TIGER AFRICA

Content

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esa

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TIGER Workshop 2006 Report

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University of Western Cape

Organised in collaboration with:

African Development Bank
African Ministerial Conference on Water
CEOS
Canadian Space Agency
Department of Water Resources and Forestry, South Africa
European Space Agency
Ramsar-Africa
UNESCO-IHP
UN-ECA
University of Western Cape
ITC

Co-sponsored by:

Canadian Space Agency
European Space Agency
UNESCO-IHP

Introduction

Water information systems are a key factor for improving water governance and to implement successfully Integrated Water Resource Management (IWRM) action plans. Today, in many African countries, policies and management decisions are based on sparse and unreliable information.

In 2000, the UN General Assembly included among the Millennium Development Goals (MDGs) a task to reduce by half the proportion of people without sustainable access to safe drinking water. During the 2002 Johannesburg World Summit on Sustainable Development (WSSD), the Heads of States and delegations called on all countries to develop Integrated Water and Resources Management (IWRM) and water efficiency strategies.

In response to WSSD, the European Space Agency (ESA) launched the TIGER initiative in 2002, as a CEOS (Committee on Earth Observation satellites) contribution to assist African countries to overcome water-related problems and to bridge Africa's water information gap using satellite data.

In the last few years TIGER has involved more than 150 African universities, water authorities and technical centres. TIGER supports African partners with access to space-borne data and products, by offering specific training on EO applications for water management, by funding North-South collaborative projects aimed at developing and demonstrating tailored EO-based information services and systems to support African water authorities, and by favouring take-off, operationalisation and technology transfer of those demonstrated systems to African water authorities in order to attain the final goal: improving water governance and IWRM.

TIGER has evolved thanks to the contributions of partners such as UNESCO (and its International Hydrological Programme), UN Africa-Water group (UN-Economic Commission for Africa), African and international institutions in the context of water resource management (e.g. African Ministerial Conference on Water), space agencies (e.g. Canadian Space Agency - CSA), development partners (e.g. African Development Bank) and other international and African organisations (e.g. CSIR of South Africa, Ramsar-Africa, African Departments of Water).

In order to review the status of the initiative and to prepare the basis for the next implementation period, more than 80 African water authorities, scientists and remote-sensing experts gathered in Cape Town, South Africa, from 20 to 25 November to attend the 3rd TIGER Workshop.

The workshop was organised with the objectives to:

- Review the main results of the TIGER research component and its projects.
- Review the preliminary results of the water information services development projects.
- Discuss the main strengths and challenges of the initiative so far.
- Prepare the basis for the next implementation period set to begin in 2008.

Figure 1 TIGER Workshop 2006, November 2006

The workshop was complemented with dedicated training sessions:

1. A four day Training session on Advanced Optical Remote Sensing dedicated to ESA Principal Investigators (22-25 October).
2. A four day Training session on Optical Remote Sensing organised by UNESCO (22-25 October).

Figure 2 Advanced Optical Remote Sensing Training, November 2006

Source: ESA.
For more information: http://www.esa.int/tiger
Contact: tiger@esa.int

Welcome and Opening:

Introduced by the vice-Rector of the University of the Western Cape, Professor Stan Ridge, Minister of Water Affairs and Forestry of the Republic of South Africa, honourable Lindiwe Benedicta Hendricks opened the Workshop.

The Minister pointed out how the 2006 United Nations Human Development Report is highlighting the importance of technology in facilitating access to water, by filling some existing gaps and stated:

"we must therefore congratulate the European Space Agency, UNESCO, and other international partners for their response to this need by having an initiative to address the information gap."

Figure 3 Minister of Water Affairs and Forestry of the Republic of South Africa, honourable Lindiwe Benedicta Hendricks, during her speech

Appreciation was then expressed about the ongoing collaboration among various players in both the public and private sectors to ensure access to information by African countries, in support of sustainable and integrated management of water resources.

The speech was concluded by the following statement:

"space information can effectively be used for management of resources upon which our livelihood depend. I hope the deliberations and discussions during the next two days are fruitful and take Africa to the next level by contributing to the socio-economic development of our continent."

Session 1

Introduction to the African Water Sector: needs and challenges

Chair:
M. Donkor, UN Economic Commission for Africa

Speakers:
M. Donkor, UN Economic Commission for Africa
T. Woudeneh, African Development Bank
C. Moseki, Department of Water Affairs and Forestry, South Africa

Summary

The Session focused on some of the key developments in the African water sector, providing an overview of the main aspects impacting the TIGER initiative and its evolution. The session was closed with an overview of the status of the TIGER Action Lines.

Mr. M. Donkor presented the status of the African African Water Information Clearing House (AWICH). There is a need for systematic data collection, improved accessibility to African Water Information and enhanced connectivity and data exchanges between African Stakeholders. AWICH aims at bridging existing gaps by creating networks and coordinating initiatives involving national water workgroups. TIGER is providing concrete actions which match with the very core mandate of AWICH and, announcements and products related to TIGER might be disseminated through the African Geo/Water Information Clearinghouse Network members.

Mr. T. Woudeneh provided an overview of activities related to the African Water Facility (AWF), which is an initiative led by AMCOW to mobilise resources to finance water resources development activities in Africa. Three main outcomes are pursued:

- Improved IWRM, by supporting RMC to improve or establish policies and institutional frameworks, and prepare strategies, investment programmes and implementation plans;
- Improved transboundary water resources management, by supporting joint development of shared waters in the areas of advocacy, partnership and joint development programmes of mutual benefit. In consultation with AMCOW and NEPAD, nine river basins (Senegal, Niger, Volta, Lake Chad, Congo, Nile, Zambezi, Okavango, Orange/Senqu) and three shared aquifers (including the Iullemeden aquifer, Nubian Sandstone aquifer and the Northern Sahara Aquifer System) have been selected
- Increased water sector investments, supporting water resources development programmes and project preparation at national and regional level, to attract immediate investment interventions and providing targeted investment resources for small-scale water infrastructure development.

In addition, interventions are made under two crosscutting components such as:

- Information and Knowledge, by supporting the establishment and enhancement of information and knowledge systems, and water resources management capacities at national and regional levels,
- Monitoring and Evaluation system development at national and regional levels, to foster water development effectiveness

The African Development Bank is in charge of approving project proposals and operational guidelines. Proposals may be submitted by water authorities working in a national or regional framework, the main task of the facility is to support the enhancement of the quality of the proposals. To date, 50 projects, for an aggregated value of 40.5m Euro are being implemented or are under consideration.

Within the context of TIGER a number of proposals are under evaluation to be the first set of projects under the TIGER operational component.

Finally, *Mr. C. Moseki* provided an update of the status of activities carried out within the context of TIGER. To support water authorities and other relevant stakeholders to implement IWRM effectively in Africa, TIGER is building upon existing capacities, initiatives and programmes, exploiting the synergies, maximising results and trying to avoid duplications. This includes the coordination with existing initiatives, policies under development, strategies of development partners and planned or existing programmes.

Several lines of action are being carried out by TIGER to go towards an African Water Observation System:
- Training and Capacity Building: to develop the technical, human and institutional capacity of African partners to collect, elaborate, disseminate and use EO-based information. Training sessions specifically addressed to users (e.g. water authorities) or researchers and technical centres have been organised by the TIGER partnership in Africa and Europe. A Capacity Building Facility has been launched by ESA in September, to provide scientific coaching to a set of research projects.
- Networking: to develop partnerships, networks and mechanisms for promoting water information and knowledge sharing, common research programmes and best practices. To date, more than 200 organisations are involved in different TIGER projects.
- EO data access: to develop effective mechanisms to ensure sustainable access to EO data in Africa. ERS, ENVISAT, Radarsat, SPOT and Landsat data are distributed at no cost and with a facilitated access to TIGER projects.
- Water information systems: to develop EO-based Water Information Systems and services at trans-boundary and national level in support to IWRM. The TIGER model has been developed to incorporate advanced IT within African water management practices of the different stakeholders in both the water management process and the geo-information provision sector. The model follows a three-stage approach:
  - 50 research projects carried out by African and North-South research teams are supported with facilitated data access and training;
  - 16 North-South Technology Transfer Projects funded by ESA and CSA with more than 6M Euro overall are developing products and services in collaboration with African stakeholders, following a Develop-Demonstrate-Transfer (DDT) approach aimed at transferring technical capabilities to local service providers
  - On the basis of demonstrated services and systems, African partners will be supported to launch projects in collaboration with development partners and donors (e.g., African Development Bank) in order to support the transition from pre-operational to operational; to date a proposal submitted to ADB by the Lake Chad Commission is under evaluation.

African ownership of TIGER will be reinforced by the opening of an Executive Bureau at UNESCO's premises in Nairobi in early 2007, managed by an African officer.

Session 2

TIGER Development projects: From research to operational water information services

Chairs:
C. Moseki, Department of Water Affairs and Forestry, South Africa
T. Woudeneh, African Development Bank

Speakers:
L. Shouten, Vexcel Netherlands.
S. Saradeth, GAF AG, Germany.
G. Pace, ACS, Italy
I. Nyambe, University of Zambia
M. Gregor, GIM, Belgium
AM El Ganzori, Ministry of Water Resources and Irrigation, Egypt
G. Pegram, University of Kwazulu-Natal, South Africa
A. Bartsch, University of Vienna, Austria
J. Benveniste, European Space Agency;

Summary

Intermediate results of North-South Technology Transfer Projects were presented, in some cases by the users. Projects are carried out in close cooperation with African stakeholders and aim at developing and demonstrating tailored EO-based information services and systems to support African water authorities in collecting water-relevant information on a regular basis. The aggregated investment from ESA and CSA on such projects exceeds 6 M Euro.

The GlobWetland Project aims at developing demonstration products based on EO to improve the ability of wetland managers to better monitor and assess the condition of wetlands within their respective countries. It is conceived as a user-oriented project, where the final Information Service should provide a clear response to specific user needs. Therefore, the project is built up around the information requirements provided by a User Group made up of the National Authorities responsible for the implementation of the Ramsar Convention in several countries worldwide. This set of information needs represents the core of the project and the basis for the development of the GlobWetland Information Service, which should be implemented, validated and assessed for a representative set of wetland areas proposed by the members of the User Group in their respective countries. Insights about results produced over St Lucia (South

Africa), lake Bogoria (Kenya) and Lake Chad were presented, together with planned developments.

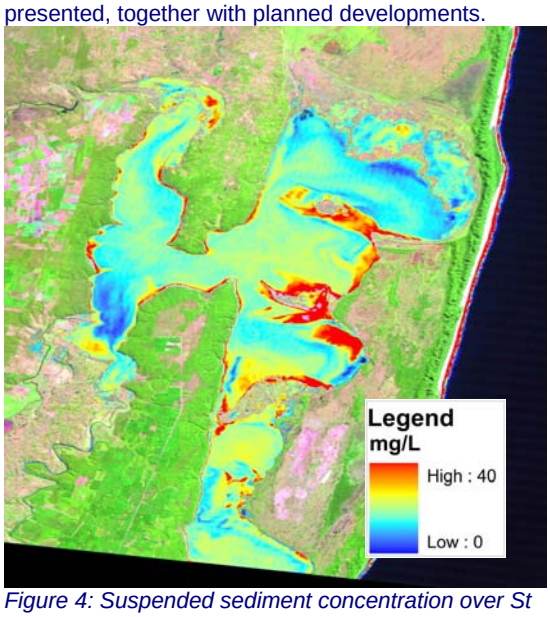

Figure 4: Suspended sediment concentration over St Lucia (South Africa) derived from the GLOBWETLAND project from EO data.

The main objectives of the *Aquifer* project are:

- To support the involved national authorities and international institutions with Earth Observation (EO) based technology for a better management of internationally shared water resources and aquifers
- To strengthen overall and integrated water management practices
- To build up a local capacity for service provision of EO-based information products in support of aquifer management

The project aims at supporting national authorities and international institutions in aquifer management though tailored and GIS-compatible demonstration products and services thereby facilitating their uptake in daily work-operations. The project is its final phase and is providing products, services and specific training to users involved in the management of Iullemeden and SASS transboundary aquifers.

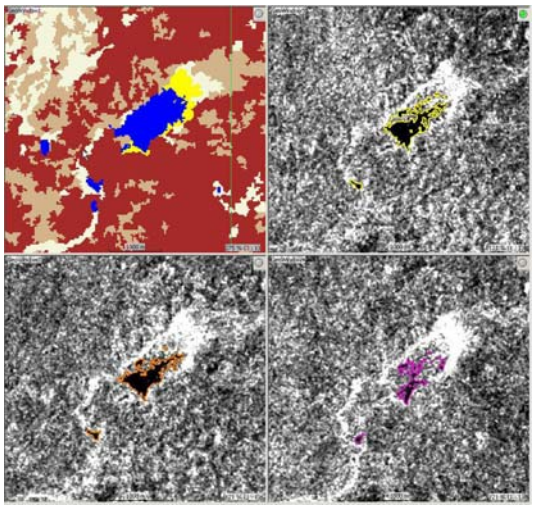

Figure 5 Water bodies identified by the Aquifer project at different dates in the Iullemeden area using ASAR/SAR data

WADE aims at exploring underground and superficial water resources in arid and semi arid regions in Africa using Synthetic Aperture Radar (SAR) imagery. SAR has a great potential due to its limited cost and high spatial resolution; the availability of an advanced technological tool for water resources detection and mapping can represent a significant improvement for sustainable water management. Specific project goals are to map in the selected study area permanent water-related human artefacts (foggara, wells, channels), to map natural seasonal water resources understanding their dynamics through multi-temporal analysis, to transfer advanced technologies and tools to AGRHYMET, the user.

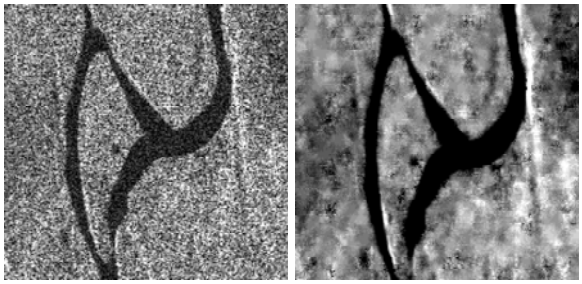

Figure 6 Left: ASAR image. Right: the same image pre-processed with a noise removal algorithm developed by the Wade team

IWAREMA aims at developing spatial data inputs for an integrated management concept for Zambia's water resources that is set up by Zambian government.
The specific objectives are to provide the end-user team with a set of service products that are derived from earth observation and that shall enable the end-user to increase their capabilities in the management of their water resources.
The portfolio consists of three base mapping products, a number of indicators derived from the base products and the information bulletins that are produced from the products and the indicators. The information bulletins for decision- and policy makers are the outcome of the integrated analysis of the products performed by all partners in the project.

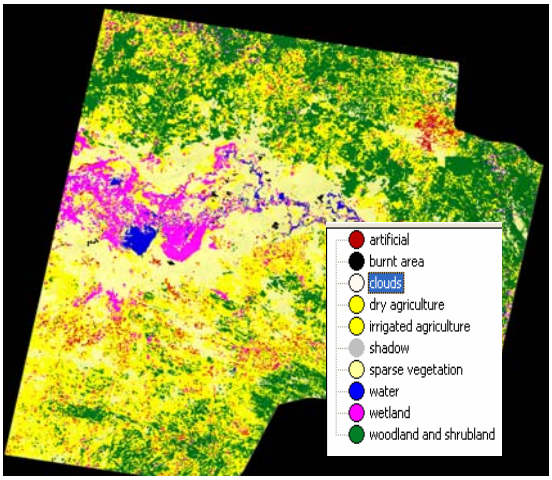

Figure 7 Landcover map of a portion of Zambia, derived from Landsat ETM+data

The main objective of the project *Water Quality in Egypt* is to design, develop and implement an Earth Observation (EO)-based capacity for the operational monitoring of water quality in Lake Manzalah, Egypt. Lakes are a

precious source of freshwater in Egypt, and the usage of lake water must be carefully managed to satisfy a variety of different, and often competing, domestic, agricultural and industrial uses. Key to the formulation of adequate water management scenarios is accurate and reliable information on the occurrence and distribution of water quality indicators, such as turbidity, algal blooms or areas infested with invasive plant species. The project will provide a set of comprehensive water quality products derived from EO data in a regular manner. The extraction of water quality information from satellite imagery will make use of the existing in-situ monitoring network for data calibration and validation.

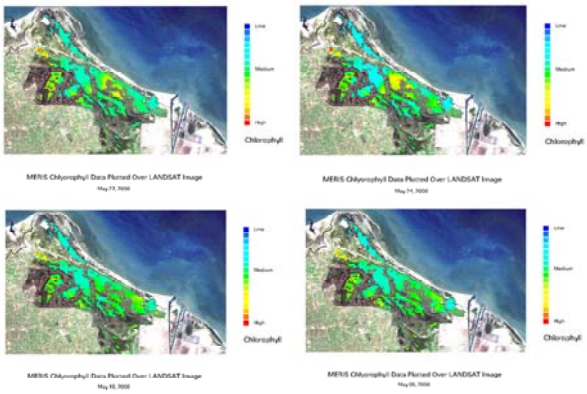

Figure 8 Chlorophyll content mapped by the project at different dates of May 2006 from MERIS data, shown on a Landsat image

Lake Victoria is the largest fresh water lake in Africa. It is well-known for its environmental problems and for its economic value to the riparian countries. The national fisheries research institutes of Uganda, Kenya and Tanzania and other water management authorities are committed to both monitor the threats that face the lake and inventory the resources of the lake. The involved countries seek to manage the lake in a sustainable way. Thus far they have hardly used information that has been derived from satellite data. The Lake Victoria project aims to foster the use of this kind of information over the area. Its goals are to develop dedicated products and services and to local build capacity at the three institutes to ensure that expertise is available to implement this data at an optimum level.

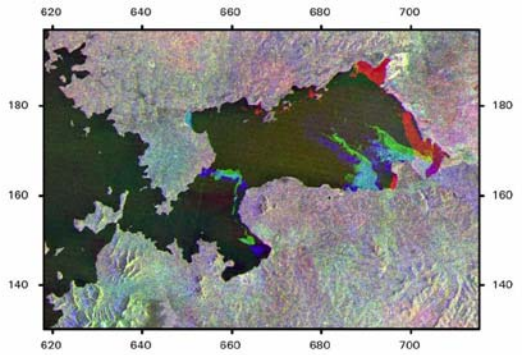

Figure 9 Water hyacinth detection on Radarsat images over a Kenyan portion of Lake Victoria (Winam gulf) at three different dates (Red: 4 March 98; Green: 26 July 98; Blue: 26 July 98 -12 hours later)

SHARE aims at enabling an operational soil moisture monitoring service for the region of the Southern African Development Community (SADC). With this service SHARE will address one of today's most severe obstacles in water resource management which is the lack of availability of reliable soil moisture information on a dynamic basis at a frequency of a week and less. The soil moisture information system is based on the newest radar satellite technology. The service will use data delivered by ENVISAT's ASAR sensor operated in global mode and the METOP scatterometer sensors. The synergistic use of both systems will allow frequent, high resolution monitoring of regional soil moisture dynamics. The long-term vision of SHARE is to supply soil moisture information for the entire African continent, at a resolution of 1 km, posted on the web, freely accessible to all.

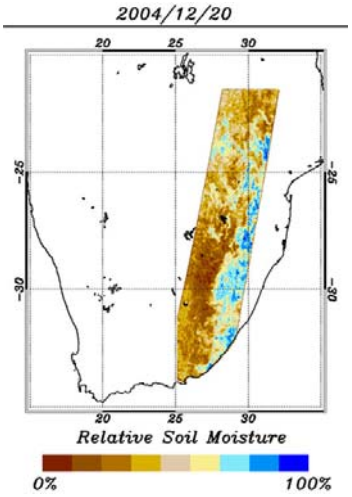

Figure 10 Experimental 1 Km pixel size soil moisture product from Scansar (ENVISAT ASAR GM).

The large majority of the world's population dwells alongside, and is depending on, continental water bodies. Inland water bodies (rivers, lakes, wetlands, floodplains) play important roles in a variety of interdisciplinary applications and are often the centre of focus with regards to environmental and conservation issues. Routine monitoring of these basins has further importance for regional and continental scale hydrological, biochemical and climatology studies as well as for estimating the global water mass budget in relation to sea-level changes.

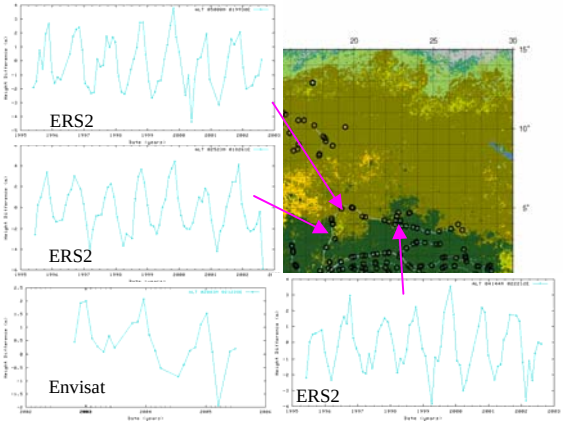

Figure 11 Time series of river heights from altimeter, over Congo

Recent research into the application of altimetry for monitoring river and lakes levels has been carried out and has demonstrated the advantages of using data derived

from satellite as global coverage and regular temporal sampling of the data sets. The main objective of the ESA *River and Lake* project is to provide the hydrologic community with easy-to-use, effective and accurate river and lake height measurements exploiting ERS and ENVISAT's satellite altimeters.

The project *StéréoSat Afrique* promotes the use of satellite images to meet geospatial data requirements for the West African region. Through innovative use of synthetic stereoscopy methods and satellite image processing, this project optimizes topographical and thematic data for ecosystem analysis and water resource management. Key players in the region obtain current and accurate information on paper and in digital format to assess ecosystem vulnerability, the impacts of weather and climate, and the results of human activities, for example erosion, silt deposits in riverbeds, and water contamination from pesticides and other agricultural sources.

Figure 12 Detailed base-map produced by the project exploiting IKONOS data

The Southern Africa region is experiencing a variety of environmental stresses imposed by human induced pressure forces (dams, land use change, etc.) as well as natural ones (erosion, cyclones, etc.), exacerbated by the impacts of climate variability. The key objectives of the project *IRBM Africa* include:

- Documented parameters, data and information concerning the Vulnerability levels of the Zambezi Delta system and medium Limpopo basin for both the natural and human dimensions
- Adaptation/ mitigation strategies in response to observed or projected climatic/hydrological (flood drought events) and anthropogenic stresses over the basin systems are formulated
- A methodological approach to assess vulnerability levels and formulation of adaptation/mitigation strategies making use of remote sensing and GIS technologies as a decision support tool is developed

Local capacity and awareness is raised on the importance of remote sensing and GIS technologies for integrated river basin management

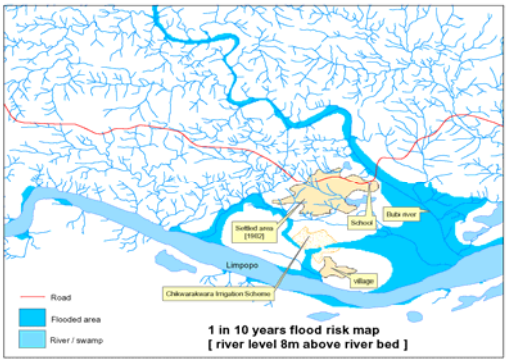

Figure 13 Hazard map for the 10-years flood event in Mozambique

ARBRE is partnering with the World Bank's Community Based Rural Development Project and the Global Environment Facility (GEF) programme on Sahel Integrated Lowland Ecosystem Management to develop a series of Earth observation products. These products are designed to complete biophysical inventories and to study the dynamics of water in small watersheds managed by communities in Burkina Faso. They complement Burkina Faso's National Community-Based Rural Development programme by introducing a landscape dimension and an integrated ecosystem management approach to local development planning.

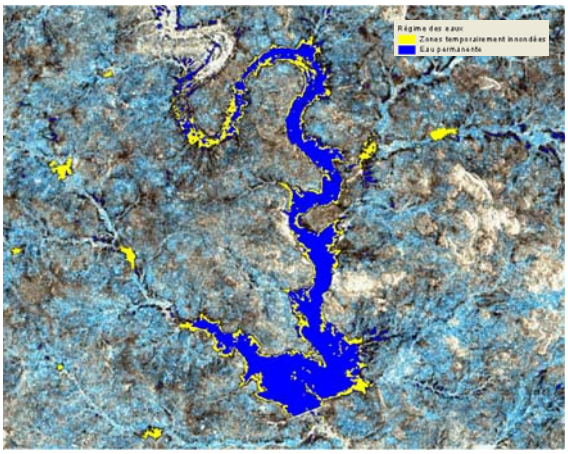

Figure 14 Surface water map over Sanmatenga province (Burkina Faso) derived from SPOT data

The project *Mosquito habitats* aims to provide detailed maps, monitor changes to mosquito habitats (wetlands), and develop malaria risk maps using data on topography, larva ecology, human health, households, and habitats over Kenya. This information will be an integral part of an overall larva-control strategy to identify larvicide-application practices that would reduce the mosquito population. Detailed space-based data on wetlands and mosquito control are not available for the region but can be obtained for reasonable cost by high-resolution Earth-observation sensors. Data acquired over time can monitor the change and provide a more accurate resource map. Continuous cloud cover during wet seasons and the cumulus clouds caused by heat during the dry season means that an all-weather satellite with high spatial resolution modes, like RADARSAT, will provide a reliable source of multi-temporal imagery.

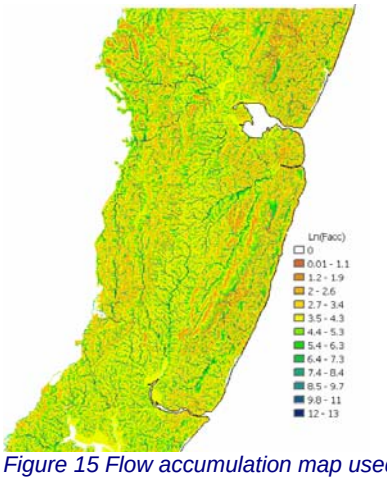

Figure 15 Flow accumulation map used as input to the mosquito habitat map

The project *Hydrogeology in Northern Ghana* aims at enhancing existing methods of groundwater exploration in northern Ghana with approaches based on remote sensing. With RADARSAT-1 imagery as the primary synoptic view, complementary information will be added from optical satellite data. Operational protocols developed to extract groundwater parameters from satellite imagery will be integrated with an existing hydrogeological analysis data model. These, too, will work from the synoptic view of remote sensing and through careful analysis to obtain information that improves the success rate of water drilling operations. World Vision Ghana and the University of Ghana Centre for Remote Sensing and Geographic Information Services are project partners and will help in transferring expertise to the communities.

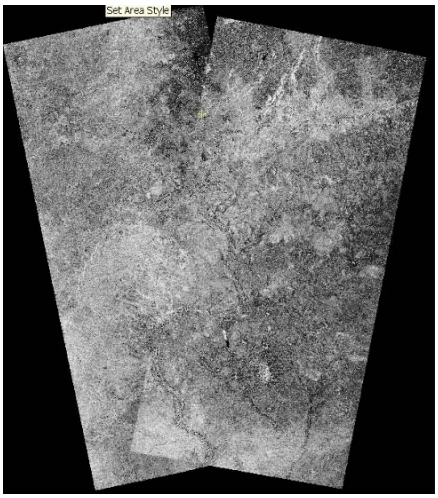

Figure 16 Radarsat mosaic of northern Ghana

The *Morocco IDAS* will develop a Decision Aid System for water resource management based on a Geographic Information System (GIS), satellites data and auxiliary data (geology, land use, land cover, topography, lineaments etc.) for the Sous-Massa basin in Morocco. Since 1975, the area has seen extraordinary economic growth. Agriculture, tourism, and population expansion contribute to increased demand for water and overexploitation of groundwater resources. Updating information on the water system will help with sustainable management of these resources. The project will integrate, in a geographic information system, an approach that uses satellite images and traditional information as an analysis tool for better management of the water resources and mapping of the groundwater potential and evolution.

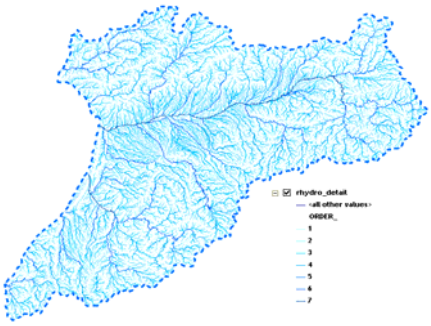

Figure 17 Drainage network and stream order of the Sous-Massa river basin (Morocco)

Session 3

Earth Observation, Capacity Building and Water Management in Africa

Chair:
H. Ntale, AMCOW

Speakers:
H. Ntale, AMCOW;
Bob Su, ITC;
Imraan Saloojee, GEO Secretariat;
Alex Makarigakis, UNESCO-IHP;
Joel Arumadri, NTEAP

Summary

Availability of water information in Africa is often scattered: the water sector needs harmonised and coordinated actions to foster existing capacities and to ensure sustainable IWRM at national and regional level.

Mr. Ntale provided an overview of the main developments related to AMCOW: The water sector is evolving in Africa. This is reflected in the discussions held during many consultations, conferences and meetings in 2006. Strengthening of monitoring and evaluation mechanisms can be done via an increased regional collaboration and enhancing existing systems at national level. Capacities and data already exist: MDG country status reports produced by the World Bank WSP programme are based on local data sources. River basin organisations should be a primary actor: this would allow to develop and to implement a uniquely African approach. Synergies and points of contact between initiatives focusing on Africa's water sector shall be found and exploited. The issue of finding resources may be facilitated by the development of WMO guidelines to assist national Hydrological Services to present their needs to governments and donors. In addition TIGER could play a role to access funding, should it be considered part of NEPAD's African networks of centres of excellence in water sciences and technology. Finally, it is felt that more attention should be given to trans-boundary groundwater management, integrating it into basin management, raising awareness, developing capacity, building knowledge and promoting and institutionalising cooperation.

Mr. Su introduced the Capacity Building Facility, funded by ESA and hosted by the Dutch Institute ITC, which has been launched in 2006 to support the completion of a number of selected TIGER research projects. The task is to support TIGER research projects to achieve their objectives, while developing their human, technical and institutional capacity to use EO technology in water resources management. The facility is responsible for the organisation of training sessions in Africa, tailored Capacity Building Actions to support at least 15 selected TIGER projects to be completed in 2007, resource mobilisation and communication and promotion, including the coordination of a special issue on TIGER in an international scientific journal. The first training session has been held after the workshop, a second training session in Africa is foreseen for 2007.

The intergovernmental Group on Earth Observations (GEO) is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next 10 years. GEOSS will work with and build upon existing national, regional, and international systems to provide comprehensive, coordinated Earth observations from thousands of instruments worldwide, transforming the data they collect into vital information for society. GEOSS will yield a broad range of societal benefits, including:

- Reducing loss of life and property from natural and human-induced disasters.
- Understanding environmental factors affecting human health and well-being.
- Improving management of energy resources.
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.
- Improving water resource management through better understanding of the water cycle.
- Improving weather information, forecasting and warning.
- Improving the management and protection of terrestrial, coastal and marine ecosystems.
- Supporting sustainable agriculture and combating desertification.
- Understanding, monitoring and conserving biodiversity.

GEOSS will also tackle 5 transverse areas (Architecture, Data Management, User Engagement, Capacity Building and Outreach) which are shared by the social benefit areas. GEO was formally established in 2005 and is composed by 66 Countries, the European Commission and 44 International Organisations. It is established on a voluntary and legally non-binding basis, with voluntary contributions to support activities; African participation should be improved. 4 Committees are established to provide high-level review advice, recommendations, and support in the ongoing development and implementation of the GEOSS 10-Year Implementation Plan. 72 tasks were identified in the workplan 2007-2009, several (e.g. Data Integration and Analysis System or the Agricultural Risk Management) may be relevant to TIGER activities.

UNESCO, and in particular its International Hydrological Programme (IHP) is leading and contributing to several initiatives in the fields of applications of remote sensing for sustainable development in Africa. Among the various activities finalised to IWRM and sustainable development, such as capacity building, training, supporting scientific research and networking, a range of projects were presented such as GOOS-AFRICA, ISARM, SIMDAS, FRIEND and HELP. UNESCO is actively involved in TIGER, where it is facilitating the dialogue between the remote sensing and water communities, is contributing with publications, training activities and support to workshops and is implementing some projects.

The Nile RAK project is designed to promote the sustainable management and use of the environment and resources within the Nile. The project utilizes participatory processes to gather input from project stakeholders during all phases of the project including: design, implementation and evaluation. A CD-ROM produced by the project was presented. This is a learning tool encouraging knowledge and awareness regarding the environmental resources and management of the Nile Basin. Earth Observation-based applications (satellite data), training programmes and maps are integral components of the project and provide decision makers with an improved capability to understand and manage the environment within the basin.

Sessions 4

The TIGER Scientific and Research Component

Chairs:
A Thomas, Western Cape University, South Africa
A Er-Raji, CTRS, Morocco

Speakers:
C Ngouanet, National Institute of Cartography, Cameroon
K Labassi, Université Chauib Doukkali, Morocco
L Palamuleni, University of Johannesburg, South Africa
A Er-Raji, CTRS, Morocco
A Thomas, Western Cape University, South Africa
L. Kgotlhang, Department of Water Affairs, Botswana
M. Fofana, Station de Lamto, Ivory Coast

Posters:
N Mega, CNTS, Algeria
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Summary

In 2004, 50 projects aimed at advancing in the use of EO technology for IWRM have been selected from more than 90 proposal submitted by African and North-South research teams to represent the TIGER Water Research component. The teams are supported by TIGER with free EO data, tools and capacity building and training. Preliminary results from a set of projects were presented.

In the last 30 years, number and intensity of landslides in an area of Cameroon-which lays on a tectonically unstable zone has increased. Two landslides in 2001 and 2003 resulted in almost 50 human losses: the research activity is aiming to derive risk maps of the area, to support the work of decision makers. Agriculture practices may act as accelerating factors for the degenerative processes, and EO observations (radar and optical), jointly with available cartographic production are used to derive landuse dynamics. Derived information is inserted in a GIS, where it is being analysed in order to compare elements at risk with hazard areas.

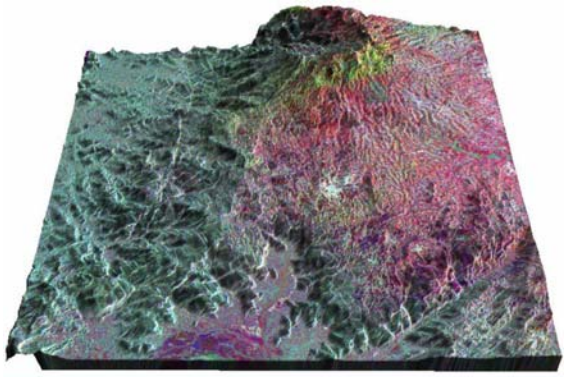

Figure 18 Perspective view of landuse variations derived from ENVISAT data acquired on June 2004 (Red), March 2004 (Green), Dec 2003 (Blue).

EO data are used in an arid area of Morocco to derive and update geologic information, which can be used for hydrologic and hydrogeologic characterisation. Optical, Radar and pre-existing topographic data are used in synergy to derive lineament maps of the area as well as to extrapolate lithologic information. The output product, for which EO contribution was estimated as 60%, provide new information compared to previous cartographic production (at 200.000 and 500.000), allowing a better detail and precision. Use of additional data will enable further refinements of the product.

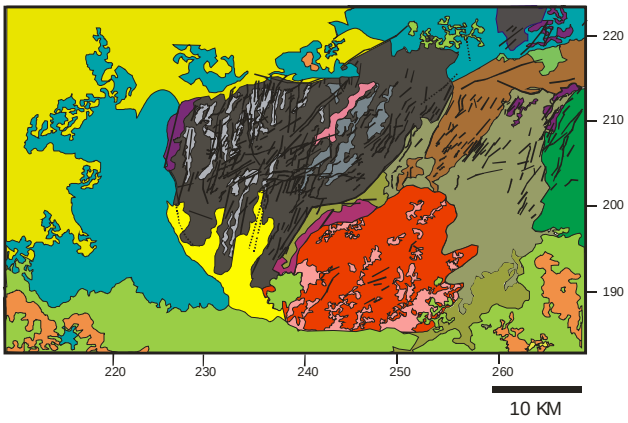

Figure 19 New geologic map at 1:100.000 for the studied area in Morocco

Land cover changes in Malawi are mainly related to vegetation clearing for farming, building of houses and charcoal production and inappropriate agricultural practices. This has lead to an increased incidence of flood disasters. EO data are used to identify and quantify spatio-temporal variability of landcover changes. The information produced will be used as input to hydrological modelling; furthermore monitoring from space may allow to promote sustainable utilisation of the land and water resources in the area.

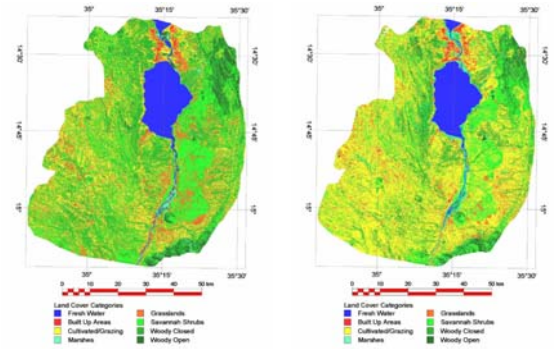

Figure 20 Landcover maps of July 1989 (left) and May 2002 (right) derived from Landsat data

A project is being carried out in Morocco, finalised to straiten IWRM capacities of the local agency in charge of water resources management in the Souss-Massa Hydraulic Basin through an operational exploitation of earth observation data. This is achieved by CTRS with a conceptual, methodological and operational contribution with the end user. Landsat, Spot, Aster and ASAR data acquired at different dates are used for geologic and structural mapping, for landcover and landuse monitoring and for creation of DEMs. Land cover dynamics are studied and multi-criteria analysis is carried out to identify recharge zones and potential zones with available water resources.

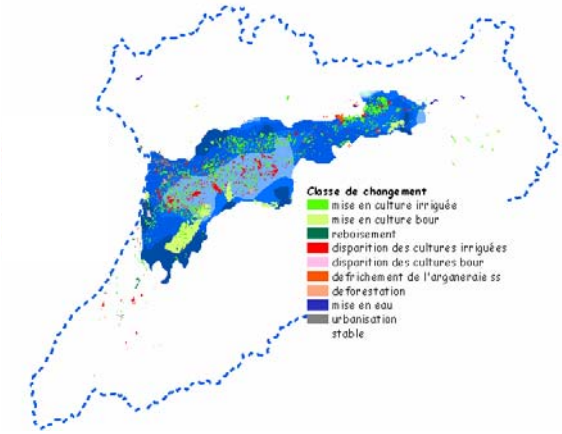

Figure 21 Preliminary map of changes detected in the Sous-Massa area

Land use maps are essential for hydrologic modelling, since they may delineate potential sources of runoff / infiltration and non-point sources of pollution. GIS techniques have been applied over some test-sites in South Africa to prepare accurate land use / land cover maps exploiting a variety of spatial data derived from spaceborne and in-situ observations, and for subsequent hydrologic modelling.

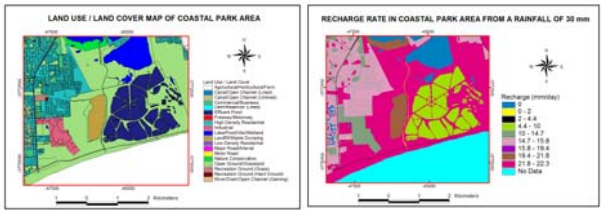

Figure 22 Left landcover/landuse map of Coastal park area (South Africa), right: aquifer recharge rate modelled with GIS for a rainfall of 30 mm.

The Okavango delta, Botswana, is an example of shared water basin. In-situ and airborne/spaceborne data are being jointly used to feed and calibrate an hydrological model, adapted from MODFLOW 2000. ASAR Wide Swath data are processed with BEAM and MATLAB to derive flood patterns and flood frequency. The model should produce information to be used to feed the political decisions on shared water use between the riparian states and to guide management policies in the delta.

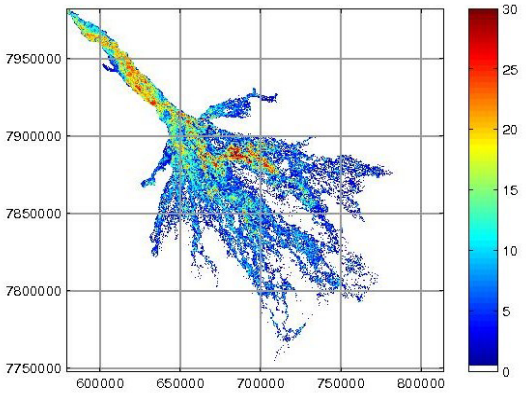

Figure 23 Flood frequency over the Okavango delta, derived from analysis of ASAR data

A comprehensive study of the Bandama river basin (Ivory Coast) by using satellite data is ongoing. The main objectives are: hydrologic and structural cartography, monitoring of vegetation land cover and hydro electrical lakes (Kossou and Taabo on Bandama River), identification of the use of water in human activities and potential impact on the basin seimicity. Datasets are being compiled and analysis is being carried out to identify the most useful tools for the scientific community and the decision makers for integrated water resource management.

Figure 24 Aerial photo of Bandama river, close to Lamto (Ivory coast)

Session 4
Round Table discussion: Conclusions & Follow up

Chair: *M. Donkor, UN Economic Commission for Africa*

Speakers
M. Tawfiq, WMO
Henry Ntale, Chair AMCOW-TAC
Woudeneh Tefera, Chief Water operations Manager, AfDB
Chris Moseki, Department of Water Affairs and Forestry, South Africa
Jean-Marc Chouinard, CSA

The round table was introduced by a presentation of the World Hydrological Cycle Observing System (WHYCOS), a demand-driven programme aimed at stimulating water resources assessment activities, building capacity and strengthening cooperation at river basin, regional and global levels. The goal is to support the establishment and improvement of consistent and reliable operational hydrological information systems. Guidelines have been created to assist in developing and implementing the HYCOS components, ensuring that projects remain consistent with the WHYCOS objectives while responding to local needs, realities, and changing situations. The training programme of any HYCOS component includes a module on Satellite Information for Planning and Management of Water Resources, a goal common to the TIGER initiative. Clear synergies and areas for collaboration are identified.

The main points derived from the roundtable discussion are summarised below. These points represent a key input to prepare the next implementation period.

- EO is a tool which allows retrieval of information complementary to existing in situ based techniques. Funds are needed to go towards operational services: it is essential at this stage that governments are aware of advantages of the new technologies and become fully involved in the process. River basins shall take the lead at the regional level.

- Services are to be operated through national and basin authorities, noting that monitoring of the resources and evaluation of the impact of the development are regional needs.

- It is equally important that research activities are pursued: African knowledge centres shall strengthen their linkages and ongoing research must be clearly positioned to fulfil needs of regional agendas, in a coordinated approach. Existing capacity shall be strengthened at national level and shall be coordinated at regional level.

- TIGER is progressing: users are getting involved and science and applications are being developed. The focus shall now be on what is delivered and how the information will effectively be used in day to day operations. EO worldwide is at a crossroad: nowadays information is delivered directly to the end users and availability of data in near real time has enabled the transition from a mapping to a monitoring concept. Data and technical tools may already exist, these must be complemented with appropriate resources.

- Policy makers are already aware of TIGER, since AMCOW have endorsed the initiative: it is essential not to loose the momentum. Results were shown and products were demonstrated during the workshop: it is important that all this excellent information is adequately advertised, so as to reach a larger African audience, sharing the TIGER vision and hence strengthening the initiative.

- TIGER was endorsed by AMCOW, and progress is evident in the delivery of information products and the potential for EO technology to support water authorities. However, now there is the critical need to demonstrate how the delivered products may offer practical solutions to the key problems in the field. The next implementing period should strive to empower water authorities to tackle and solve critical problems affecting people more efficiently, exploiting the advantages of EO technology. The foreseen project reporting to AMCOW in March 2007 may be a good occasion to achieve enhanced political follow-up.

Conclusions

To ensure a balanced Pan-African TIGER participation, there is a need for increased **communication** about the initiative.

- Main users of TIGER products shall be **the governments**: this will ensure support from the donors and would be the first step towards development of **sustainable operational products** and services. On the medium/long term this shall lead to the development of an **African private sector** providing services to the ministries.

- A monitoring system is needed at **multiple scales**, from local to the broader African scale and Remote Sensing is just a part of it: efforts shall be done for an **integration** of different data sources. Existing systems and databases shall be strengthened and **updated** with new information.

- Scientific research must be pursued, identifying the **best tools** and viable methodologies for the African context. Workshops and conferences represent one of the available means to **share** and discuss experiences. Ways forward to strengthen the creation of centres of scientific excellence in Africa might be through creation of **PhD scholarships** to be sponsored by donors.