en des temps très courts. Également, l’intervention de l’homme dans le cycle naturel et le régime des eaux peut amplifier l’effet de ces inondations. L’impact de ces dernières se manifeste notamment au travers des interventions ayant un effet négatif sur les propriétés naturelles d’emmagasinement des eaux qui sont la végétation, les sols, les grandes étendues et le réseau fluvial.

Dans le Grand Tunis, les événements pluviométriques très forts générateurs d’inondations semblent enregistrer une recrudescence accélérée depuis le début des années 90 du 20ème siècle. L’ensemble de cette
région a été touché par des pluies de forte intensité en des temps très courts entraînant des conséquences graves sur l’infrastructure et surtout pour les populations. En effet, outre les pertes en vies humaines et les dommages matériels considérables, les écoulements générés par ces pluies engendrent des effets irréparables. Ceci rend les infrastructures et les nouveaux espaces de croissance urbaine dans les parties aval des bassins versants vulnérables et toujours exposés au risque d’inondation.


**ANALYSE ET DIAGNOSTIC DES PERIODES SECHES DANS LE BASSIN D’ICHEKUL (TUNISIE) EN UTILISANT DES DONNEES JOURNALIERES DE LA PLUVIOMETRIE**

Majid Mathlouthi ¹, Fethi Lebdi ²

1. Laboratoire de Recherche en Sciences et Techniques de l’Eau de l’INAT,
2. Institut National Agronomique de Tunisie (INAT), Tunisie,

**KEYWORDS:** événement pluvieux, intensité de sècheresse, période sèche extrême, changement climatique, tendance

**ABSTRACT**

La sécheresse est un phénomène naturel qui peut survenir dans toutes les régions. La variabilité climatique et le changement climatique à plus long terme ont des conséquences économiques, sociales et environnementales. Il est probable que le changement climatique augmente la fréquence et la durée des sécheresses, ce qui pourrait contribuer à la dégradation des terres. Cette étude porte sur les périodes sèches observées dans le bassin d’Ichkeul, à climat méditerranéen, situé au Nord de la Tunisie en utilisant les données journalières de la pluviométrie à partir de 7 stations d’observation au cours des périodes d’échantillonnage de 1959 à 2005. Une période sèche se définit comme étant la période entre deux jours pluvieux ayant reçu une précipitation supérieure à un seuil de pluie donné. Par conséquent, un événement pluvieux est une série ininterrompu de jours pluvieux comprenant au moins un jour ayant reçu une précipitation supérieure au seuil (Fig. 1).Dans cette étude le seuil a été fixé à 1 mm de pluie correspondant à l’évapotranspiration journalière minimale dans la zone. Cette définition a permis l’évaluation de la sécheresse dans le bassin d’Ichkeul. Le but principal de cette étude était d’analyser les périodes sèches, en particulier les cas extrêmes (sécheresses météorologiques), et de les évaluer sur une base quotidienne. Une analyse conventionnelle des périodes sèches ne fournit pas de relation entre la fréquence et la durée de ces périodes, mais elle montre que les périodes sèches se produisent de façon aléatoire pendant la saison pluvieuse dont la longueur est aussi aléatoire. Les tendances et les fréquences des sécheresses ont été analysées à l’aide d’un cadre général pour détecter et comparer les propriétés des états secs basées sur des échelles de temps quotidiennes et annuelles. Les tendances ont été estimées en utilisant deux méthodes différentes. Dans l’ensemble, les tendances ont montré une diminution, en particulier au cours de la période de 1976-1990. Les résultats ont montré des baisses sporadiques dans les événements secs et des événements d’extrême sécheresse. La structure spectrale permet une inférence de base fréquence maximale et a confirmé une période interannuelle de 2 à 3 ans de variabilité dans l’occurrence de la sécheresse dans le bassin. En outre, les fonctions de distribution de probabilités des périodes sèches aux stations du bassin ont été analysées pour confirmer qu’elles suivaient une distribution géométrique-binomiale. Des tests supplémentaires ont été utilisés pour déterminer s’il y a un second seuil, en utilisant les modèles d’ajustement Weibull et gamma. Afin d’étudier l’homogénéité spatiale, le domaine de périodes sèches maximales dans le bassin a été généré en utilisant un tableau de vecteurs basé sur la date d’occurrence et la durée de la période sèche maximale. En raison de la dépendance de la durée de la période de cycle climatique annuel, les plus longues périodes sèches ont été observées à partir du Février jusqu’à la fin de la saison pluvieuse le mois de mai. L’intensité des sécheresses diminue dans la région d’oued el Gauss. Les sécheresses de 1987 et 2001 ont été considérées comme les plus longues de sécheresse dans le bassin. Les déficits en eau ont affecté le barrage Ghézala à partir de cette sécheresse, ont produit de graves dommages et des préjudices importants et coûteux.
Likely changes in mean and extreme precipitation in Africa in response to changes in radiative forcing are investigated using an ensemble of the Coupled Model Intercomparison Project Phase 5 (CMIP5) models forced by the representative concentration pathway (RCP) 4.5. Only results for southern and East Africa will be presented. Extreme seasonal precipitation is defined in terms of 10-year return levels obtained by inverting a generalised Pareto distribution fitted to excesses above a pre-defined high threshold. Both present (control) and future climate precipitation extremes are estimated. The future to control climate ratio of 10-year return levels is then used as an indicator for the likely changes in extreme seasonal precipitation.

Over the western parts of southern Africa, an increase in the severity of dry extremes parallels a statistically significant decrease in mean precipitation during austral summer months. Over a large part of the climatologically dry areas of southern Africa featuring the Kalahari Desert, precipitation minus evaporation (P – E) is projected to decrease. Worsening of water scarcity and an extension of the desert area seem likely.

Despite recurrent droughts in East Africa in recent years, CMIP5 models project a positive shift of the rainfall probability density function. Droughts are projected to become less severe while floods are likely to become more frequent in the future. Over much of East Africa, except parts of southern Sudan, rainfall increases are projected to exceed those of surface evaporation, which has positive implications for surface water availability. During East Africa’s short rains (October – December), rainfall increases are linked to differential warming in the tropical Indian Ocean which favours an increased likelihood of positive Indian Ocean dipole events.
RESPONSE OF THE SWAT MODEL TO DIFFERENT RAINFALL FORCING: A CASE STUDY OF THE ROXO RESERVOIR WATERSHED, PORTUGAL.

Priscilla Imuwahen Aigbedion\textsuperscript{1}, Oladapo T. Okareh\textsuperscript{2}

1. Centre for Health, Environment and Safety Studies, C/o 2Department of Environmental Health Sciences, Faculty of Public Health, University of Ibadan, Ibadan, Oyo State, Nigeria,
2. Department of Environmental Health Sciences, Faculty of Public Health, University of Ibadan, Ibadan, Oyo State, Nigeria

KEYWORDS: rainfall forcing, simulations, ArcSWAT, Roxo reservoir

ABSTRACT

This research examines the impact of different rainfall forcing methods on the Soil Water assessment Tool (SWAT) hydrology/water quality model. ArcSWAT 2005 interfaced with ArcGIS 9.2 was used to extract and process the input parameters which include a digital elevation model (DEM), land cover and soil map GIS data layers. Three types of rainfall forcing, which include the SWAT weather generator, point gauge and satellite observation rainfall data were used for simulation.

Simulation was carried out in three phases by driving the model with three sources of weather and climatic data: (1). SWAT weather generator (Wgn); (2). Observed ground rainfall data; (3). Satellite rainfall estimate. The simulation options used the Curve number (CN2) method for calculating the surface runoff (USDA-SCS, 1972), a first order Markov chain for rainfall distribution estimation, Penman–Monteith method for evaporation and Muskingum channel routing. The output frequency was on monthly basis while the model gave observed yearly summaries. A comparison was made between the simulation outputs and the result shows that the point gauge rainfall input to be better than the weather generator and satellite rainfall forcing. After analyzing cold simulation results, the gauge simulation was chosen for hydrologic model calibration.

CUSTOMIZING NASA’S EARTH SCIENCE RESEARCH PRODUCTS FOR ADDRESSING MENA WATER CHALLENGES

Shahid Habib\textsuperscript{1}

1. NASA Goddard Space Flight Center, Earth Sciences Division, Greenbelt, Maryland, USA,

ABSTRACT

As projected by IPCC 2007 report, by the end of this century the Middle East North Africa (MENA) region is projected to experience an increase of 3°C to 5°C rise in mean temperatures and a 20% decline in precipitation. This poses a serious problem for this geographic zone especially when majority of the hydrological consumption is for the agriculture sector and the remaining amount is for domestic consumption. In late 2011, the World Bank, USAID and NASA have joined hands to establishing integrated, modern, up to date NASA developed capabilities for various countries in the MENA region for addressing water resource issues and adapting to climate change impacts for improved decision making for societal benefits. The main focus of this undertaking is to address the most pressing societal issues which can be modeled and solved by utilizing NASA Earth Science remote sensing data products and hydrological models. The remote sensing data from space is one of the best ways to study such complex issues and further feed into the decision support systems. NASA’s fleet of Earth Observing satellites offer a great vantage point from space to look at the globe and provide vital signs necessary to maintain healthy and sustainable ecosystem. NASA has over fifteen satellites and thirty instruments operating on these space borne platforms and generating over 2000 different science products on a daily basis. Some of these products are soil moisture, global precipitation, aerosols, cloud cover, normalized difference vegetation index, land cover/use, ocean altimetry, ocean salinity, sea surface winds, sea surface temperature, ozone and atmospheric gasses, ice and snow measurements, and many more. All of the data products, models and research results are distributed via the Internet freely through out the world. This project will utilize several NASA models such as global Land Data Assimilation System (LDAS) to generate hydrological states and fluxes in near real time. These LDAS products will then be further compared with other NASA satellite observations (MODIS, VIIRS, TRMM, etc.) and other discrete models to compare and optimize evapotranspiration, soil moisture and crop irrigation, drought assessment and water balance. The floods being a critical disaster in many of the MENA countries, NASA’s global flood mapping and modeling framework (CREST) will be customized for country specific needs and delivered to the remote sensing organizations for...
their future use. Training is an important component under this activity and adequate level of training will be offered to build basic capacity to work with NASA provided data products, models for their future use. This paper provides a comprehensive introduction to NASA’s Earth Science mission for understanding the behavior of our home Planet, projecting its health for future generations and applying research results solving societal issues.

INTER-COMPARISON OF ATMOSPHERIC PRECIPITABLE WATER FROM GROUND-BASED GPS MEASUREMENT AND REGIONAL CLIMATE MODEL EXPERIMENT OVER EASTERN AFRICA

G. Mengistu Tsidu
1
1. Department of Physics, Addis Ababa University, POBox 1176, Addis Ababa, Ethiopia,

ABSTRACT

Drought and floods represent climate hazards that can cause great damage in terms of human suffering and loses on every sector of the economy. Both can be traced in terms of the analysis of water vapor cycles in the atmosphere. It is known since long time that an increase in water vapour enhances the greenhouse effect and gives rise to further warming. According to the Intergovernmental Panel on Climate Change (IPCC) reports water vapor feedback acting alone approximately doubles the warming from what it would be for fixed water vapor. It acts also to amplify other feedbacks in general circulation models, such as cloud feedback and albedo feedback. On longer time scales, water vapor changes are thought to contribute to an important positive feedback mechanism for climate change. Warming of the surface, particularly the sea surface, leads to enhanced evaporation. Due to fact that water vapor is a greenhouse gas, enhanced water vapor in the lower troposphere results in further warming, allowing a higher water vapor concentration, thereby creating a positive feedback. Thus, an understanding of the mechanisms distributing precipitable water vapor (PWV) through the atmosphere and of water vapor’s effects on atmospheric radiation and circulation is vital to estimating long-term changes in climate. The column content of water vapor (or Precipitable Water – PWV) can be obtained from the GPS electromagnetic signal’s non-hydrostatic tropospheric path delay and satellites such as MODIS. In the last decade different works showed the feasibility of GPS system to obtain water vapor measurements by means of space-borne GPS receivers (water vapor profiles) or by means of ground-based GPS receivers (PWV). The potential for GPS to detect PWV has been well demonstrated. Agreements at the level of 1–2 mm of PWV between GPS, radiosonde, and microwave water vapor radiometers (WVR) have been reported in previous research. Since the infrared satellite techniques only work in the absence of significant cloud cover and radiosonde measurements are made mainly over the land and are hardly available over the Eastern Africa region, the availability of relative large number of GPS ground receivers over the Eastern Africa region may serve to establish more accurate estimation of vertically integrated water vapor in the atmosphere over the region. Atmospheric precipitable water is derived from ground-based GPS receivers network using GAMIT software and the results are compared with that from ERA-Interim reanalysis dataset. Seasonal and diurnal variations of the two datasets are analyzed. It has also been found that general circulation model has dry bias over lowlands and wet bias over highlands while the correlations between the two datasets generally exceed 0.8 at different time scales.
IMPACTS DE LA VARIABILITÉ DU CLIMAT ET DES MODIFICATIONS DU COUVERT VEGETAL SUR L’ECOULEMENT ET LA RECHARGE DES RESERVOIRS SOUTERRAINS DANS L’HYDROSYSTEME DU N’ZO (OUEST DE LA COTE D’IVOIRE)

K.F. Kouamé1,4, M.J. Penven2, M. Bernier3, A.M. Kouassi1, M.B. Saley1, B.T.M. N’Guessan4, J. Biémi1
1. Centre Universitaire de Recherche et d’Application en Télédétection (CURAT), Côte d’Ivoire,
2. Laboratoire climat et occupation du sol par télédétection ; Rennes, France
3. Institut National de la Recherche Scientifique, Centre Eau, Terre et Environnement, Canada
4. Direction des Ressources en Eau (DRE), Ministère des Eaux et Forêts

KEYWORDS: modélisation, télédétection, SIG, HYDROTEL, variabilité climatique, hydrosystème

ABSTRACT
L’étude du fonctionnement de l’hydrosystème du N’zo, situé en région guinéenne humide à l’Ouest de la Côte d’Ivoire, est basée sur le couplage du modélėhydrologique distribué HYDROTEL aux données géospatiales issues de la télédétection et de SIG. Les simulations hydrologiques montrent une assez bonne reproduction des processus hydrologiques (Nash en validation : 76 à 93 % ; écarts de volume < 20 %). Les paramètres d’évaluation de performance montrent que le modèle HYDROTEL, initialement conçu pour les milieux tempérés peut s’appliquer à la modélisation des processus hydrologiques des milieux tropicaux. Ainsi, la modélisation des écoulments et des échanges "eaux de surface/eaux souterraines" dans un double contexte de variabilité du climat et de modification du couvert végétal permet-elle d’analyser les processus hydrologiques dans l’ensemble du bassin. Dans le secteur amont du bassin, le couvert forestier n’a pas connu de changement notable (30,9 % en 1986, puis 27, 3 % en 1990 et 27,5 % en 2002). La constance du couvert végétal et des variables d’état du sol influencent très peu la variabilité de la réponse du bassin aux événements pluvieux. Aucun impact significatif n’est ressenti sur le régime hydrologique. La variabilité des écoulments, relevée au cours des simulations avec HYDROTEL, est liée à la variabilité pluviométrique. Les épisodes de sécheresse qui ont prévalu de 1970 à 1990 ont perturbé le fonctionnement du bassin et affecté les ressources en eau de surface et souterraine.

En aval du bassin, les modifications environnementales ont été très importantes. Le couvert forestier dense qui occupait 40,7 % du bassin en 1986 a été réduit de moitié en 2002, où il n’occupe que 20 % du bassin. Cette régression forestière au profit des mosaïques "forêt-cultures" et "culture-forêts" a affecté considérablement les réponses hydrologiques de l’hydrosystème. Cette étude basée sur l’intégration de données de télédétection et des SIG dans un modèle hydrologique distribué a permis de mieux comprendre le fonctionnement du bassin du N’zo et constitue une innovation dans la gestion des ressources en eau dans une perspective de développement durable.

FARMERS PERCEPTION AND ADAPTATION TO CLIMATE CHANGE: IN BAHIR DAR ZURIA DISTRICT, AMHARA REGIONAL STATE, ETHIOPIA

Solomon Addisu Legesse 1
1. Bahir Dar University, College of Agriculture and Environmental Science, , Bahur Dar, Ethiopia,

KEYWORDS: climate change, adaptation, perception

ABSTRACT
Agriculture is the main sector of Ethiopian economy. It comprises about 52% of GDP, generates more than 85% of foreign exchange earnings and employs about 80% of the population. Adaptation to climate change is a two-step process, which initially requires the perception that climate is changing and then responding to changes through adaptation. Many research findings indicated that climate change have significant impacts on tropical regions, particularly poor countries are vulnerable to the harmful effect of climate change. This paper tried to show the significant of climate change by using 30 years temperature and rainfall data in addition to primary data collected using questionnaires to assess the perception of farmers. Climate models such as INSTAT and Climate prediction models are used. Accordingly, the average annual maximum temperature is increased by 1°C (from 26 to 27°C).
This value is also computed Using the equation, $y = 0.0226x + 26.104$ (obtained from the trend line). The change in annual maximum temperature change is found to be around 1.06°C. To the average, the annual maximum temperature is found to be 26.104, however; this value is not kept constant as a result of the change in climate by 1°C. On the other hand; the change in annual minimum temperature change is found to be around 3.16°C. To the average, the annual minimum temperature is found to be 10.118°C, however; this value is not kept constant as a result of the change in climate by 3°C. When we compare to the change in annual maximum temperature to the change in annual minimum temperature, the annual minimum temperature shows a great difference. These indicate that the temperature is increasing time to time. There is a significant change in the average amount of annual rainfall from 1961 up to 2009. The trend line shows that the average amount of annual rainfall becomes decreased approximately by about 162.964mm. This is computed by using the equation $y = -3.3258x + 1519.4$. As indicated in the equation the slope is negative, this is because of the decreasing of average amount of annual rainfall. To the average, the amount of annual rainfall is found to be 1519.4mm, however; this value is not kept constant as a result of the change in rainfall approximately by 162.964mm. Regarding the direction of the change in temperature and rainfall 78% of the sample households perceive an increase in annual temperature and 66.7% a decrease in annual rainfall. Therefore we concluded that most of the farmers in the study area have information or concept about climate change. Higher temperature and changing precipitation levels caused by climate change will depress crop yields and also increase spread of diseases for both humans and crops. Farmers’ ability to perceive climate change is a key precondition for their choice to adapt.

APPLICATION DES TECHNIQUES SPATIALES POUR LE SUIVI DE LA SECHERESSE AU MAROC

Noureddine Bijaber 
1. Centre Royal de Télédétection Spatiale, Maroc

KEYWORDS: sécheresse, télédétection, météorologie, agriculture

ABSTRACT
Le Maroc est un pays caractérisé par une faible pluviométrie annuelle moyenne et une forte variabilité intra et interannuelle des précipitations. Au cours de ces dernières décennies, il a souffert de plusieurs épisodes de sécheresse. Ceci a des répercussions essentiellement sur l’agriculture pluviale qui occupe une superficie importante du pays (plus de 85% de la SAU) et aussi sur tous les autres secteurs dépendant des ressources en eau (l’industrie, le tourisme les ménages et surtout ceux qui se trouvent dans le milieu rural...).

Depuis les années 80, le Maroc a mis en place des structures et des programmes importants de lutte contre les effets de la sécheresse et d’économie de l’eau. Néanmoins, les approches adoptées restent plus réactives que proactives. Le système mis en place mérite d’être renforcé et amélioré par la création d’un système d’alerte précoce qui peut aider dans la gestion du risque de la sécheresse.

Les données d’observation de la terre, de part leur caractère synoptique et global, leur répétitivité et leur format numérique facilement utilisable, et en combinaison avec les données météorologiques, agronomiques, forestières et socio-économiques, contribuent d’une façon considérable à l’élaboration d’indicateurs d’alerte et de suivi spatiotemporel de la sécheresse.

L’objectif de la présente étude (projet SMAS, Système Maghrébin d’Alerte à la Sécheresse, financé par la Commission Européenne dans le cadre du programme LIFE_Pays Tiers) est de développer une approche de gestion de risque de sécheresse à travers la mise en place d’un système d’alerte précoce basé sur des indicateurs calculés à partir de données météorologiques, satellitaires et thématiques. Ainsi, l’observation et le suivi de la sécheresse pourraient jouer un rôle important en termes d’alerte précoce avec un effet d’anticipation et de mise en œuvre de mesures préventives.

L’alerte précoce à la sécheresse utilise des données macrogéographiques élaborées à l’échelle nationale, collectées, pour les plus dynamiques d’entre elles (météorologiques et satellitaires), sur un rythme quotidien, décadaire ou mensuel. L’analyse de ces données permet de calculer des indicateurs de la vulnérabilité conjoncturelle. Les indicateurs utilisés sont : l’indice de végétation standardisé (SVI), l’indice de condition de végétation (VCI), l’indice de condition de température (TCI), l’indice de l’état de santé de végétation (VH), l’indice des précipitations standardisé (SPI), le rapport à la normale (RN), l’état d’avancement des travaux des sols et des réalisations des semis des céréales d’automne ainsi que l’état d’avancement de la préparation des sols et la réalisation des reboisements forestiers.

**EVALUATION DE LA VULNERABILITE AU CHANGEMENT ET A LA VARIABILITE CLIMATIQUE ET DE LA SECURITE ALIMENTAIRE AU MAROC A L’HORIZON 2030: LIENS ENTRE LES MOTEURS SOCIO-ECONOMIQUES ET AGRICULTURE.**

I .Ifaadassan ², L .Bounoua ², M .MESSOULI ¹
1. NASA Goddard Space Flight center Greenbelt Maryland 20771
2. Département de Biologie LHEA 0033, Faculté des Sciences Semlalia Marrakech

**ABSTRACT**

L’étude prospective de l’impact des Changements Climatiques (CC) sur les rendements agricoles au Maroc d’ici à la fin du 21ème siècle (Banque Mondiale), indique que l’augmentation de l’aridité va avoir des répercussions négatives sur les rendements agricoles, surtout à partir de 2030, et ce sont les cultures pluviales (non irriguées) qui seront particulièrement affectées par les CC. Il ressort, également de cette étude, que le progrès technologique (amélioration des rendements agricoles en conditions arides et semi-arides), l’irrigation (gestion de l’eau au niveau de la parcelle agricole, du bassin versant et de la région) et l’utilisation des terres selon leur vocation agricole sont des clés importantes d’adaptation aux CC.

Nous proposons de développer un modèle qui permettra l’analyse quantitative des conséquences environnementales, sociales et économiques actuels et potentiels sur les changements d’utilisation des terres agricoles dans les 20 prochaines années. Les mesures satellitaires de la NASA (LTD, MOD12Q1 et MOD15A2) offrent une occasion unique pour répondre à ces priorités nationales d’importance stratégique. Le modèle proposé, qui intègre la télédétection, les statistiques socio-économiques et démographiques et des indicateurs de changements climatiques, cherche à créer un cadre où des questions peuvent être posées et répondues. Nous allons utiliser le modèle pour répondre à plusieurs scénarios plausibles et d'explorer comment les variations des forçages auraient une incidence sur l'utilisation future des terres agricoles et la production au cours des 20 prochaines années, ce qui peut avoir des répercussions importantes sur les services éco-systémiques, la sécurité alimentaire, le bien-être humain et la durabilité des moyens de subsistance.

Le modèle proposé repose sur les règles fondamentales relatives à l’offre et la demande. En général, la loi de la demande stipule que plus le prix d’un bien est minime plus les gens vont l’exiger. D’autre part l’offre devient plus élevée lorsque les prix sont en hausses, augmentant ainsi les revenus, mais le prix reste toujours en augmentation. Dans ce cadre théorique, l’échange va atteindre l’équilibre lorsqu’il est égal à l’offre.

Dans le monde réel, cet équilibre est toujours en fluctuations et prend des valeurs stochastiques. Dans notre étude, l’indice de vulnérabilité (VI) sera défini comme le rapport entre les quantités demandées et fournies des denrées agricoles, représentées par NPP et exprimées en grammes de carbone.

**PRODUITS D’OBSERVATIONS ET DE PREVISIONS METEOROLOGIQUES : CONTRIBUTIONS DE L’ACMAD A PREVISION DES PHENOMENES EXTREMES ET A LA PREVENTION DES SYSTEMES D’ALERTE PRECOCE EN AFRIQUE**

Abdou Adam Abdoul-Aziz Abébé ¹
1. Département Veille et Prévision Numérique du Temps ACMAD,

**ABSTRACT**

Les dernières décennies du 20ème siècle ont été marquées par des variabilités et changements climatiques, des modifications importantes avec notamment la fréquence des sécheresses, les débuts et fins de saison de pluies, les inondations et des pauses pluviométriques très prononcées en cours de saison.
Dans ce contexte de forte variabilité pluviométrique à plusieurs échelles de temps : décennale, interannuelle, intra-saisonnier et à court terme, L’une des options d’adaptation aux impacts de cette variabilité et des changements climatiques est l’amélioration des systèmes d’alerte précoces nationaux et régionaux, afin de réduire la vulnérabilité des sociétés et des écosystèmes. Cela passe nécessairement par une amélioration de la prévision des phénomènes météorologiques à forts impacts socio-économiques, incluant toutes les échéances de prévision du temps, depuis la courte échéance (1 à 2 jours)en passant par la moyenne échéance (7 à 10 jours) à la prévision climatique saisonnière (1 -3 mois). Ces diverses échéances correspondent à des problématiques différentes telles que la sécurité alimentaire, la gestion des ressources en eau, la santé, l’environnement, la sécurité des personnes et des biens... L’économie africaine est partiellement tributaire des informations météorologiques sur la qualité et quantité de pluie espérées pendant l’été, les périodes favorables aux semis et aux récoltes, les périodes de pause pluviométrique longues (plusieurs jours à quelques semaines). Ces informations sont cruciales pour optimiser la planification. Elles favorisent des prises de décisions durables et économiques pour les communautés déjà très vulnérables. Ainsi, leurs besoins en produits de prévisions couvrent le court terme jusqu’à l’échelle saisonnière. Les épidermes récurrentes en Afrique (paludisme, méningite, choléra...) sont associées à des phénomènes climatiques caractéristiques des différentes saisons, poussières, vents de sable, humidité, températures, pluies, inondations...Le développement de systèmes d’alerte précoce en matière de santé ne pourra se faire sans une amélioration du suivi et de la prévisibilité de ces paramètres et phénomènes. Les phénomènes à fort impact et potentiellement dangereux pour les populations (vents forts, poussières, pluies intenses ...) sont associés au développement de la convection, dont la prédictibilité diminue au fur et à mesure que l’échéance s’allonge. La prévision météorologique et climatique de la courte échéance à la prévision saisonnière, tant au niveau régional qu’au niveau national. Un effort particulier est porté sur le renforcement des capacités au niveau des services météorologiques nationaux afin de leur permettre d’élaborer des produits utiles aux usagers concernés. Pour la fourniture d’information climatique aux Service Météorologiques Nationaux et aux organisations humanitaires et à nos partenaires, l’ACMAD utilise les produits d’observation par télédétection suivants pour le suivi environnemental et la gestion de risque climatique: La température de la surface de la mer pour l’élaboration de l’appréciation saisonnière de la pluviométrie ; Le NDVI pour la veille environnementale, notamment le suivi de la sècheresse ; Les différentes imageries satellitaires d’EUMETSAT pour les suivi des poussières atmosphériques ; L’albédo et la température de la surface pour le suivi de l’évolution des plans d’eau et de l’humidité de la surface, paramètres utilisés dans le suivi de risque d’inondation. Intégrées aux Systèmes d’Alerte Précoce et aux processus de prise de décision dans la gestion de risque aux catastrophes naturelles, ces informations apportent des valeurs ajoutées et concourent au développement durable

SEASONAL ANALYSIS OF LAND SURFACE TEMPERATURE (LST) AND RAINFALL VARIABILITY OR SUB-SAHARAN AFRICA

Amos T. Kabo-bah 1, Chenai E. Madamombe 2, Donald T. Rwasoka 3, Webster Gumindoga 3, Kamila Kabo-bah 5
1. Green WaterHut, Box UP913, KNUST, Ghana,
2. Digby Wells Environmental, Fern Isle, Section 5< 359 Pretoria Avenue Randburg, 2125, Republic of South Africa
3. Upper Manyame Subcatchment Council, Box 1892, Harare, Zimbabwe
4. University of Zimbabwe, Dept of Civil Engineering, Box MP 167, Harare, Zimbabwe
5. School of Geography, Nanjing Normal University, No1 Wenyuan Road, Nanjing, China

KEYWORDS: Land surface temperature, TAMSAT rainfall products, Seasonal variability

ABSTRACT

Anticipated climate change and increased climate variability have the potential to affect the spatial and temporal distribution of rainfall and also land surface temperature (LST).

It is the general observation that, LST and rainfall are somehow related and influence land-atmosphere flux exchange such as evaporation. The ability to describe the variability and interrelationships of these phenomena sp
atally and temporally can be supported by the growing satellite data availability. These interrelationships have however not been thoroughly explored in developing countries. Though, it might be common in developed countries about such conditions and relationships for their countries, the development and availability of similar studies are still premature and maybe non-existent now in Sub-Saharan Africa. To address this issue, this study assessed the relationships and seasonal variability of LST and Rainfall for the selected regions in Ghana and Zimbabwe using NOAA-AVHRR satellite datasets (2000-2010) and Tropical Applications of Meteorology using Satellite (TAMSAT) rainfall derived products (2000-2010) for the analysis. Specific relationships developed for both dry and wet seasons promise to be useful inputs for irrigation and general water resources management purposes. The results in this study also form a foundation for other related work involved in the use of LST and rainfall for other environmental modelling purposes.

ESTIMATION OF EVAPOTRANSPIRATION IN THE OM ALRABEEA BASIN IN MORROCO USING THE SEBS MODEL

Firas Alazem , Amos Tierneyang Kabo-bah , Mohammad Abdullah Alshamrani
Saudi Geophysical Consulting Office, PO, Box 1587, Alkhobar 31952, Kingdom of Saudi Arabia,
2. 2College of Hydrology and Water Resources, Hohai University, 1 Xikang Road, Nanjing 210098, China
3. 3Green WaterHut, Box UP 913, KNUST, Kumasi, Ghana,

KEYWORDS: Sebs, Actual Evaporation, Om Albraco Basin, Morroco

ABSTRACT

Evapotranspiration (ET) is an important indicator for assessing the water balance of catchments as it is a key loss factor. In the management of large catchments and related study areas, it has become imperative to understand the spatial actual evapotranspiration, as this is important for hydrologic, environmental and irrigation purposes. Therefore, reliable estimation of actual evaporation is critical for informing decision makers and planners in use and management of water resources for securing food production and adequate water supply to communities. The traditional methods of estimation of actual evapotranspiration do not inform us of the spatial behavior and hence, makes it difficult to comprehend the spread of ET during planning of water resources. The Surface Energy Balance System (SEBS) model in Integrated Land Water Information System (ILWIS) software has proven in the last decade as an appropriate tool for estimating the actual evaporation in a study area using a combination of satellite data and meteorological input. The SEBS model generates land surface fluxes using remote sensing data and meteorological data inputs to derive actual evapotranspiration. In this research the SEBS model was run using atmospherically rectified MODIS satellite imagery collected over clear sky days between the period of 2001 and 2012 for the Om Alrabeea basin of Morocco. The results were check for consistency and physical applicability with estimates from the FAO Penman-Montieth potential evapotranspiration. These results showed a comparable variation of evaporation over the whole study area. It indicated that both meteorological and SEBS derived actual evaporation were comparable spatially but differ in quantities at some specific locations as a result of the technical difference between the two methods (potential – Penman-Montieth estimate and actual – MODIS ET estimate). Also, these differences could be attributed to the assumptions made in both meteorological data inputs and some remote sensing data used for the research. Typically, the results show that the MODIS ET show a variation of 0.5mm/d to 8.5mm/d for the study period. It was realized that for some months for instance January, there were typically “white scars” in the MODIS ET estimates. These “white scars” were considered large cloud activity during this period and rendered some pixels with null values. These null values were typically not used in computation to avoid large introduction of errors to final ET estimates. Generally, the variation of ET estimates also show a rather erratic trend indicating the climate change variability in this region. Also, the MODIS ET estimates for some parts of the study area recorded zero ET for a particular day. This was considered very possible in a region where the desert can be potentially too dry such that, within a certain depth of soil and surface, it is impossible to evaporate any water. Hence, actual evapotranspiration for such study locations record no value. Notwithstanding, the research showed that MODIS data could be used to estimate actual evaporation using the SEBS model. The SEBS model also demonstrated its applicability to support the spatial determination of the actual evapotranspiration in the Om Alrabea basin of Morocco. The methods used in this research could be applied to other places of study in Africa.
PRELIMINARY RESULTS

Figure 1. SEBS daily evapotranspiration for month of October 2001 (mm) for the Om Alrabeaa Study area

Figure 2. SEBS daily evapotranspiration for month of April 2002 (mm) for the Om Alrabeaa Study area

Figure 3. SEBS daily evapotranspiration for month of October 2003 (mm) for the Om Alrabeaa Study area
GROUND-BASED FTIR MEASUREMENTS OF N2O AND CH4 AT TROPICAL SITE: CHARACTERISATION AND COMPARISON WITH SATELLITE DATA

G. Mengistu Tsidu¹, S. Takele Kenea¹, T. Blumenstock¹, F. Hase²
1. Department of Physics, Addis Ababa University, POBox 1176, Addis Ababa, Ethiopia,
2. Institute for Meteorology and Climate Research (IMK-ASF), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

KEYWORDS: hydrologie, télédétection, climat, semi-aride, neige, Haut Atlas

ABSTRACT

Since May 2009 high-resolution Fourier transform infrared (FTIR) solar absorption spectra are recorded at Addis Ababa (9.01°N latitude, 38.76°E longitude, 2443 m altitude above sea level), Ethiopia. The vertical profiles and total column amount of ozone (O₃) were deduced from the spectra by using the retrieval code PROFFIT (V9.5) and regularly determined instrumental line shape (ILS) was applied. A detailed error analysis of the O₃ retrieval is performed. Averaging kernels analysis of the target gas provide that the major contribution to the retrieved information always coming from the measurement. We have compared the FTIR retrieval of ozone Volume Mixing Ratio (VMR) profiles and column amounts with the coincident satellite observations of Microwave Limb Sounding (MLS), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) and Tropospheric Emission Spectrometer (TES), Ozone Monitoring Instrument (OMI) and Atmospheric Infrared Sounding (AIRS) instrument. A good agreement is determined from an intercomparison of O₃ profiles and column amounts of different instruments. The mean relative differences are generally found below +15% in the
altitude range of 31 to 36 km for comparison of VMR profiles made between MLS and MIPAS, whereas comparison with TES has shown below 9.4% relative difference. Furthermore, the mean relative difference is positive above 31 km, suggesting positive bias in the FTIR measurement of O₃ VMR with respect to MLS, MIPAS and TES. The overall comparisons of columns amount of satellite measurements with the ground-based FTIR instruments show better agreement exhibiting mean relative differences of ground-based FTIR with respect to MLS, TES and OMI within +0.21% to +4.88% and corresponding standard deviations of 4.33 to 10.55%. However, in the case of AIRS, the mean relative difference is -4.59%.
CLIMATE CHANGE ADAPTATION PRACTICES IN RURAL FARMING COMMUNITIES OF UGANDA: A CASE OF HIGHLANDS AND SEMI-ARID AREAS

Mwerera R.L. 1, Isubikalu P. 2, Majaliwa J.G.M. 3
1. Department of Environmental Management, Makerere University College of Agricultural & Environmental Sciences P. O. Box 7062, Kampala Uganda,
2. Department of Extension Education, Makerere University College of Agricultural & Environmental Sciences P. O. Box 7062, Kampala Uganda
3. Department of Geography, Geo-informatics and Climate sciences, Makerere University College of Agricultural & Environmental Sciences P. O. Box 7062, Kampala Uganda

KEYWORDS: Adaptation, perception, Climate change, Sustainable land management

ABSTRACT

Climate variability and change in Uganda have affected the livelihoods of many people in various ways, but most significantly are farmers who largely rely on rain fed agriculture. The study was carried out to capture farmers’ perception about climate change, identify existing adaptation practices and constraints to adaptation in rural farming communities of semi-arid (Nakasongola district) and highlands (Kabale district) of Uganda. This information was collected through semi-structured questionnaire, focus group discussions, key informant interviews and observations. A total of 80 households and 20 key informant interviews, and 4 FGDs were conducted. Respondents were drawn from villages with land management projects (SLM) and high access to market (HAM), SLM with low access to market (LAM), No SLM with HAM, and No SLM and LAM. The results revealed that majority of farmers in highlands and semi-arid were aware of climate change. The farmers in highlands (32%) and semi-arid (43%) were closely in agreement that temperature has increased. However, 29% in highland and 11% in semi-arid did not know if there is a change in temperature. There was strong association between the presence of SLM projects and accessibility to market and people perceptions on change in temperature ($X^2=30.45$, $P=0.0005$). The major adaptation practices used by the farmers were changing planting dates, changing crop varieties, changing crop types, implementing soil and water management practices like terracing and mulching, expanding amount of land under production and fertilizer application. The constraints to adaptation included lack of access to money, no access to credit facilities, lack of agricultural inputs and lack of information on climate change and variability.

ANALYSE DE LA STRUCTURE DES ECHOS RADAR PAR APPROCHE FRACTALE

Hamza Talem 1, Boualem Haddad 1, Mohamed Khider 1
1. USTHB, Faculté d’Electronique et d’Informatique, BP 32 El Alia Bab Ezzouar,

KEYWORDS: Land surface temperature, TAMSAT rainfall products, Seasonal variability

ABSTRACT

Ce papier porte sur l’analyse de la texture des échos radar par l’approche fractale. Les paramètres considérés dans cette étude sont la dimension fractale et la lacunarité fractale. L’objectif recherché et de savoir si les deux paramètres permettent d’identifier les échos parasites en provenance de la surface terrestre dans les images radar. Pour ce faire, nous avons considéré deux sites radars où prévalent des climats différents. Il s’agit des régions de Bordeaux (France) et Sétif (Algérie).

La dimension fractale est une mesure de l’irrégularité d’un objet. Parmi les algorithmes utilisés dans le calcul de la dimension des images radar, nous avons appliqué l’approche Aire/ Périmètre et la technique comptage de boites ou Box – Counting [Mandelbrot, 1983].

L’approche Aire/ Périmètre utilise la relation : $P = C SDp/2$
Où $P$ et $S$ désignent respectivement le périmètre et l’aire de l’écho et C’est une constante.

Le principe de notre algorithme consiste en premier lieu de segmenter et codifier les différentes régions contenues dans l’image radar. Ensuite, on comptabilise pour chaque région le nombre de pixels $S$ recouvrant la surface et le nombre de pixels $P$ délimitant son périmètre. A partir de la courbe de tendance représentée par le couple de valeurs ($Ln (S)$, $2*Ln (P)$), on déduit la valeur de DP.

La technique Box Counting est la méthode la plus utilisée pour le calcul de la dimension fractale. Elle consiste en la génération de l’image contour des cellules. Puis, on pave notre image par des boites de taille $[xL]$. 

266
Ensuite, on comptabilise le nombre de boîtes N. Cette opération est répétée pour différentes valeurs de L [2, 4, 8,...,2p]. La valeur 2p représente la taille maximale de l'image. On représente Ln (N) en fonction de Ln (1/L) et ensuite, on ajuste le nuage de points par la droite Ln(N) = Df * Ln (1/L). La dimension fractale correspond à la pente de la droite. La table 1 donne les différentes dimensions fractales.

<table>
<thead>
<tr>
<th>Type d'ondes</th>
<th>Type d'écho</th>
<th>Dimension fractale</th>
<th>Taux de corrélation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radar du Levé</td>
<td>Echos de précipitations</td>
<td>1.421 ± 0.0410</td>
<td>1.4124 ± 0.0090</td>
</tr>
<tr>
<td>Radar du Levé</td>
<td>Echos du sol (Foule)</td>
<td>1.466 ± 0.0270</td>
<td>1.422±0.0145</td>
</tr>
<tr>
<td>Radar du Levé</td>
<td>Radar du sol (Foule)</td>
<td>1.39±0.0160</td>
<td>1.39±0.0160</td>
</tr>
<tr>
<td>Radar du Levé</td>
<td>Radar du sol (Foule)</td>
<td>1.39±0.0225</td>
<td>1.39±0.0225</td>
</tr>
<tr>
<td>Radar du Levé</td>
<td>Radar du sol (Foule)</td>
<td>1.41±0.0310</td>
<td>1.41±0.0310</td>
</tr>
</tbody>
</table>

**Table 1.** Valeurs de la dimension fractale estimée par les deux approches aire/périmètre et comptage de boîte, pour les différents échos.

Nous constatons que la dimension fractale de chaque type d'écho dépend de l'approche utilisée. La structure des échos radar n'est donc pas mono fractale mais plutôt multi fractale. Aussi, on remarque que les valeurs de la dimension fractale des précipitations et des échos du sol se chevauchent. On déduit donc que la dimension fractale ne peut pas servir à identifier les échos parasites. La lacunarité fractale, du latin lacuna, lacune ou trou a été introduite par Mandelbrot en 1983 pour caractériser la distribution des trous dans un objet géométrique à une échelle donnée. Plus un objet est homogène, plus sa lacunarité sera faible. À l'inverse, plus la variété des trous contenus dans un objet est grande, plus sa lacunarité sera élevée. La lacunarité notée Λ est donnée par [Mandelbrot, 1983] : 

\[ Λ = \frac{E(M_a)}{E(M_a)} \left(1 \right)^{1/2} \]

où Ma est la masse d'un ensemble fractale (le nombre de pixels), E(·), la valeur moyenne de la quantité entre crochets. Pour calculer ce paramètre, nous avons utilisé l'algorithme de glissements de boîtes proposé par Allain et Cloitre (1991). La figure 1 donne les variations de la lacunarité fractale pour le site de Bordeaux en fonction de la taille L de la boîte. On constate pour cette région que les échos radar sont décrits par des lacunarités différentes quelque soit l'échelle d'analyse L. On relie que les précipitations sont plus homogènes que les échos parasites en provenance de la surface terrestre. L'analyse des lacunarités fractales obtenues pour le site de Sétif confirme l'homogénéité des précipitations par rapport aux échos parasites du sol. Ce résultat a été aussi vérifié pour les sites de Melbourne (États-Unis) et Dakar (Sénégal. On peut donc conclure que la lacunarité fractale est un paramètre discriminant entre les précipitations et les échos parasites du sol.

**Figure 1.** Variation de la lacunarité fractale pour les échos de précipitations (rouge), les échos fixes du sol (bleu) observée à Bordeaux.
ADAPTATION OF FARMING SYSTEMS TO LAND USE MANAGEMENT AND CLIMATE CHANGE IN AKURE, NIGERIA

Awodun, M. A
Department of Crop, Soil and Pest Management, Federal University of Technology, P. M. B 704 Akure. Nigeria

ABSTRACT
Agriculture is of paramount importance in the developing world. It supports a significant proportion of the population economies and livelihoods and most other sectors or activities depends on it but climate change impacts is already being felt throughout in the developing world. Thus, from economic development perspective, adaptation is crucial in order maintain the natural resources and reduce vulnerability impacts. Comparative field survey was carried out on demonstration plots at the Federal University of Technology Akure and on farmers plot at Igoba in Ondo State, Nigeria to ascertain the coping and adaptive level of mono-cropping, intercropping and mixed cropping farming systems by farmers to climate change. Results showed that farmers' revenues are negatively affected by warmer and dryer climate. Mono-cropping is the most vulnerable farming system but mixed cropping proved more adaptive to climate change. It was also observed that, mitigation and adaptation strategies by farmers to improve resilience to impacts of climate change involved selection of crops combination that will survive harsh condition such as maize-beans, cowpea-sorghum and millet–groundnut. It was evident that, blending of global and more localized strategies can do much to mitigate and helps farmers reduce adaptation cost.

DEVELOPPEMENT D’UN SYSTEME D’INDICATEUR DE SUIVI DES CHANGEMENTS CLIMATIQUES DANS LA REGION DE MARRAKECH TENSIFT AL HAOUZ

N. Boukachaba 1, A. Babqiqi 2, et M. Messouli 3
1. Université Cadi Ayyad, Faculté des Sciences Semlalia, LHEA Département de Biologie, Marrakech, Maroc
2. Observatoire Régional de l’Environnement et du Développement Durable

KEYWORDS: Impact Variabilité Changement Climatique

ABSTRACT
La problématique des changements climatiques est devenue de plus en plus préoccupante. Les différentes observations montrent (IPCC 2007, WGI – The Physical Science Basis) un réchauffement global accompagné d’une évolution vers un système climatique plus fragile (hausse du niveau de la mer, dérèglement des systèmes pluviométriques, augmentation des phénomènes extrêmes, réduction des ressources en eau ...). De plus, les projections futures promettent des évolutions dans le sens de l’aggravation. Les impacts de ces changements climatiques à l’échelle globale comme à l’échelle régionale ont des coûts socio-économiques importants particulièrement pour les pays les plus vulnérables.

Le Maroc est l’un des pays concernés par les changements climatiques. Les sécheresses fréquentes qu’il a connues ces dernières décennies (1981-1984, 1991-1995) et le rabattement de la nappe phréatique, dont les effets sur l’économie nationale n’étaient pas négligeables, en témoignent. En effet, ces sécheresses ont causé une réduction de la capacité des barrages, un dérèglement du régime des oueds, une réduction des rendements des cultures ...


La région de Marrakech Tensift Al Haouz reste l’une des régions les plus vulnérables au Maroc vu son type du climat aride à semi-aride, sa position géographique et ses ressources hydriques faibles. Afin de mieux suivre les impacts des changements climatiques sur le milieu naturel et les activités socio-économiques de la région (principalement l’agriculture), il est nécessaire de procéder à une évaluation précise de ces impacts à l’aide d’un système d’indicateurs. Ainsi, préparer la plateforme pour la mise en place d’un plan territorial en matière des changements climatiques dans la région.
Le travail vise à appliquer les outils scientifiques et techniques disponibles au niveau international pour développer un système d’indicateurs de suivi des changements climatiques et d’évaluation de ces impacts sur l’agriculture et les ressources hydriques. Les indicateurs développés seront intégrés par thématiques dans un système d’information géographiques (SIG) pour faciliter leur exploitation par la suite.

**TERRESTRIAL ESSENTIAL CLIMATE VARIABLES FROM REMOTESENSING FOR IMPROVED REGIONAL CLIMATE IMPACT STUDIES IN WEST AFRICA**

_Ursula Gessner_¹, Markus Niklaus ¹, Tobias Landmann ², Claudia Künzer ¹, Stefan Dech ¹,²
¹. German Aerospace Center (DLR) – German Remote Sensing Data Center (DFD), Oberpfaffenhofen, 82234 Wessling, Germany,
². University of Wuerzburg, Department of Remote Sensing, 97074 Wuerzburg, Germany

**KEYWORDS:** Land surface temperature, TAMSAT rainfall products, Seasonal variability

**ABSTRACT**

Climate change is regarded as one of the biggest threats for ecosystem functioning and human livelihood in West Africa. Around 80% of the West African population depends on rainfed agriculture and yields are closely related to seasonal climatic conditions. Latest climate studies based on modeling and remote sensing have revealed a strong coupling between land surface processes and climate at seasonal and intra-seasonal time scales particularly in West Africa (Xue et al., 2012). However, the current understanding of emerging climate impacts in West Africa is mainly based on models considering land surface input data which have been derived at global or continental scales. The used land surface datasets are not adjusted to the specific conditions of the West African region, such as persistent cloud coverage, high interannual and seasonal variability of vegetation and high landscape heterogeneity of savannas and other regions of small-scale agriculture. Furthermore, climate modeling approaches often assume stable land surface conditions and do not exploit the potential of remotely sensed time series to reproduce the seasonal cycle and interannual development of many Terrestrial Essential Climate Variables (ECVs; GTOS, 2008).

One goal of the WASCAL (West African Science Service Center on Climate Change and Adapted Land Use) initiative, funded by the German Ministry for Education and Research (BMBF) is to evaluate and enhance remote sensing products of ECVs which will be used as input for regional climate models and land surface – climate interaction studies in West Africa.

Here we present several terrestrial ECVs based on remote sensing time series which show potential to better account for land surface – climate coupling in regional climatic impact studies of West Africa (here: Ghana, Burkina Faso, Ivory Coast, Togo and Benin). Focus of the presentation will be on land cover datasets, leaf area index (LAI) and vegetation cover as well as on time series of lake level / surface water extent based on multi-sensor remote sensing data. Existing global and continental datasets of land cover and LAI are compared and their suitability for the West African region is evaluated. First regionally adapted datasets of vegetation cover and surface water extent will be presented. The examples illustrate the need for and the potential of well-adapted remotely sensed time series of ECVs for improved regional climate modeling studies in West Africa.

**SATELLITE-BASED RAINFALL ESTIMATION: EVALUATION AND CHARACTERIZATION (A CASE STUDY OVER OMO-GIBE RIVER BASIN: ETHIOPIA)**

_Dereje Mekonnen Asfaw_

Geospatial Technology Development Directorate Technology study and supervision departement,

**ABSTRACT**

Rainfall is a key climatic element considered as the most important factor that influencing the Ethiopian agriculture and it is also principal cause of droughts and flood triggered by the fluctuation and excess of rainfall extreme events respectively. It is known that the pattern and distribution of rainfall in Ethiopia is highly variable. Therefore, the understanding of such situations and integration of this knowledge into planning and decision making process is not doubtful. At present, the great amount of available rainfall data does not allow to a direct access by human user to the whole content of information. As D.Grimes, professor of reading university in UK, cited in the proceeding of meteorological satellite data users conference in 1997, the past 30
Impact of Urbanization on Water Resources in the Context of Climate Change (A Case Study of Jaipur Urban Area through Multi-Temporal Remotely Sensed Data and GIS)

Kamal Narain Joshi

1. Institute of Development Studies, 8-B, Jhanlana Institutional Area, Jaipur-302 004 (India),

ABSTRACT

One of the many environmental problems incurred by climate change is the negative impact on water resources in urban areas. The effects of climate change on water quality and availability are significant, including shortages and contamination that directly affect health of people and proper functioning of urban development and government. Unplanned growth of urban area further deteriorates the situation. The present paper provides an overview of some of the effects of urbanization on water quality as well as quantity in Jaipur urban Agglomerates, the most populous area in the state of Rajasthan (India). The study has been carried out with the help of remote sensing and GIS techniques. The paper investigate the effects of land use change (from rural land use i.e. forest, agriculture, pastoral and culturable wasteland to urban land use) on water resources.

The Jaipur city has experienced its expansion at the cost of peripheral agricultural land, quite often very fertile and productive. This process has been resulted the conversion of agricultural lands which was prone to ground water recharge zone into non-agricultural uses mostly commercial and residential purpose. Apart from the diversion of lands for non-agricultural uses, the extensive damage to ecology and environment due to industrial waste, pollution, and misuse of land can also be seen in the urban areas and its periphery.

During the course of study a series of thematic maps covering climatic parameters and anthropogenic activities have been prepared to depict the changes and its impact on water resources vis-à-vis land use. It was found that due to increasing pressure of population and anthropogenic activities like infrastructure development, industrial development and other urban development activities have made negative impact on water resources and encroached upon lakes, rivers, streams, and ponds etc in the vicinity of urban area. Finally, it is suggested that by using remote sensing and GIS technique one can prepare an integrated plan for urban development in which surface water bodies can be protected which in turn would take care of recharge of ground water and also provide the surface water in decentralized manner in the urban area.
COULD LOCAL PERCEPTIONS OF WATER STRESS BE EXPLAINED BY LULCC?

Ayeni, A. O.¹, M. A. Cho ² A. Ramoela ², R. Mathieu ², J. O. Adegoke ³, A. S. O. Soneye ¹

1. Department of Geography, University of Lagos, Lagos – Nigeria,
2. Ecosystem Earth Observation Group, Natural Resources & Environment, CSIR Pretoria, South-Africa
3. Department of Geo-Sciences, University of Missouri, Kansas City, United State

KEYWORDS: Local, perceptions, water stress, LULCC, derived savanna, SW-Nigeria

ABSTRACT

The negative impacts of land use/land cover changes (LULCC) are many but not limited to: massive alterations ecosystem processes and biogeochemical cycles (e.g. nitrogen, carbon and water), earth-atmosphere interactions, loss of biodiversity, and soil degradation at different spatial and temporal scales. The continuous conversion of forest land into the cultivation and built-up would have destructive consequence on the ecological biodiversity, reduction in the livelihood, and exacerbate the risk of climate change implications in such area. Mapping land use/land cover changes (LULCC) is essential for a wide range land use planning and adaptation mechanisms to global warming/climate change, impacts of natural hazard and socio-economic dynamics in global and local scale. In this study, LULC changes are investigated by using Remote Sensing and rural communities’ perception information on water stress in the induced derived Savanna of Southwestern, Nigeria. Orthorectified Landsat multi-temporal remotely sense datasets of years 1970 & 1972; 1986/1987; 2000/2001 and 2006 were acquired and processed using ENVI 4.4 version maximum likelihood classification method. The result reveals that forest areas were found to decrease with increased in built-up and cultivation/others (open space, bare land, grassland etc.) area. Between 1972 and 2006, forest had reduced by about 50% while built-up almost increased by about 300% of its size in 34years. Forest loss was found to be higher in the Northeast part of forest – savanna fringe and in areas where built-up used to be sparse in the past. The matrix analysis of change detection between 1972 and 1987, 1987 and 2002, and between 2002 and 2006 depicted -20,963.53km² (-48.96%), -4,551.08km² (-20.82%), and -1,156.33km² (-6.68%) image difference in forest landcover with almost 60% loss to cultivation/others class. Notably, however, in areas where forest lost prevailed, increased fetch to the storage water (surface earth dams). Between 1987 and 2006, five dams were constructed in the area which is suspected to have reduced rivers and streams input to the area. The communities’ perception explicit that changes in climatic condition particularly consistent reduction in rainfall, continuous forest degeneration in the last 30years, and diversion of rivers and streams into surface storages (earth dams and reservoirs) are the major factors responsible for water stress and scarcity in the most rural communities of induced derived savanna of SW Nigeria

COASTAL ADAPTATION TO SEA LEVEL RISE ALONG AL BURULLUS AREA, MEDITERRANEAN SEA, EGYPT

Ahmed Kotb ¹

1. Professor of Hydrogeology, Faculty of Science, Al Azhar Univ., Cairo, Egypt

ABSTRACT

Izbat Burj Al Burullus is a village on the Mediterranean Egyptian coast, between Damietta and Rashid cities. The Global warming and climate change processes are affecting sea levels of the study area. Features of the present situation and forecasted scenarios for the future are the main goal and challenge of the present work. Egypt is considered one of the top five countries expected to be mostly impacted with about 1.0 m SLR in the world. The Nile delta coastal zone is most vulnerable to SLR due to its relatively low elevation and local land subsidence. The Nile Delta coast consists of sandy beaches approximately 240 km in length. This coastline has two promontories at Rosetta and Damietta and one “bulge” at Burullus with concave shorelines in between. Burullus area is chosen as a model for this study which is expected to be repeated for other Nile delta regions, because it is located in the center between the two Nile branches. The main objective of the present study is to determine the main impacts of sea level rising on the area of study. Digital Elevation Model DEM (90*90m), satellite imagery, maps, literature review and site visits are the main sources of data had been used in the work. Arc GIS, Global mapper, 13, Golden Software 9.0 and packages are
used to simulate the problem. Contour maps of the lake and sea bottom indicated clearly and attractively the presence of specific bottom characteristics along the coastal region. Three scenarios have been predicted: 0.5m SLR, 1m SLR, and 1.5m SLR scenarios. These scenarios show the areas that will be affected by the SLR. The western part is the most vulnerable part to the SLR, which explains why people do not live there.

RETRIEVAL AND VALIDATION OF O3 MEASUREMENTS FROM GROUND-BASED FTIR SPECTROMETER AT EQUATORIAL STATION: ADDIS ABABA, ETHIOPIA

S. Takele Kenea 1, G. Mengistu Tsidu 1, T. Blumenstock 1, F. Hase 2
1. Department of Physics, Addis Ababa University POBox 1176, Addis Ababa, Ethiopia,
2. Institute for Meteorology and Climate Research (IMK-ASF), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

KEYWORDS: Land surface temperature, TAMSAT rainfall products, Seasonal variability

ABSTRACT
Since May 2009 high-resolution Fourier transform infrared (FTIR) solar absorption spectra are recorded at Addis Ababa (9.01° N latitude, 38.76°E longitude, 2443 m altitude above sea level), Ethiopia. The vertical profiles and total column amount of ozone (O3) are deduced from the spectra by using the retrieval code PROFFIT (V9.5) and regularly determined instrumental lineshape (ILS). A detailed error analysis of the O3 retrieval is performed. Averaging kernels analysis of the target gas provide that the major contribution to the retrieved information comes from the measurement. We have compared the FTIR retrieval of ozone Volume Mixing Ratio (VMR) profiles and column amounts with the coincident satellite observations of Microwave Limb Sounding (MLS), Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) and Tropospheric Emission Spectrometer (TES), Ozone Monitoring Instrument (OMI) and Atmospheric Infrared Sounding (AIRS) instrument. A good agreement is found from an inter-comparison of O3 profiles and column amounts from different instruments. The mean relative differences are generally found below +15% in the altitude range of 31 to 36 km for comparison of VMR profiles made between MLS and MIPAS, whereas comparison with TES has shown below 9.4% relative difference. Furthermore, the mean relative difference is positive above 31 km, suggesting positive bias in the FTIR measurement of O3 VMR with respect to MLS, MIPAS and TES. The overall comparisons of columns amount of satellite measurements with the ground-based FTIR instruments show better agreement exhibiting mean relative differences of ground-based FTIR with respect to MLS, TES and OMI within +0.21% to +4.88% and corresponding standard deviations of 4.33 to 10.55%. However, in the case of AIRS, the mean relative difference is -4.59%.
THE NATIONAL REMOTE SENSING COMMITTEE (CNT), A SPATIAL IMAGES END-USERS NETWORK IN MADAGASCAR: FIRST EXPERIENCE RETURN

Solofo Rakotondraompiana 1,2, Miadana Faramalala 3, Solofoarisoa Rakotoniaina 1,4 and Samuel Razanaka 5

1. Institut & Observatoire de Géophysique d’Antananarivo (IOGA), laboratoire de géophysique de l’environnement et télédétection. Université d’Antananarivo (Madagascar)
2. Ecole Supérieure Polytechnique d’Antananarivo, département de géologie. Université d’Antananarivo (Madagascar)
3. Faculté des Sciences, département de biologie et écologie végétales. Université d’Antananarivo (Madagascar)
4. Faculté des sciences, département de physique. Université d’Antananarivo (Madagascar)
5. Centre National de Recherche sur l’Environnement (CNRE). Madagascar

ABSTRACT
Comité National Télédétection (CNT) is a network of spatial images end-users in Madagascar. Objectives are capacity building, to share information and to encourage emergence of new projects using remote sensing data. CNT was operational since 2009 and this is our first return of experiences.

CNT is an initiative of searchers from University of Antananarivo and it gathers about forty institutions including public administration, universities, private companies and NGOs.

It allows us to transmit to member scientific information about satellites and remote sensing data, to get information from members about their situation so we could use this information for capacity building and negotiation with foreign partners.

CNT has now its own website where we put all information to member and share image data to all users.

But we also meet some problems concerning mainly the legal status of CNT.

THE EUROPEAN UNION GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY (GMES) INITIATIVE AND ITS GLOBAL LAND COMPONENT

Michel Massart 1, Etienne Bartholome 2, Jide Kufoniyi 3, Kamal Labbassi 4, Zeil Peter 5

1. European Commission, DG ENTR, GMES Bureau, 45, Avenue d’Auderghem, 1040, Brussels, Belgium,
2. European Commission, DG JRC, Land Resource Management Unit, TP 440, 2749, Via Fermi, 2107 Ispra, Italy

ABSTRACT
Managing natural resources and biodiversity, observing the state of the oceans, monitoring the chemical composition of the atmosphere: all depend on accurate information delivered in time to make a difference. The European initiative for the Global Monitoring for Environment and Security (GMES) provides data to help deal with a range of disparate issues including climate change and border surveillance. Land, sea and atmosphere - each is observed through GMES, helping to make our lives safer. GMES is clearly considered as the Earth Observation Flagship of the European Union. Its purpose is to deliver information on environment and security which correspond to user needs.

GMES services are based on Earth monitoring data, collected from space (satellites) and in situ measurements. The services produce output information in the form of maps, datasets, reports, targeted alerts, etc. After years of research investment, GMES is becoming a fully operational service programme which is expected to help people and organisations take action, make appropriate policy decisions and decide on necessary investment. GMES also has great potential for businesses in the services market, which will be able to make use
of the data it provides free of charge. Several GMES services have currently been defined: Land, Marine, Atmosphere, Emergency, Climate change and Security.

The Global Land component of the Land Service has been built initially to support EU policies at international level and the European commitments under international treaties and conventions, such as the three Rio conventions on Climate Change, Desertification and Biodiversity. The Global Land component will also be a major contribution of EU to the Global Earth Observation System of Systems (GEOSS).

The Global Land component will start its operational activities in January 2013 with the production of biogeophysical terrestrial parameters at worldwide and African levels, i.e. for example NDVI (Normalized Difference Vegetation Index), Fcover (Fraction of Vegetation Cover), FaPAR (Fraction of Absorbed Photosynthetically Active Radiation), LAI (Leaf Area Index), Albedo, Soil moisture and Land Surface Temperature at global scale. This initial list is completed with additional products that have also demonstrated maturity and user acceptance. The typical time integration and update frequency will be 10 days for the output products which will be delivered on near real time.

The reprocessing of historical data (10 years) to ensure re-analysis and inter-annual comparisons is also part of the activities, as well as the development of an efficient archiving and cataloguing system, including metadata production, and the set up of an easy access data dissemination service which will allow timely provision of data to the operational users as well as access to archived products. A particular attention will be paid to the reviewing, validation and quality control of the products, of the production chains, and of the data dissemination service.

The initial list of terrestrial parameters has been selected through consultation with stakeholders. It builds on the results of FP 7 projects as GEOLAND2 (BioPar service), and other FP7 "GMES and Africa" related projects, on the EUMETSAT LANDSAF and ESA GSE developments, on the DG JRC policy support activities and on the consultations held during GMES User Fora.

The Global Land component will provide information for the Agriculture sector with the production of biophysical parameters relevant for crop monitoring and for crop production forecast. It will also support environmental policies in Africa with a specific orientation towards biodiversity, desertification, drought and water monitoring and early warning purposes, and, at the same time, the Earth system modelling with a focus on the land / atmosphere processes, including the related carbon and water fluxes which are highly relevant for the Climate Change policy.

The Global Land component is supported by an Open and Free Data Access Policy allowing a wide use of the data, fostering the development of downstream applications by African partners and thus strengthening the EO application sector. The component will ensure the continued provision of products to activities developed under the EU-Africa partnership: e.g. projects as AMESD (African Monitoring of the Environment for Sustainable Development) and MESA (Monitoring for Environment and Security in Africa). It will also support the current "GMES and Africa" initiative.

**SPACE-BASED TECHNOLOGY IN CAPACITY BUILDING FOR SUSTAINABLE DEVELOPMENT**

Ojo A. G., Adesina F. A.

1. African Regional Centre for Space Science & Technology Education, PMB 019 OAU Campus, Ile-Ife
2. Department of Geography Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

**ABSTRACT**

Space technology remains a critical driving force behind the success stories of the economies of many nations of the world today. Nigeria has made good effort to be in this community of Nations who produce space data and provide space-based services.
The path to the attainment of Nigeria’s relatively high profile in space-based technology and application was charted with the establishment of the National Space Research and Development Agency (NASRDA) in 1999 and the subsequent launch of Nigeria’s first Earth Observation Satellite (NigeriaSat-1) in September 2003. Nigeria has pursued the establishment of space capabilities as an essential tool in her socio-economic development particularly in the enhancement of the quality of life of her people. The need to build indigenous capacity in Space Science and Technology (SST) in Nigeria and indeed all over Africa can therefore not be over-emphasized.

The advent of space technology has changed the way resources are managed. It has revolutionized the development and use of technology in handling data acquisition, management and transfer as well as sharing. With space-based technology, it is now possible to arrive at informed decisions in socio-economic development planning. The use of space-based resources thus has the potential to impact many areas of socio-economic development including food security issues, energy, resource inventory and management, environmental monitoring, healthcare delivery, infrastructural development, disaster prevention and rapid response in emergencies, defence and security. It is also capable of enhancing Nigeria’s commitment towards global partnership to address global challenges such as hunger and diseases and promote peace, education, human rights, gender equality and environmental sustainability.

The interface of space technology and sustainable development has to be defined and exploited through appropriate capacity building for national development. This requires concerted efforts at putting space resources in the mainstream of tools for the development of the various sectors of the nation’s economy. Hence, Space technology offers a wide range of innovative and cost effective solutions for sustainable development by providing a unique opportunity to balance consumption and production, and therefore ensure sustainability of our resources and the global environment.

GEOMATICS EDUCATION AT THE MIDLANDS STATE UNIVERSITY IN ZIMBABWE

Shoko, M. 1

1. Department of Surveying and Geomatics, Midlands State University, Gweru, Zimbabwe

KEYWORDS: Authors, Conference, Manuscript, Guidelines, Remote Sensing

ABSTRACT

Education is a continuous contributor to professional continuity and research. The biggest challenge facing capacity building in the field of geomatics is that there appear to be far more data users than there are data collectors. It must always remain a primary area of interest in order to nurture its growth for a successful cascade of geoinformation management. In Zimbabwe formal education aligned with the paradigm of geomatics began in 1995 when the university of Zimbabwe converted the Land Surveying degree it had offered for over a decade to bear the name “Surveying and Geomatics” in line with global trends. Five years later the State University in the Midlands act established a university in Gweru. It became Zimbabwe’s third university and the second institution to offer a degree in Geoinformation. Through motivation and research activity by the two departments as well as a growing global awareness of GI, the advent of Geomatics has gradually cascaded to other scientific institutions. They may not offer a full geomatics programme but offer modules in GIS and Remote Sensing application hence contributing to capacity building as well. To date the Midlands State University has churned out over 400 graduates since its inception. This paper reviews the MSU geomatics department’s growth and also depicts the statistics surrounding its contribution to the geomatics industry in Zimbabwe.
UNESCO-BILKOTRAINING RESOURCES IN MARINE REMOTE SENSING DEVELOPED FOR THE 
EAMNET PROJECT

Valborg Byfield 1, Kwame A. Agyekum 2, Stewart Bernard 3, Malcolm Dobson 4, Michael G. Grant 5, 
Deon C. Louw 6, Benedicta M. Oben 7, Yohanna Shaghude 8, Christo Whittle 9
1. University of Salzburg, Austria,
2. Department of Oceanography& Fisheries, University of Ghana, Legon, Ghana
3. CSIR-NRE, Ecosystems Earth Observation, Stellenbosch, South Africa
4. Scotland-on-Line, Technology Park, Gemini Crescent, Dundee, DD2 1SW, United Kingdom
5. Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL1 3DH, United Kingdom
6. Ministry of Fisheries and Marine Resources, Swakopmund, Namibia
7. Department of Plant and Animal Sciences, University of Buea, Cameroon
8. Institute of Marine Science, University of Dar es Salaam, Zanzibar, Tanzania
9. Department of Oceanography, University of Cape Town, Rondebosch, 7701, South Africa

ABSTRACT

EAMNet (Europe Africa Marine Earth Observation Network) links information providers, user networks and 
centres of excellence in Europe and Africa, which are involved in coastal and marine applications of satellite 
data. An important component of this project is the development of training resources for use in African 
universities and professional training courses, using images from African waters to demonstrate key 
applications of satellite remote sensing. The project has developed a series of lessons for the UNESCO-Bilko 
software, which explain how to carry out common image processing and analysis techniques, such as the 
application of flags to mask invalid or poor quality data, the use of image arithmetic, and the use of 
Hovmöllerdiagrams and EOFs for time series analysis.

The Bilko software was first developed in 1987, at a time when marine EOwas almost entirely limited to 
specialists working on expensive, high-specification computers. Today EOIs simply another observational tool, 
acknowledged for its power to provide marine observations with a temporal and spatial coverage that is not 
available from other sources. However, in many countries barriers still exist to the effective use of EOdata in 
the management of coastal and marine environments. This is why the Intergovernmental Oceanographic 
Commission (IOC) and the European Space Agency supported the update of Bilko in 2003-6, and now again in 
2012-14. It is also why the capacity development plans of GOOS-Africa called for development of new lessons 
using examples from African waters and building on African expertise, and thus why Bilko became a core tool in 
the EAMNet training programme.

Why Bilko? There are many reasons: chief of these is the Bilko approach to capacity development. Many 
potential users of EO data will berelatively isolated from others working in their field of marine science. Lacking 
access to EO expertise, they may be reluctant to use remote sensing in their work, despite their recognition 
that this is an area of growing importance.

Similarly, would-be EO teachers maybe unfamiliar with the various satellite technologies, or they may have 
limited access to EO data and processing facilities,and therefore choose only provide theoretical courses, 
rather than practical, hands-on experience of image processing and interpretation. Bilko training resources are 
designed to overcome these limitations. The lessonsare designed for students and teachers working on their 
own with limited technical support. Everything required to complete a lesson is provided: data, processing 
tools, instructions for use, and background information needed for data analysis and interpretation. This paper 
provides examples from some of the most recent Bilko lessons, and shows how the software may be used to 
support marine environmental research and management in Africa.
ASSESSING STRUCTURES FOR GEOINFORMATION (GI) RESEARCH CAPACITY DEVELOPMENT SUSTAINABILITY IN AFRICA: A NIGERIAN CAPACITY BUILDING PERSPECTIVE

Thontteh Olufunmilayo E 1, Adesina Francis A. 2, Kufoniyi Olajide 2
1. Regional Centre for Training in Aerospace Surveys (RECTAS), Obafemi Awolowo University (O.A.U) Campus Ile-Ife, Nigeria
2. Geography Department, Obafemi Awolowo University (O.A.U) Campus Ile-Ife, Nigeria

KEYWORDS: GI, Research, Systematic, capacity building, innovation, adaptation, diffusion, education.

ABSTRACT
The geospatial information (GI) world is awash with diverse evaluations of the quality and quantity of capacity availability and effectiveness in this field of endeavor. It is therefore essential to identify the salient components that have measurable potentials to contribute to the attainment of a systematic fulfillment of GI capacity development requirements for the African continent in the long run. It is necessary to define a systematic structure for the GI capacity building to facilitate rapid and sustainable human and economic advancement in Africa. To this end, this research has pursued the following objectives: to set a regional context for GI capacity development in Africa through an overview of the contributions of the African regional institutions for GI capacity building and to show the presence of any GI capacity coverage gap within the continent. To present a more tractable example of the current capacity impact at a national level, the research has used the Nigerian example to show the spread of GI capacity development from the perspective of diffusion of innovation adaptation. This investigation was based on 5 years epochs between 1980-2010.

To pursue the stated objectives, two categories of institutions were identified: a) Regional institutions from international records of the United Nations Economic Commission for Africa (UN-ECA) through request for data and online questionnaire administration and related information from internet and other printed material sources; b) Nigerian institutions from records of Nigerian National Universities Commission. There was also the use of key informants in the departments within the institutions where these courses were offered. The scope of institutions used to chart the emergence of GI related institutions and courses within Nigerian institutions included tertiary and specialized GI institutions. Also, the types of human capacity considered are Postgraduate Diploma (PGD), Professional Master/ Master and MA/M.Sc level qualifications. For this research, PGD and MA/M.Sc qualifications are considered as a stepping stone to a research oriented career in the GI field whereas, Professional Master/Master course is considered as advance capacity for professional competence. Responses from questionnaires administered by email to target respondents resulted in information used to clarify (as much as possible) the volume of each of these capacities that have been produced over this 30 year period. A count also of institutions’ inception periods were plotted within each 5 year period. Statistical graphs were used to show trend and the resulting graph was compared to the innovation adaptation model curve. Although the pattern of GI capacity development in Nigeria varies from the standard innovation adaptation model, the classification in its current stage is placed between the early adopter and the early majority.

The results also showed that there has been a continuous increase in the number of institutions getting involved in the generation of capacity for GI resource usage, and SDI functions but the larger focus of these capacity is geared towards providing profession feeds i.e Professional Master/Master and other short term courses which currently finds a ready professional market but risk stunting the diversification and scientific development and expansions of GI use within Africa.

RENFORCEMENT DE CAPACITES AU CENTRE ROYAL DE TELEDETECTION SPATIALE : OBJECTIFS, DEMARCHE ET REALISATIONS

Amal Layachi 1
1. CRTS, Morocco

ABSTRACT
En tant qu’institution nationale chargée de la promotion et du développement de la télédétection spatiale au Maroc, le CRTS a positionné dès le départ l’activité de renforcement de capacité à l’échelle nationale et...
DEVELOPMENT AND APPLICATION OF REMOTE SENSING TECHNOLOGY TO THE CAMEROON GULF OF GUINEA COAST: PRESENT STATUS AND FUTURE PERSPECTIVES

Benedicta M. Oben 1, Pius Mbu Oben 1, Valborg Byfield 2, Judith G. Makombu 1, Elizabeth B. Tabi 3, Rhoda N. Bughe 4
1. Department of Plant and Animal Sciences, University of Buea, Cameroon,
2. National Oceanography Centre, European Way, Southampton, SO14 3ZH, United Kingdom
3. Fisheries Research Centre, IRAD, Batoke – Limbe, Cameroon
4. Department of Microbiology, University of Yaounde 1/ ENS, Yaounde, Cameroon

ABSTRACT
The Guinea Current is the dominant feature of the shallow ocean off the coast of countries in Western Africa stretching from Guinea Bissau in the north to Angola in the south (Gulf of Guinea). It is recognised as one of the world’s most productive marine areas, rich in fishery resources, petroleum production, and an important global region of marine biological diversity. However, the coastal areas of the Gulf of Guinea and particularly the Cameroon coast are faced with numerous problems that threaten their productivity and biological diversity. These include the presence of noxious algal blooms and epidemic disease pathogens; habitat degradation; declining fish stocks and a relatively slow uptake of aquaculture, largely considered as the last frontier sustaining the contribution of fish to food security. Research survey based in the University of Buea, Cameroon has indicated the development of capacity in Satellite Remote sensing (SRS) and related technology as playing a key role in mitigating and providing possible solutions to some of these issues. The present paper reviews some of these problems in more detail, presents capacity developed so far in SRS and shows future areas planned for remote sensing application. The possible implications of ensuing models for other parts of sub-Saharan Africa and the importance of collaborative research with scientists from other parts of the world more developed in the use of SRS technology is also highlighted.

SUPPORTING SUSTAINABLE DEVELOPMENT AND CAPACITY STRENGTHENING IN AFRICA THE “PRIORITY AFRICA” INITIATIVE OF THE UNITED NATIONS UNIVERSITY

Joerg Szarzynski 1, Elias Ayuk 1, Jakob Rhyner 1
1. UNU-EHS / UNU-ViE

ABSTRACT
Addressing the needs of developing countries - in particular Africa - is a cross-cutting issue throughout the work of the United Nations University (UNU). Comprising 15 institutes and programmes located in 13 countries around the world, UNU is also assisted by a network of associated institutions and numerous cooperating institutions, researchers and scholars worldwide supporting the dedicated efforts to finding research-based solutions to the most pressing problems. The mission of the United Nations University is to contribute, through collaborative research, capacity development and advisory services, to efforts to resolve the pressing global problems that are the concern of the United Nations, its Peoples and Member States. A particular niche for UNU in Africa will be to assist countries to acquire the human capacity to plan and implement programmes that
lead to the achievement of the primary objectives of the New Partnership for Africa’s Development (NEPAD) and the attainment of the Millennium Development Goals (MDGs).

In this context the UNU Priority Africa Initiative brings together ideas, expertise, capacities and resources under a collaborative umbrella that supports African development. It further streamlines UNU’s approach to the development in Africa. This is achieved through an information hub that identifies target audiences and takes stock of the rich activities being conducted by UNU in Africa. Furthermore, working collaboratively, UNU organizations, donors and partners create an environment of knowledge sharing. Ensuring that Africa has co-ownership of its own development is a major element of the initiative. This is achieved through UNU Twin Institutes as well as building networks with and between African partners.

This paper will present major aspects of UNU’s focus on Africa aiming to make UNU activities in and on Africa of greater relevance to the African continent and its people, the UN organizations and UNU end-users; it aims to make UNU-generated knowledge on peace, environment, development and sustainability better acknowledged, recognized and used. In the particular context of early warning, vulnerability assessment as well as risk and disaster management UNU is seeking for strong collaboration and reliable networking with already existing competency centers and universities in Africa with core competencies in the field of Remote Sensing and Geographic Information Systems. Thus, the further intention of this paper is also to explore the potential of future collaboration with major players in the field of earth observation and geo-information science for environment and development in Africa and in particular to develop local synergies, research projects and capacity development initiatives that benefit African people and contribute to the development of the continent.

**CONTRIBUTION OF SPATIAL DATA INFRASTRUCTURE IN INTEGRATED MANAGEMENT OF NATURAL RESOURCES AND ENVIRONMENT IN THE NIGER RIVER BASIN**

Mahamadou S. Keita

1. Regional Centre for Training in Aerospace Surveys (RECTAS), OAU Campus, Ile-Ife, Nigeria

**KEYWORDS**: Spatial Data Infrastructure, Natural Resources, Environment, River basin

**ABSTRACT**

Nowadays, the management of natural resources and environment has become a major issue of global concern. In West Africa in general and the Niger River basin in particular, the various studies and diagnostic investigations revealed major environmental problems such as deforestation, land degradation, pollution, siltation and others.

The Niger River basin covers an area of about 2 million square kilometres in nine countries (Benin, Burkina Faso, Cameroon, Ivory-Cost, Guinea, Mali, Niger, Nigeria and Chad) who share it. Niger River is the third longest river in Africa after the Nile and the Congo. It is 4200 kilometres long from its source in the tropical forest of Guinea-Conakry to the south of Nigeria where it joins the Atlantic Ocean in a wide delta. The Niger River contributes to livelihoods and the geopolitics of countries in its basin. Niger is also a symbol of regional identify, a process of migration and trade, but also a potential source of conflict and a catalyst for cooperation. In the area, several development projects were initiated for the relief of the victims of natural disasters that inevitably occur in inadequate conditions of exploitation of natural resources, often to the detriment of the environment. Unfortunately, these projects have not been up to expectations due to a lack of coherence, reliability of geospatial data and methods used. Obviously, this problem of availability of reliable data and tangible results seriously hampers the implementation of development projects.

The objective of this on-going research is to develop a tool for all the actors involved in the management of the Niger River basin to face the challenges associated with the extraction of geographic information, the revision and a better dissemination. In other words, to allow stakeholders to provide reliable geospatial data for the management of natural resources and the environment of the Niger River basin and to exchange them properly.
The methodology proposed for this research consists:

To make an inventory of the development projects in the Niger basin, the actors involved and the existing geospatial data, systems and policies (National Statistical Systems, Environmental Information Systems, Geographic Information Systems, National Spatial Data Infrastructure, etc...);

To propose a mechanism for creating a set of fundamental data and a harmonised framework for collecting, processing and exchange of data that meet the needs of all stakeholders;

To adopt standards for the production of reliable geospatial data;

To harmonise the data, the method sand concepts used by the stakeholders for a perfect integration;

To undertake the harmonisation of metadata;

To develop a Regional Spatial Data Infrastructure (RSDI) which will be recorded in a “Regional Spatial Data Infrastructure Policy” document;

To implement this powerful tool in the sustainable management of natural resources and environment in the Niger River basin.

The model of Regional Spatial Data Infrastructure in the Niger Basin (RSDI-NB) to be developed will be used to facilitate the implementation of development projects in the Niger River basin.

The results of the different case studies will clearly demonstrate the contribution of the Spatial Data Infrastructure (SDI) in the management of natural resources and environment in the Niger River basin and also the importance of SDI in decision-making and sustainable development of riparian countries of the Niger River. The prototype RSDI-NB and the Regional Policy will be proposed for presentation, extension, validation and implementation for other initiatives in West Africa (UEMOA, ECOWAS, ABN, etc...).

A PERSPECTIVE OF THE KENYA SPACE PROGRAMME. YESTERDAY, TODAY AND THE FUTURE

Anthony M. Mwangudza 1, Andrew O. Nyawade 2, John N. Kimani 2, Margaret Maimba 3
1. Italian Space Agency (Broglio Space Centre – Malindi), Kenya
2. Ministry of State for Defence, Kenya
3. National Council for Science and Technology

ABSTRACT

Kenya is currently pursuing the goal of attaining a newly industrialized nation status by the year 2030. The basis of this dream (VISION 2030) is that the national economic programme shall be science and technology driven. The country recognizes that a powerful component of technology that drives world economies is space technology and its applications.

Therefore, it is imperative that the Government of Kenya invests in space enterprise, espouses space technology transfer and institutes capacity building in Space science and technology. To manage these developments, the Kenya government in 2009 gazetted the Kenya National Space Secretariat to initiate the process of formulating a National Space Policy and realise the Kenya Space Agency by 2012.

Kenya’s gross domestic product is set to increase 18 times in the next eight years, if it focuses on innovation and training. Kenya by 2020 could command 20 per cent of the Africa’s GDP of about Ksh249 trillion (i.e. Ksh54.8 trillion), if innovations and human capital become the nation’s growth focus. The projected GDP can be realized with increased innovations in ICT, agriculture and improved efficiency in governance and human capital, particularly rigorous exposure of the population in science, technology and ICT innovations. The optical fibre network (National Optical Fibre Backbone Infrastructure - NOFBI) which has been rolled out all over Kenya is a pointer to the determination of the government’s endeavour to connect the entire country. This is a key component in communication and data sharing, which is essential in quick disbursement of space based related information and data products.
In readiness for this engagement, about 30 Kenyan professionals have been trained and are practicing in space science and technology related fields. Currently, enough qualified technical personnel and research scientists have been trained in remote sensing, orbital mechanics and navigation, spacecraft payloads and platforms, communications, space mission design and analysis, and various aspects of space activities, and are currently working in their specific fields of specialization. At the moment, Kenya has fairly achieved a critical mass necessary to pursue the next level of becoming a space faring nation.

Kenyan scientific community is geared towards research in space science and technology, and more programmes will be rolled out in other related fields in our institutions of higher learning. Internship programmes are available at the Broglio Space Centre, Malindi for students’ advancement, collaborative research projects with other universities and theses development in space science and technology up to PhD level. Training programmes are on course for students and scientists to study in Italy through the Kenya-Italy bilateral agreement. Kenyan researchers continue to participate in research projects such as aerosol particle pollution research in weather and climate change detection and monitoring in collaboration NASA, land surface temperature, vegetation index and desertification monitoring in the Northern frontier regions of Kenya, ocean surface temperature, chlorophyll and sediment monitoring off the shores of the Kenyan coast and lake Victoria, detection and monitoring of forest fires in collaboration with the Italian Space Agency. Other work includes projects undertaken at the Regional Centre of Mapping of Resources for Development, Nairobi and other institutions.

Mounting of the Astronomy and astrophysics undergraduate degree course at the University of Nairobi, and the Tracking, Telemetry and Command Station at Broglio Space Centre in Malindi through the support of Satellites dedicated to high energy astrophysics, SWIFT and AGILE. These satellites dedicated to the study of various aspects of the activities in space including the phenomena of gamma ray bursts attributed to collapsing of stars, and the emissions from black holes have offered invaluable experience to Kenyans.

Kenya is located at an appropriate site similar to the European Space port in Kourou (French Guyana) ideal for equatorial based launches, hence it is prudent to look for private public partnerships, regional and international cooperation for the establishment a land based launch facility on the Kenya coast which gives an azimuthal rocket launch window of about 60 degrees. Kenya also needs to claim its rightful geostationary orbit slot for a communication satellite. Such infrastructure is also necessary for rapid economic development in terms of revenue earning and savings for the country and the region.

The short and long term perspectives (VISION 2030) will rely on the key aspects in satellite data acquisition, necessary

Optical and SAR data for surveillance, mapping of land and coastal resources and exploration, including the Kenya extended economic zone, environmental assessment (atmosphere and land), monitoring of pipelines and other infrastructure in the country and collaboration with the other East African countries, rocket launches and cooperation is viewed as strategic.

However, there are some challenges which have to be overcome such as updating of the space policy that may be hampered by political, bureaucratic and financial considerations, inadequate training, infrastructure and capacity building, the high cost of accessing space technology and lack of an indigenous satellite for national use.

None the less, Kenya in the context of the East African Community States, which include Uganda, Tanzania, Rwanda, Burundi, and soon Ethiopia, South Sudan and Somalia are going to be a regional focal point for Space Science and Technology activities. In line with Vision 2030, Kenya must establish a ground launch base, design, build and launch an indigenous spacecraft by 2030. The Inter-governmental agreement between Kenya and Italy as established and its existing infrastructure, be fully exploited for rapid development in training, satellite data acquisition and processing, and must fully participate and meaningfully contribute to the African Resource environment and Management satellite Constellation (ARMC) Initiative.
GAZELLE STRATEGY: DEFINITION OF A REMOTE SENSING STRATEGY FOR MEDITERRANEAN AFRICA

Marino Palacios Morera 1, Gemma Ventura Parra 1, Araceli Pi Figueroa 2, Antonio Reppucci 2, Isabelle Piccard 3, Yetkin Özüm Durgun 3, Dirk Tilsner 4, Lourdes Bugalho 5, Jolijn Leen 6, Joeri van Wolveelaer 6, Pierre-Philippe Mathieu 7
1. Indra Sistemas S.A./ Mar Egeo, 4. Pol. Ind. n° 1. (Madrid)-Spain,
2. STARLAB. C/Teodor Rovira 1, 45. 08022 Barcelona-Spain
4. EDISOFT, S.A. Rua Quinta dos Medronheiros, Apt. 382, Lazarim. 2826-801 Caparica-Portugal
5. Instituto de Meteorologia de Portugal. Rua C do Aeroporto. 1749-077 Lisboa, Portugal
7. European Space Agency. Via Galileo Galilei-Casella Postale 64. 00044 Frascati (Rome)-Italy

ABSTRACT

Introduction

The Gazelle Strategy consists on a characterization study of the Mediterranean Africa (Algeria, Egypt, Libya, Morocco and Tunisia) on EO sector.

The aim of Gazelle is to analyse the current situation of EO sector in this region in order to draw a Strategic Plan to steer activities during the following 5 years.

It includes a market characterization supported by the execution of 4 Service Trials in different Mediterranean Africa countries and a final Action Plan reflecting the recommendations for the future.

Service Trials description

The objective of the Service Trials is to validate the local demand and the potential for EO based solutions through them involving EO European service industry and local partners.

The following table shows the Services Trials that are currently under execution:

<table>
<thead>
<tr>
<th>Service Trial Title</th>
<th>EO Service</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Remote sensing as a tool in the application of international agricultural insurance: grassland monitoring in Algeria</td>
<td>Agricultural Insurance</td>
<td>Algeria</td>
</tr>
<tr>
<td>2. Production of Urban Atlas (1:10.000 scale) for Rosetta City</td>
<td>Land Cover Mapping</td>
<td>Egypt</td>
</tr>
<tr>
<td>3. Drought risk estimation and its impact on cereal crops by developing indices from Earth Observation: application to agricultural insurance on a pilot site in Morocco</td>
<td>Drought Risk Monitoring</td>
<td>Morocco</td>
</tr>
<tr>
<td>4. Vulnerability cartography of the aquifer system of Mateur plain (North-East of Tunisia)</td>
<td>Water Quality Monitoring</td>
<td>Tunisia</td>
</tr>
</tbody>
</table>

A promising Service Trial was selected in Libya, but due to the internal situation of the country in 2011 it has been cancelled.

Service Trial 1. Execution: EDISOFT (Portugal).

Main goal. Demonstrate the operational advantage and use of vegetation monitoring data obtained from combined sensor systems at medium and large resolution observation systems for index-based insurance.

Partnership. The user partnership is constituted by MAPFRE RE (main user) and ENESA (as an international coordinator). A local insurance institution - CNMA (Caisse Nationale de Mutualité Agricole) - is also supporting the Trial.

Input data. LSA SAF, MERIS FR, MODIS AQUA/TERRA from 2005 to 2009.
Methodology. An image fusion approach based on multi-resolution and multi-source spatial analysis is used in order to obtain a composite image with the spectral and temporal characteristics of the underlying low and medium resolution products.

Final products. Grassland map (boundaries), vegetation conditions (at critical stages of growth).

- **Service Trial 2.** Execution: Eurosense (Belgium).

**Main Goal.** Demonstrate that urban mapping services provide useful information for urban planning.

**Partnership.** The final user is the General Organization for Physical Planning (GOPP), the national authority responsible for the urban planning activities.

**Input data.** VHR optical imagery (Quickbird, 2003 and WorldView-2, 2010) is used to support the urban mapping. HR Landsat images of years 2011, 2002, 1984 and 1972 are used to develop urban extent and land cover maps; these provide an assessment of the regions’ land cover changes.

**Methodology.** Manual classification techniques are used for the creation of the urban atlas maps. A pixel-based classification approach is used to carry out the high resolution land cover mapping.

**Final products:** Urban atlas maps and land use change analysis (VHR); and HR urban extent and land cover maps enabling an urban change analysis over the last 40 years.

- **Service Trial 3.** Execution: VITO (Belgium).

**Main goal.** Investigate if indices derived from MR (250-500m) sensors can be used for insurance against drought (for cereals), to provide reliable information for damage and risk assessment and possibly for compensation payments, or if HR (10-30m) images are required.

**Partnership.** CRTS (Centre Royal de Teledetection Spatiale du Maroc) as a local contact point.

**Input data.** (i) EO data: optical medium resolution images from MODIS-250m (2000-2011) and MERIS FR sensors (2009-2011), HR (30m) Landsat 5/7 TM/ETM+ images (2007, 2009-2011) and VHR (5m) RapidEye images (2009-2010), (ii) meteorological data, (iii) land cover information (iv) yield statistics.

**Methodology.** A number of indices, such as NDVI, fAPAR and DMP, will be computed from MODIS and MERIS images and the correlations with cereals yield will be investigated. The best sensor/index combination will be used for crop damage and risk assessment. The results will be validated using HR (Landsat) and VHR (RapidEye) imagery.

**Final products.** Anomaly maps, potential damage maps and risk maps at medium resolution.

- **Service Trial 4.** Execution: STARLAB (Spain).

**Main goal.** Groundwater represents an important reserve in Tunisia, a country where water is scarce. The area of study (Mateur plain), which host an important aquifer, supports intensive fishery activities and several aquaculture farms. The aim of the Trial is to provide water quality indicators in the Ichkeul lagoon that can be used as indicators of pollution level in the aquifer.

**Partnership.** Centre National de la Cartographie et de la Télédétection (CNCT) acts as a User Federator (CNCT group: Thouraya SAHLI CHAHED, Sinan BACHA, Ahmed EZZINE, Najeh SAYAH and Neila BOUZGUENDA). The products will be delivered to the final user, i.e. Commissariat Régional au Développement Agricole de Bizerte (CRDA).

**Input data.** MERIS FR.

**Methodology.** MERIS L1B products will be calibrated and corrected using specific algorithms for inland waters. In a second step the relevant water quality parameters will be estimated. Then vulnerability maps will be produced analyzing the time series of different water quality.

**Final products:** monthly and seasonal Chlorophyll, Total Suspended Matter (TSM) and Algal Bloom maps, both with thematic and numeric content. The monthly and seasonal aggregation will be based on P90; and Vulnerability maps associated to Chlorophyll, TSM and Algal Bloom maps.

**General conclusions**

The final stage of the Gazelle Strategy will be a definition of an Action Plan. This Plan will be based on all the information gathered during the surveying process which included a market characterization of the demand and supply factors in close contact with local Mediterranean Africa stakeholders and the execution of the Service Trials previously described.
EVALUATING USE OF EARTH OBSERVATION PRODUCTS BY GOVERNMENT DECISION-MAKERS

Kate Lance ¹, Yola Georgiadou ²

1. SERVIR Coordination Office, USRA/NASA Marshall Space Flight Center, National Space Science and Technology Center (NSSTC), 320 Sparkman Dr., Huntsville, AL 35805, USA
2. Faculty of Geo-Information Science and Earth Observation of the University of Twente (ITC), PO Box 217, 7500 AE, Enschede, The Netherlands

ABSTRACT

A substantial body of earth observation data, predictive models, and geo-referenced information exists from which decision-makers should be able to act to develop and implement effective policies, decision-makers. Nevertheless, mixed results in the uptake of these information assets are common. Simply creating and providing useful information does not mean that it will be used, or used wisely. Whether and how new information is used depends upon whether and how it is incorporated into a complex action cycle from providers to users. SERVIR and ITC are refining quantitative and qualitative methods to evaluate how users embed earth observation data into their decision processes. SERVIR, a unique development program that receives strategic direction from the United States Agency for International Development (USAID) and technical expertise from National Aeronautics and Space Administration (NASA), has been developing Earth observation products to enable government decision makers to better address climatic impacts due to climate variability and change. SERVIR provides a timely opportunity for longitudinal analysis of EO product usage. SERVIR has maintained a database of project partners and individuals who have participated in project-related training. Also, SERVIR has documented cases of routine use of EO products by government agencies (e.g., for fire hotspot and chlorophyll monitoring), whose use context now can be studied in depth. At the same time, situations in which information products have not been used can be explored, thus capturing reasons why EO information products seemingly have been passed over. Three factors are thought to influence the likelihood that information will become embedded in users’ decision-making: the information’s perceived value in achieving users’ goals; its compatibility with decision-making routines (format, timeliness, and accessibility); and its comprehensibility (congruence of the character of the information with the ability of users to understand and use it). SERVIR and ITC will use a stages-of-use analytical framework to evaluate information product use based on interviews and surveys to policymakers/decision-makers. Product value, compatibility, and comprehensibility also will be assessed. This paper discusses the evaluation framework that is being developed by SERVIR, as well as the methods for conducting the research. Beyond the methodological contribution, the results of this work should make a significant contribution to EO system developers. Studying the information behavior of decision-makers should help improve how products are designed and deployed, how use of these information products can be better cultivated, and ultimately help improve the impact of EO products.

10 M-RESOLUTION SENTINEL-2 SATELLITE DATA: AN OPPORTUNITY FOR AFRICA

R. Badal ¹, E. Bartholomé ¹, G. Gulemvuga 3, F. Huynh ⁴, B. Koetz ⁵, T. Korme ⁶ I. Kusane ⁷, M. Leroy ⁸, A. Nonguierma ⁹
1. MOI, Quatre-Bornes, Mauritius
2. JRC, Ispra, Italy
3. CICOS, Kinshasa, DRC
4. IRD, Montpellier, France
5. ESA, Frascati, Italy
6. RCMRD, Nairobi, Kenya
7. BDMS, Gaborone, Botswana
8. CNES, Toulouse, France
9. UNECA, Addis Abeba, Ethiopia

ABSTRACT

The African decision-maker community at national and regional level is in need of good quality high resolution data covering wide parts of the countries for environmental issues such as urban sprawl, water quality, land degradation, deforestation, etc. as well as for resources management. This was one of the conclusions of the
2nd AMESD (African Monitoring of the Environment for Sustainable Development) Forum held in Mauritius in July 2011, which gathered technical experts and decision makers coming from all countries of Africa.

AMESD, a program led by the African Union Commission and funded by the European Union, is probably the first attempt to produce politically-sustained regional infrastructures aiming at providing environment monitoring services based on Earth Observation data at pan-African level. The satellite data accessible in AMESD (2008-2012) as well as in its successor MESA (2013-2018) is based on the implementation of several C-band satellite data reception stations per country, allowing national and regional administrations and institutions to access through the EUMETCast satellite communication system operated by EUMETSAT a wide variety of low-resolution (~1-5 km) environmental and meteorological satellite data and derived products covering the African continent and surrounding marine and coastal areas.

Besides this, the TIGER initiative of the European Space Agency (ESA) supports, under the leadership of AMCOW (African Ministers’ Council On Water), water authorities and technical centres in the African water sector to enhance their capacity by exploiting Earth Observation products and services. Over its 10 years of existence the TIGER initiative has established and supported capacity building activities and development projects in a large number of African countries. ESA has also established through its ENVISAT program the Data Dissemination System (DDS), which since 2005 gave access to large volumes of ESA and ESA Third Party Mission data over Africa.

These activities form a strong basis for the development of Earth Observation in Africa as part of the 8th area: “Science, information society and space” of the Africa – EU strategic partnership, for which a number of key policy areas of interventions have been identified: management of natural resources, marine and coastal areas, water resource management, impact of climate variability and climate change, natural disasters, food security and rural development, infrastructures and territorial development, conflicts and political crises.

When it comes to operational implementation of activities the problem of timely access to high resolution satellite data still remains critical in Africa. For an efficient use by operational users in Africa it is essential (1) that the data be easily accessible to the users, (2) that the data volume be of manageable size, (3) that the data be provided at low or marginal cost, (4) that the data have adequate repetitiveness, (5) that the data be sufficiently processed (i.a. cloud masking, geometric, radiometric and atmospheric corrections) and with a good quality processing.

To answer these needs several options have been considered so far. For the future there is an emerging offer of medium to high resolution satellite remote sensing data in Africa, through the promotion by several countries, including South Africa, Nigeria, Kenya and Algeria of the ARM (African Resource Management) satellite constellation. Although promising, it is still uncertain when and how the data will be available at pan-African level, and with which specifications of resolution, spectral bands, repetitiveness, and processing level. The Geo-Africa concept, proposed by the Astrium-EADS, a commercial space company, is quite innovative and is based on a 1-ton geostationary satellite able to acquire data throughout Africa in the visible and near infrared with a repetitiveness of 5 days at 20 m resolution. However the cost of the program – numbered in hundreds of million Euros – seems prohibitive and it is unlikely that the program will ever be funded. In the meantime the Chinese-Brazilian CBERS satellites provide free-of-charge useful high resolution satellite data. The CBERS-3, -4 and -4B satellites to be launched in 2012, 2014 and 2016 are equipped with a 5m-resolution camera with 60 km swath, and 20m-resolution cameras with 120 km swath.

The processing level of the available products and the means of distribution of the data to the users are still, however, to be clarified.

The Sentinel-2 mission, developed by ESA within the GMES (Global Monitoring for Environment and Security) program, will offer an interesting additional opportunity to cover African needs in high resolution data, in the framework of the Africa-EU partnership mentioned before and its related GMES-Africa program in discussion. The two Sentinel-2 satellites, the first one officially planned to be launched by end 2013, will image every pixel on Earth at 10 to 20 meter resolution in several visible, near and shortwave infrared bands with a repetitiveness of 5 days (2 satellites) or 10 days (1 satellite). ESA will produce and make available open and free Level 1C data (top of atmosphere orthorectified reflectance) globally on Earth at 10 meter resolution with at most 24 hours delay with respect to the acquisition time.
Although of high value for many classes of users, the 1C processing level may be insufficient to many others focussing on downstream thematic applications, and who do not want or have the resources to carry out by themselves additional pre-processing, such as cloud screening, atmospheric correction and multi-date synthesis. Such processing lines exist. As an example, CNES has developed with the scientific support of CESBIO (http://www.cesbio.ups-tlse.fr) a multi-sensor processing line applied already successfully to Landsat and Formosat satellites data. The processing includes an automated atmospheric correction scheme and cloud mask delineation algorithm, leading to daily surface reflectance products (level 2A); and a timecompositing to produce essentially cloud free, atmospherically corrected images on a monthly basis (level 3) is underway. An operational production centre using this processing line is currently being built at CNES to process Sentinel-2 data over France, and the extension to wider area coverage could be envisaged. As another example, ESA is developing Sentinel-2 level 2A processing tools that will be made available openly to the user community. Note that the level 1 to level 3 processing reduces the data volume by a factor 3 (1 satellite) to 6 (2 satellites).

Such processing lines could be used to produce e.g. monthly composite surface reflectance products at 10 m resolution in several spectral bands covering part or all of the African continent, and these products could in turn be distributed on a per-country basis to the African user communities such as the ones, already structured in National Focal Points in the AMESD – MESA and TIGER programs. This approach basically extends to high-resolution satellite data the principles of central pre-processing already operationally implemented for low resolutions satellite data exploited by the AMESD-MESA partners in Africa.

The data volume analysis shows that the level 3 data over Africa is about 3 Tbytes per month. If such a volume had to be continuously transferred to African countries through EUMETCast and the AMESD station network or the DDS network of ESA, the transfer rate would be about 10 Mbits per second, which could lead to unsustainable operation costs. Alternative “smart” solutions have therefore to be identified and implemented. If for instance the data distributed to each country cover only the surface of this country, the data to be transferred each month to each country amount to 50 – 250 Gbytes, which is the size of the latest generation USB keys. Such USB keys can simply be sent by post and therefore easily manageable at low cost. Additional solutions could also include lossy compression procedures to further reduce data volume.

Self-evidently, in the long run, such an effort must lay the foundation of multi-level endogenous enabling environments in Africa equipped with the appropriate human, hardware and software resources to exploit such data and able to develop or adapt their operations and services to this new data flow. It must also lead to a strong transfer of related applicable technology and know-how that will enable the continent to develop its own technologies, systems and information services.

In summary, this paper shows that most necessary components will be soon in place and can be activated to serve the African user community in high resolution Earth Observation data in a systematic and reliable way:

1) a constellation satellite system and a ground segment operated by ESA as part of the GMES program to produce globally 10 meter resolution level 1C data, 2) post-processing lines able to reduce the data flow and improve its quality to finally produce cloud-free monthly composites, and 3) on the user side networks are in place or being reinforced through various initiatives as mentioned before, including UN Economic Commission for Africa programme to build up Spatial Data Infrastructures in Africa.

REMOTE SENSING SERVING AFRICAN NEEDS: AN ISPRS PERSPECTIVE

Ian Dowman

1. Department of Civil Environmental and Geomatic Engineering, University College London, Gower Street, London WC1E 6BT, United Kingdom

ABSTRACT

Observation of the Earth from space and from airborne platforms can now provide very large volumes of data in a timely fashion. There are however many factors which govern how the data is used and by whom. These factors include the price of the data, the policy of the government of the country where the data is to be used, and the infrastructure to access, process, analyse and distribute the data and the information extracted from the data. Within Africa there are many variations on these factors, and many models used to acquire, process and use the data. Furthermore there are a number of international and regional organisations which seek to...
influence the use of the data and to develop collaboration and infrastructures to improve the efficacy of remote sensing data to benefit society and the citizens of Africa.

This paper will review the current sources of data in Africa and will look at the organisations which have an interest in the acquisition and use of data. These organisations include national and regional space agencies and mapping agencies, as well as intergovernment agencies such as United Nations, the Group on Earth Observation (GEO) and the UN Forum of Global Geospatial Data Management (GGIM). In addition Non-Government Organisations (NGOs) such as the International Society for Photogrammetry and Remote Sensing (ISPRS) have a role to play, particularly in capacity building; and there is an increasing trend amongst NGOs to collaborate and provide more effective capacity building.

The paper will discuss how all players in the remote sensing community: international bodies, government, industry and NGOs, can contribute to the development of sustainable growth of the remote sensing sector and how this can benefit many sectors of society in Africa. It will also look at the impediments to growth and discuss some ways of overcoming these.

**CONSTITUTION EVOLUTION AND DIVERSIFICATION, FUTURE CONCEPTS AND PLANS**

**Owen Hawkins** 1, **Luis Gomes** 1, **Simon Crouch** 1, **Mauritzio Vanotti** 1

1. Surrey Satellite Technology Ltd. 20 Stephenson Road, Surrey Research Park, Guildford, Surrey, GU2 7YE, United Kingdom

**KEYWORDS:** Constellation, SAR, DMC

**ABSTRACT**

Continuing the low-cost accessible technology pathway demonstrated by the Disaster Monitoring Constellation is demanded by existing users and constellation partners. Maintaining the agile engineering techniques across both more simple and more complex platforms creates both process constraints and benefits.

Possible improvements of the original DMC satellites were identified during a user group symposium resulting in demands for a higher resolution imaging system with an always on capability to provide global imagery coverage of the entire land area daily. Cloud cover mitigation, higher resolution imagers and additional spectral bands have been built into a number of feasible constellation concepts, presented here.

Further to this development the DMC concept was extended to include Synthetic Aperture Radar capability, to operate in constellation mode. The first of these satellites is under manufacture, with the operational concepts presented here for a multinational constellation. The engineering approach is addressed, analysing its impact on the operational capabilities of each individual platform and the constellation as a whole.

This paper further forecasts the potential disruptive applications development possibilities of the constellations and a number of novel distribution concepts to facilitate wide accessibility and low imagery costs. Expected applications in Maritime Security, Agricultural Monitoring and Forest monitoring are discussed. The data mining potential of a always-on archive.

**TOWARDS FREE SATELLITE DATA AND FREE SOFTWARE FOR DISASTER MANAGEMENT**

**Richard Teeuw** 1, **Mathias Leidig** 1

1. Centre for Applied Geosciences, School of Earth & Environmental Sciences, University of Portsmouth, UK

**ABSTRACT**

Disaster management applications of remote sensing are examined in this research, focusing on the uses and limitations of datasets and software that are free or low-cost (ie, costing less than US$ 100). A wide range of
Theme 7: Discussion Sessions

oral presentation

geospatial datasets are currently freely available, from digital elevation models (DEMs) and thematic digital maps, to multi-spectral satellite imagery and virtual globes, such as Google Earth.

Maps of hazardous terrain and vulnerable features can be derived from sets of satellite data such as Shuttle Radar Topography Mission (SRTM) DEMs and Landsat imagery. The derived maps are particularly useful for regional or district (1:50,000 to 1:250,000 scale) emergency planning in low-income countries.

Data integration, spatial/temporal analysis and map production are limited by the frequently high price of geoinformatic software, making the development and application of suitable free and open-source software (FOSS) a priority – this is particularly the case with regard to Object-Based Image Analysis.

Whilst the Internet allows the distribution of free or low-cost geospatial data, software and training materials, there are still some regions with limited and expensive Internet access: improved Internet access for such regions should be a priority.

CONTRIBUTION DES IMAGES SATELLITAIRES A HAUTE RESOLUTION DANS LES DOMAINES DE L’ENVIRONNEMENT ET DU DEVELOPPEMENT EN AFRIQUE : ETAT DES LIEUX ET PERSPECTIVES

Albert H. Anoubon Momo

1. Senior Channel Partner Manager GeoEye, USA

ABSTRACT

L’observation de la terre à partir des satellites est désormais une technologie bien éprouvée. Depuis plus d’une dizaine d’années, des millions de km² d’images sont collectées régulièrement par divers satellites. La résolution de ces images a fait un progrès considérable ces dernières années et il est naturel maintenant de trouver des images avec des résolutions en dessous du mètre. Ces images à haute résolution ouvrent des perspectives plus larges.

Elles sont mises à la disposition d’une communauté de plus en plus grande d’utilisateurs dans des domaines aussi variés que :

- La sécurité nationale et les services d’intelligence
- La cartographie
- L’aviation
- Les services maritimes
- Les hydrocarbures
- La veille environnementale
- Les infrastructures et autres travaux publics
- Le bâtiment
- Les assurances
- L’aménagement urbain
- Les gouvernements locaux et nationaux
- L’agriculture
- La gestion des forêts
- La gestion et la prévention des catastrophes
- Le monitoring
- Les mines
- etc.

En particulier dans les domaines de l’environnement, de la gestion des ressources et de la prévention des risques naturels, les images satellitaires sont devenues incontournables et contribuent significativement à faciliter les missions des différents acteurs pour autant qu’ils sachent s’en servir.

De nombreux pays, conscients de l’importance de l’information spatiale, utilisent au quotidien cette technologie au point d’en faire un outil désormais incontournable. Chaque jour, de nouvelles applications des images satellitaires émergent de même que le champ des utilisateurs continuent de s’agrandir.
Longtemps parent pauvre des évolutions technologiques dans le domaine de l’observation de la terre, l’Afrique devrait tirer profit de ces images à haute résolution pour intégrer leur utilisation dans ses projets de développement.

Cette présentation a pour but de faire un état des lieux à la fois des techniques d’observation de la terre à partir des satellites que des images satellitaires disponibles ainsi que d’envisager les perspectives qu’elles offrent aux différents acteurs de développement en Afrique.

Un historique de l’utilisation des satellites pour l’observation de la terre est nécessaire pour se faire une idée de l’évolution de cette technologie. Ceci permettra également, par la suite, de présenter les programmes du futur qui promettent d’atteindre des niveaux inimaginables il y a quelques années encore. De même est-il important de montrer les nouvelles perspectives dans le secteur notamment le passage de l’imagerie satellitaire par le biais de l’acquisition des pixels à l’accès à l’information spatiale à travers le « cloud ».

Forts de ces éléments de base, il convient alors de donner un aperçu aussi détaillé que possible des différents champs d’application de l’imagerie satellitaire en expliquant à la fois l’utilisation qui en est faite ou qui peut en être faite en Afrique. Ce tour d’horizon mettra en exergue les nombreuses potentialités de l’imagerie satellitaire dans les domaines de l’environnement et du développement de même qu’il mettra l’accent sur des exemples concrets et des cas pratiques permettant d’illustrer leur utilisation en Afrique.

**THE EUROPE AFRICA MARINE EO NETWORK: RESULTS AND FUTURE WORK**

Steve Groom ¹, Stewart Bernard ², Val Byfield ³, Vincent Gabaglio ⁴, João Gomes-Ferreira ⁵, Sylvain Le Moal ⁶, Wahid Moufaddal ⁷, Yohanna Shaghude ⁸, Jun She ⁹, George Wiafe ¹⁰

¹ Plymouth Marine Laboratory, UK  
² University of Cape Town, South Africa  
³ Natural Environment Research Council – National Oceanography Centre Southampton, UK  
⁴ The European Organisation for the Exploitation of Meteorological Satellites, Germany  
⁵ Institute of Marine Research, Portugal  
⁶ MeteoFrance - Centre de Météorologie Spatiale, France  
⁷ National Institute of Oceanography & Fisheries, Egypt  
⁸ Institute of Marine Sciences University of Dar-es-Salaam, Tanzania  
⁹ Danish Meteorological Institute, Denmark  
¹⁰ University of Ghana, Ghana

**ABSTRACT**

EAMNet is a project funded by the European Commission constructing a network linking Earth Observation (EO) information providers, user networks and centres of excellence in Africa and Europe towards sustainable development in Africa. It is doing this by: supporting capacity maintenance and development in Africa; improving use of EO data for coastal and oceanic monitoring towards an Africa-wide observation system (GOOS-Africa); providing an interface between European GMES-related services and R&D projects and African initiatives with the emerging GMES-Africa initiative; contributing to the implementation of the Action Plan for GMES and Africa Partnership.

The project started in March 2010 and is in its final year. Significant achievements already completed include:

Construction of a web-based data portal providing complete coverage of 1-km resolution ocean colour and sea-surface temperature data from the MODIS and MERIS instruments of the African coast and offshore areas of the western Indian Ocean and the west coast of Africa to support the requirements of the marine and coastal theme of the African Monitoring of the Environment for Sustainable Development (AMESD).

Development of an MSc module in marine Earth observation and implementation on two MSc courses in Cape Town, an Operational Oceanography workshop in Cape Town and regional training courses in Ghana and Tanzania.
Award of nine fellowships, following international peer-review, in two rounds of applications, enabling scientists from Nigeria, Cameroon, Ivory Coast, Tanzania, Senegal and Kenya to work in centres of excellence in Africa and Europe. Targeted exchanges of personnel have also taken place between UCT & PML (2), NIOF & PML, UDSM & University of Bangor, UK, and UDSM & UCT.

Input to the on-line consultation on the draft GMES and Africa Action Plan, and assistance progressing the GMES and Africa Action plan through engagement with the new Bridging Actions for GMES and Africa (BRAGMA) project and involvement in the marine and coastal workshop during Summer 2012.

This presentation will summarise these results and discuss how the project will develop in the immediate future.
EUROPEAN VOLCANO OBSERVATORY SPACE SERVICES (EVOSS) A GMES DOWNSTREAM SERVICE FOR VOLCANIC HAZARD MONITORING

Giovanni Laneve 1, Fabrizio Ferrucci 2
1. Dipartimento di Ingegneria Astronautica, Elettrica e Energetica – Unibversità di Roma “La Sapienza”, Via Salaria, 851 - 00138 Roma, Italy
2. Institute de Physique du Globe de Paris, 4, Place Jussieu, Case 89 - 75252, Paris Cedex 05

ABSTRACT
Volcanic hazards are of major national and international importance, affecting many regions of the globe and potentially having an impact on people both on the ground and in transit in the air. In the 20th Century, 91,724 people were killed by volcanic phenomena and 5.6 million people were affected (Witham, 2005).

One in ten people live within a range of a potentially active volcano and most are in urban centres in the developing world (Chester et al 2001). As an example, the 2010 Eyjafjallajokull eruption affected 16,000 of 22,000 flights per day in Europe (a total of 95,000 flights were cancelled by 21st April) and an Oxford Economics report states that in total, the airspaceshutdown cost the UK economy a potential total direct sales loss of £741 million (Oxford Economics, 2010). This particular volcanic event, which by coincidence happened just as EVOSS starting up. This GMES ‘Downstream’ Service project called EVOSS is developing a portfolio of services aimed at robust volcanic hazard monitoring. Crucially, EVOSS is being driven by the needs of the End Users rather than a technology push for space-borne technologies. The End Users include both Volcanic Ash Advisory Centers (Toulouse and London) as well as Volcano Observatories: those of the coordinator IPGP, based in Martinique and Guadeloupe (Caribbean) and Réunion Island (Indian Ocean) and those of Arta (Djibouti), Dodoma (Tanzania), Goma (Congo), Moroni (Comoros), Addis Ababa (Ethiopia), Montserrat, Seismic Research Centre (UWI), and IMO Iceland. These end users play a large part in the project because they are the organizations that have the responsibility for volcano monitoring and volcanic hazard / risk assessments, whilst also having the remit to provide scientific advice to governments.

EVOSS is a three-year project that began in March 2010. Its spatial coverage corresponds with the METEOSAT full-disk, centred on Africa and covering the volcanic regions of the Caribbean to the west and Eastern Africa and the Red Sea to the east (Figure 1). The project is specifically aimed at supplying products for volcanoes undergoing severe unrest and the concept can be readily extended globally.

Building on projects such as GLOBVOLCANO and PROMOTE, the EVOSS international consortium was brought together by six Institutional End Users that have responsibility for volcano observatories and observation services spread across eleven volcanic areas worldwide, and experienced in the objective technical needs of managing major, local or distant volcanic unrest. The EVOSS design specifications were drawn up in close collaboration with the end users, and in fact the end users are guiding the project and the systems that it is producing. In this way, it is clear that EVOSS is not a project built on the rationale of pushing technology out to those who do not require it. There are fourteen end user organizations, ranging from the Volcanic Ash Advisory Centres (VAAC) of France and the UK, along with the Iceland Meteorological Office, and volcanic observatories across the Meteosat disk from Montserrat to Réunion.

EVOSS will provide three services: Thermal Anomalies, Volcanic Emissions (including SO2 and ash) and Ground Deformation products. The first two will be provided in near-real-time while the third will be delivered following an event. The products are derived from a wide range of sensors including SEVIRI (thermal anomalies), COSMO-SkyMed (ground deformation) alongside SCIAMACHY, OMI, GOME-2, IASI and SEVIRI for the atmospheric products. Theses sensors were chosen for their ability to provide high-to-very-high revisits or image refreshment frequencies and multi-satellite observations.

The data are subjected to systematic in-orbit (inter-satellite) validation to minimise errors, while the results, associated with inherent quality/reliability indices, are delivered seamlessly to the End User. Furthermore, the concepts and services will be validated at up to four volcanic sites experiencing severe unrest, at least one explosive and one effusive. A component of the project also focuses on analysing the financial and technical aspects of EVOSS in terms of a business model and hence evaluating sustainability in the medium to long term of the EVOSS services.
GEOINFORMATICS-BASED MAPPING OF CULTURAL HERITAGE OF SUDAN: INITIATIVES AND CHALLENGES OF THE FUTURE UNIVERSITY

Carlos M. Pascual 1, Hassan A.M. Babiker 1
1. Faculty of Geoinformatics, Future University, Khartoum, Sudan

ABSTRACT

Cultural heritage is the most universally valued and most evenly distributed resource in the world. However, it is both fragile and finite that needs geospatial inventory, scanning or digitization of best tools for conservation and restoration for various cultural plans and programs in every country, such as Sudan where cultural mapping project has been started. Cultural mapping has been recognized by national and international agencies and institutions as a crucial tool and technique in preserving the world’s intangible and tangible cultural assets and resources of a country or a given historical areas. It encompasses a wide range of techniques and activities from community-based participatory data collection and management to sophisticated mapping using geoinformatics-based tools such as geographic information systems (GIS), remote sensing (RS), global positioning systems (GPS) and internet/web-based mapping science and technologies. As an initiative of the Faculty of Geoinformatics of the Future University, a pilot project of cultural mapping of the Archaeological Sites of the Island of Meroe was conducted to build wealth of geo-referenced data and information of various cultural assets of more than 50 pyramids and related resources covering the area in Meroe located in Shendi state at northern part of Sudan. Zoning and environmental management plan thematic map of Meroe was also develop to delineate suitable protection zone boundaries for the island of Meroe. Such geoinformatics-based tools showed as indispensible technique in cultural resource mapping and management among academician, researchers, site/planning managers, inter-agency collaborators, and policy makers at local, national and international levels. Moreover, capacity building of such new and emerging geoinformatics science and technologies is very important among other integral components of cultural mapping and project design for sustainability for conservation and restoration will be presented.

ESTABLISHING A LOW COST GROUND BASED RECEIVING STATION FOR REMOTELY SENSED DATA AT THE MIDLANDS STATE UNIVERSITY IN ZIMBABWE

Shoko, M. 1, Kamanda M. 2, Senderayi L.T 1
1. Department of Surveying and Geomatics, Midlands State University, P.O. Box 9055, Gweru, Zimbabwe
2. Department of Livestock and Wildlife Management, Midlands State University, P.O. Box 9055, Gweru, Zimbabwe

ABSTRACT

Timely, accurate and comprehensive information about resources forms the basis of effective national management and planning. Satellite observations can assist in enhancing the observation capabilities by providing additional data and variables, thus complementing and integrating ground observations. Developmental challenges can be minimized through the introduction of Remote Sensing Centers for Earth observation from Space for research and development links in the chain of universities. The task of increasing the economic competitiveness of any country is not possible without reinforcing the role of the higher professional education in policy making. Various research and teaching institutions especially with earth sciences have realized the power of establishing Ground Receiving Stations (GRS). Traditional remote sensing centers at universities are equipped with ground stations enabling them to receive free data, such as worldwide known AVHRR from NOAA satellites series with resolution of 1,100 m and MODIS from Terra and Aqua satellites with 250, 500 and 1,000 m resolution. This opens a wide field for students and researchers to exchange knowledge, ideas and new developments investigating AVHRR and MODIS and other data for global changes. Midlands State University (MSU) as a research fraternity will benefit and create positive stakeholder union and visibility for its research tab through the establishment of such a station.. This paper summarizes the steps taken in establishing a low cost ground receiving station at the Midlands State University.
MOON REMOTE SENSING APPROPRIATE FOR FIXING TIME FOR SOCIAL ACTIVITIES AND EVENTS IN RURAL SETTING

Sr. Prof. Bernadette Ezeliora 1
1. Ebonyi State University, Abakaliki, Nigeria

KEYWORDS: observation, Moon, prediction, record, interpret

ABSTRACT

The purpose of this study is to develop in primary school students the skills of remote sensing and to maximise the information in fixing social activities. Great progress has been made in the application of remote sensing in various spheres of life such as disaster assessment, agriculture mining, detection of anthropogenic and natural dynamics (pollution, drought, forest fires). Remote sensing is of great help in the evaluation and monitoring of natural resources of the planet and for sustainable development with regard to environmental issues. Information system based on remote sensing data has become an important tool for solving various practical tasks today. Our inability to manage the environment cannot be far from our inability to observe critically the changes in our environment and use the data to improve and adjust the condition. Observation is an essential tool for remote sensing as well as ability to record and interpret the data. The Moon is a solar object and its appearance is received with delight and joy in rural areas where electricity is scarcely available. It can only be studied and reached through remote sensing. 100 students of senior primary students who are members of Young Scientists Club were assigned to Moon observation for 3 consecutive months of January, February and March and use the information to predict whether the Moon will appear during some of the social events like Easter, Christmas and new yam festival of 2012. Everyday each child will record and draw the shape of the Moon that day and when there is no Moon appearance it will be indicated by dash or dot. At the end of the exercise each student was to use their data to determine how many days the Moon remains visible and days it is invisible and to predict whether the Moon will appear during essential festivals. The result of the study showed that 90 were able to predict when the Moon appeared after Easter in 2012. The prediction for other events is to be confirmed later. Educational implications were discussed and recommendations were made.

SERVIR-AFRICA: AN EARTH OBSERVATION PLATFORM FOR COLLABORATION

Eric Kabuchanga 1
1. Technology Developer, RCMRD/SERVIR-Africa

KEYWORDS: web portal, geoportal, data acquisition, cloud computing

ABSTRACT

Imagine floods hitting several counties in Kenya. SERVIR One Stop will allow online access to NASA’s satellite images and computer models, where a user could select data from a weather satellite to learn how much rain has fallen on a specific area and incorporate geospatial data from another satellite to determine the shape of the flood plain.

SERVIR integrates satellite observations and predictive models with other geographic information (sensor and field-based) to monitor and forecast ecological changes and respond to natural disasters. In 2008, NASA and CATHALAC partnered with the Regional Center for Mapping of Resources for Development (RCMRD) based in Nairobi, Kenya, and together they began setting up SERVIR’s Africa hub. The SERVIR-Africa project builds upon RCMRD’s existing strengths and augments RCMRD’s data management and training capability. SERVIR One Stop was developed and demonstrates the value of increasing access to geospatial data in developing nations and building capacity to use and interpret the data to solve environmental problems. This is accomplished through an earth observation platform (and integrated web portal) that includes the following components: Web portal map plug-in, catalogue, services (data portal), metadata (geoportal) GIS web map services, spatial analysis (server-based analysis and geo-processing), Data acquisition and processing (product development and enhancement)
This paper describes, from a user’s perspective, the components of SERVIR One Stop that enable data and tools discovery, data acquisition, use/analysis, and sharing of geospatial data and information. The paper also discusses “cloud” computing which SERVIR is embracing to enable access to data and tools 24/7 regardless of power outages and other inconveniences that are oriented to internet connection and hardware maintenance.

SECOND GENERATION AFRICAN RESOURCE MANAGEMENT CONSTELLATION – IMPACTS POSSIBLE TO ADVANCES IN TECHNOLOGY

Sias Mostert, Dusan Sakulski\(^2\), Martin Jacobs\(^3\),
Space Advisory Company, Stellenbosch, South Africa

KEYWORDS: ARMC, Satellite, Constellation, Image processing, Applications

ABSTRACT
This paper will provide an update on the building blocks required to construct an African Resource Management Constellation. It is important as there have been many advances in satellite and ground segment technology since the first agreement on constructing a constellation of cooperating African satellites. The implications of these advances are many more applications that can be served by the ARMC constellation in addition to allowing more participating countries. Advances in the domain of data processing, satellite sensor technology and satellite bus technology will be considered. The implications of these advances on applications will also be reviewed. The paper will close with a review of how to execute the program effectively with African know-how and technology to achieve the original aim of using and growing know-how and technology from Africa.
IMPRINT:

**Editor and media proprietor**: African Association of the Remote Sensing of the Environment, AARSE; Secretariat, 54 Motor St. West-dene, Johannesburg 2092 South Africa; President: Tsehaie Woldai.

**Organizer of AARSE 2012**: AARSE and UCD and MARSE

**Conference Director**: Boumediene TANOUTI (President of UCD);

**Conference Secretariat**: MARSE Faculté des Sciences de l’Université Chouaib Doukkali, Route Ben Mâachou, B.P. 20, 24 000 El Jadida, marse.eljadida@gmail.com.

**Editing, graphic and design**: Local Comite of Organization (MARSE).