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Edited by GeoVille  
for:



## TIGER-NET Newsletter

Welcome to the second issue of the TIGER-NET newsletter.

Since the last newsletter, the user requirements and technical specifications for the Water Observation Information System (WOIS) were reviewed and successfully consolidated by the involved users. The responsible technical teams are currently very busy to develop the framework and design definitions of the WOIS as well as test and analyse the best methods for the required products processing chains to be implemented. We present here a short summary of these efforts.

In this newsletter we would also like to highlight the important role of the involved users in supporting the development and demonstration of a satellite based Water Observation Information System (WOIS) to prepare for the up-take of the European Sentinel satellite missions.

This has been positively noticed by the African Association of Remote Sensing of the Environment (AARSE) and lead to an official recognition and support in the official AARSE 2012 Declaration.

We are already looking forward to the first presentation of the test results and to the Qualification and Acceptance Review beginning of 2013.

Yours

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## TIGER NET



## Requirements Engineering Review Meeting

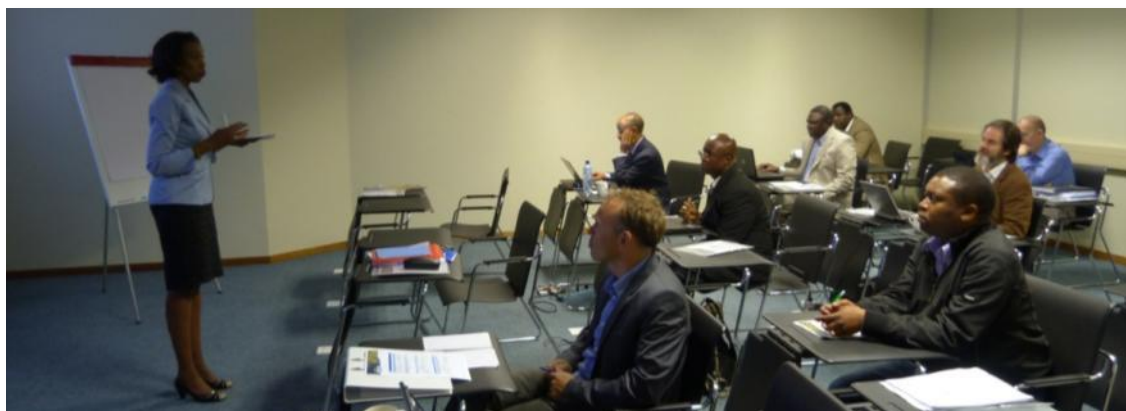
From the 5<sup>th</sup>-6<sup>th</sup> of September 2012 the TIGER-NET Requirements Engineering Review (RER) was kindly hosted by the South African National Space Agency (SANSa) and the South African Department of Water Affairs.

The main objective of this meeting was to review and to consolidate the user requirements and technical specifications for the Water Observation Information System (WOIS) to be developed within TIGER-NET.

Beside 3 representatives from the consortium (Project Manager, Responsible Technical Lead and Assistant Project Manager) and the ESA TIGER-NET coordinator, the project leaders of all involved users (Nile Basin Initiative, Lake Chad Basin Commission, Volta Basin Authority, Department of Water Affairs South Africa and the Namibian Ministry of Water) as well as one key member of the steering committee (UNESCO) were present.



The meeting was opened by the Managing Director of SANSa, Dr. Jane Mukarugwiza Olwoch.



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After presenting the summary of established user requirements from both, the consultants' and users' perspective, the summary of the outcome of the technical specifications and the feasibility studies, the requirements of the defined demonstration cases were discussed and adapted in individual consultation meetings against the feasibility and benefit for implementation. **The adapted demonstration cases to be implemented were appropriated by the users.**

The RER represents the first Milestone of TIGER-NET and successfully concludes the first project phase of cycle 1. As part of this milestone, the final, ESA reviewed versions of the Requirement Baseline and adapted, final Technical Specification documents as well as the presentations and the outcome of this meeting are delivered.



## The role of the Users in TIGER NET

The project is built upon on a close collaboration with the host institutions for the specification, testing and demonstration of the WOIS. The first key host institutions already actively involved in TIGER-NET are the Nile Basin Initiative, Lake Chad Basin Commission, Volta Basin Authority, Department of Water Affairs South Africa and the Hydrologic Division of the Namibian Ministry of Agriculture, Water and Forestry.

In a long-term, the solutions developed in TIGER-NET aim at serving the wider water related community in Africa and welcome any authorities, having an operational water management need. In fact ESA is in discussion with the Department of Water Affairs in Zambia to become an additional user of the project.

### The South African Department of Water Affairs



The Department of Water Affairs is the custodian of South Africa's water resources. It is primarily responsible for the formulation and implementation of policy governing this sector. It also has override responsibility for water services provided by local government.

While striving to ensure that all South Africans gain access to clean water and safe sanitation, the water sector also promotes effective and efficient water resources management to ensure sustainable economic and social development.

DWA's core functions are policy formulation, water resource management, infrastructure development, capacity building, intergovernmental and intra-sectorial coordination, and water regulation.

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The Demonstration Cases defined during the consultation meetings reflect the core needs for water resource management on a sub-catchment level, which is the number one issue in South Africa. Specifically, the capacities provided within TIGER-NET shall support an EO based approach for water balance monitoring, consisting of the following components:

- Water discharge forecasting (Product group: *Hydrological modelling*)
- Land cover based water demand mapping (Product group: *High resolution basin characterisation*)
- Water management related land cover change mapping (Product group: *High resolution basin characterisation*)

Special functionalities will be included in the WOIS, like water demand attribution of EO based land cover map databases, with the resulting product to be incorporated in a general water balance monitoring framework.

### The Volta Basin Authority



The 1st Assembly of the Heads of State of the riparian countries of the Volta Basin, which was held on 19 January 2007 under the auspices of the Government of Burkina Faso in Ouagadougou, signed a Convention for the establishment of the Volta Basin Authority (VBA).

The Volta is a transboundary river, which is shared by six countries in West Africa; Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali and Togo. It stretches from north to south over a distance of 1850 km with a basin covering an area of approximately 400,000 km<sup>2</sup>.

The Member States of the Volta Basin Authority are supporting the Volta Basin Observatory so as to serve as an information, communication and a decision making tool. The Observatory will support the sustainable use of water and related resources and protect and even regenerate degraded ecosystems in the basin.

Since the Volta Basin Authority is a quite young institution, the operative business regarding monitoring of water management related issues is still in the implementation phase; therefore TIGER-NET will provide a critical capacity in terms of EO data processing and future applications.

Based on VBA's mandate, reporting obligations, regulation and current practices, the highest requirement for geo-information needs are in

- improvement of the knowledge on water resources in terms of both quantity and quality of the Volta basin as will be provided by small water bodies monitoring (Product group: *Water body mapping*).

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- the capacity to monitor how changes in the environment (land cover/use change, land degradation such as forestry) affect quantity and quality of water resources (Product groups: *Medium resolution land degradation index* and *medium resolution full basin characterization*).

### The Nile Basin Initiative



The Nile Basin Initiative (NBI) is an inter-governmental organization dedicated to equitable and sustainable management and development of the shared water resources of the Nile Basin. NBI Member States include Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. Eritrea is as an observer.

The NBI was established on February 22, 1999 in Dar es Salaam, by Ministers responsible for Water Affairs of each of the nine Member States. The Nile Council of Ministers (Nile-COM) agreed on a Shared Vision which states:

‘to achieve sustainable socio-economic development through the equitable utilization of and benefit from the common Nile Basin water resources’.

The Nile Basin Initiative, being the body in Africa which has to manage the largest river system with the most member countries, has several monitoring and reporting obligations, to which TIGER-NET can contribute to. Specifically, their requirements for capacity build up are well placed within on-going initiatives aimed at IWRM. These are:

- The Eastern Nile Subsidiary Action Program (ENSAP) shall be supported for its watershed management programs with an EO based approach to establish erosion potential indicator maps and for its flood monitoring programs (FPEW) with the capacity to analyse historical floods as well as monitor on-going ones (Product groups: *Erosion potential indicator* and *flood mapping system*).
- The Nile Equatorial Lakes Subsidiary Program (NELSAP), shall be supported in its effort to assess and monitor the water quality of Lake Victoria (Product group: *Large lakes water quality and levels*)
- Both the Nile-Secretariat and ENSAP-Secretariat (ENTRO) shall be supported in the assessment and management of wetland areas (Product group: *Wetlands mapping*).



## The Lake Chad Basin Commission



The Lake Chad Basin Commission was created in 1964 by the four countries bordering Lake Chad - Cameroon, Chad, Niger, and Nigeria. They were joined in 1994 by the Central African Republic. The aims of the commission are to regulate and control the use of water and other natural resources in the basin and to initiate, promote, and coordinate natural resource development projects and research.

The Member States of the Lake Chad Basin Commission have established the Lake Chad Basin Observatory with the need for regular knowledge-based products from the regional organisation to enable all the stakeholders in the Lake Chad Basin to coordinate the sustainable use of water and the protection of the Lake Chad Basin ecosystem. EO technology, like TIGER-Net will offer, has the capability to provide the data to generate these products on a regional scale and in a timely and cost effective manner. These products could satisfy some of the needs of the LCBC for operational level products.

In general, TIGER-NET will support the Lake Chad Basin Commission by

- enabling a historical documentation of land changes within the former lake area (Product group: *High resolution basin characterisation*)
- assessing and monitoring the water quality of Lake Chad (Product group: *Large lakes water quality and levels*)
- analysing historical floods (Product group: *flood mapping system*)
- providing an capacity to plan water supply and sanitation in N'Djamena (Product group: *Water supply and sanitation planning*).

## The Namibian Ministry of Agriculture, Water and Forestry



The Ministry of Agriculture, Water and Forestry in Namibia is to realize the potential of the Agricultural, Water and Forestry sectors towards the promotion of an efficient and sustainable socio-economic development for a prosperous Namibia.

The Vision of the Ministry of Agriculture, Water and Forestry is where the nation's Agricultural, Water and Forest resources are sustainably and equitably used for improved livelihood, wellbeing and wealth for all. Its mandate is to promote, develop, manage and utilize Agriculture, Water and Forestry resources.

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The main business of the Hydrological Services division of the Ministry of Agriculture, Water and Forestry, Namibia is related to floods. Collection of ground data is often hampered by access and virtually impossible because of the partly inaccessible areas. Thus, Earth Observation is a very suitable approach to provide information on floods and related issues, while GIS techniques provide the capacity to analyse and quantify events in space and time.

The capacity that TIGER-NET can provide will cover the following flood components:

- EO based water discharge forecasting to be able to predict floods (Product group: *Hydrological modelling*)
- flood monitoring during floods enabling response and enabling documentation (Product group: *Flood mapping system*)
- vulnerability assessment in order to manage and plan flood mitigation measures (Product groups: *Hydrological characterization* and *high resolution basin characterisation*)



## TIGER NET at the 9<sup>th</sup> international conference AARSE



At the African Association of Remote Sensing of the Environment (AARSE) conference in Morocco, ESA participated with two special sessions dedicated to the TIGER initiative.

The TIGER-NET project itself was highlighted both in the special session as well as in the ESA keynote given in the plenary. The response from the African scientific community was very positive to different capacity building activities within TIGER and lead to an official recognition and support in the official AARSE 2012 Declaration. The TIGER-NET project has been widely seen as an important activity to prepare for the up-take of the Sentinel missions.

### TIGER in Africa and the AARSE 2012 Declaration:

- 1) Recognising the importance and success of continued long term collaboration between European Space Agency and African scientists within the TIGER initiative on Earth Observation techniques related to water resources management.
- 2) To support the dedicated activities in the TIGER Capacity Building Facility and within the new TIGER-NET project as essential component to prepare the African water resources expert for the exploitation of African National satellites and the upcoming SENTINEL satellite fleet of the European Space Agency.

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## Progress of the System development



*Software components of WOIS*

The work on the Water Observation and Information System (WOIS) component of the TIGER-NET project is progressing at a steady pace. The Open Source (OS) software components of WOIS have been identified and most have already been integrated into a single graphical user interface (GUI) with the rest to follow soon. This will allow WOIS to exploit the specialized tools and strengths of the different software components, while providing a single GUI to ease the learning curve of users with limited previous experience with Geographic Information Systems (GIS) software. Quantum GIS (<http://www.qgis.org/>) was chosen as the central integrating platform due to its clear and accessible GUI and strong OS development community. The other components of WOIS are:

GRASS GIS (large toolbox of raster and vector analysis algorithms), BEAM and NEST (processing of visible, thermal and radar ESA data products), Orfeo Toolbox (high resolution image processing), SWAT (hydrological modelling) and PostGIS (spatial database).

The tools from the different components are integrated using the SEXTANTE spatial data analysis library which provides a framework for seamlessly incorporating algorithms from the various providers (such as GRASS GIS, BEAM, etc.) into Quantum GIS. Once the algorithms are incorporated they can be used for creation of workflows to guide the less experienced users, while the more experienced ones will be able to access all the tools individually through the SEXTANTE toolbox, all within the Quantum GIS GUI. The workflows will provide step-by-step guidance for the processing of the TIGER NET product portfolio and other relevant GIS tasks for water management.

The image below illustrates the QGIS canvas and the Sextante toolbox with embedded functionalities from GRASS, Orfeo and GDAL. BEAM and NEST functionalities are currently being developed for SEXTANTE, and the integrated workflow designer will be used to develop step-by-step processing workflows for TIGER NET product portfolio.



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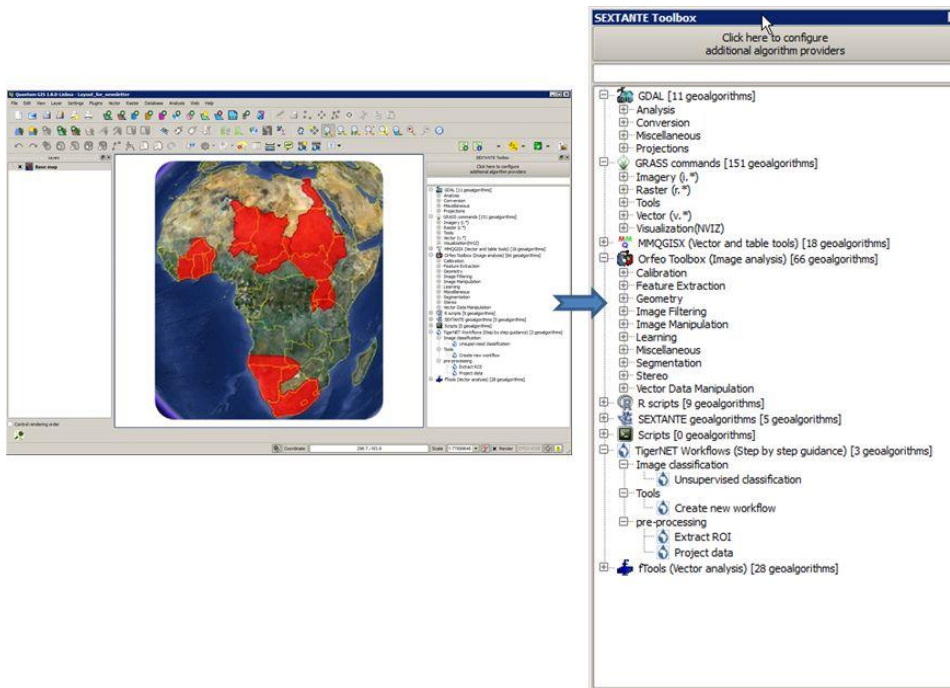


Figure 1: QGIS canvas and the Sextante toolbox



## Progress of the product development

The actual testing and design of the workflows for each TIGER NET product group is currently running in parallel with the WOIS development, and includes experimental analysis as summarized below:

- *Historic and operational information on **water quality and surface temperature for Lake Chad and Lake Victoria** is using a combination of ENVISAT and MODIS data.*
- *The base map of the basin (or sub-basin) under consideration as a baseline for further GIS activities will provide a basic, but accurate geographic digitised characterization of the main features in the area.*
- *Assessment of **land degradation and desertification** processes from trend analysis of SPOT VGT NDVI time-series data and corresponding rainfall and soil moisture data sets.*
- ***Full basin mapping** of the state and change in land cover/ land use from unsupervised/supervised classification of annual time-series of MERIS FR and MODIS data*

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- labelled in accordance to a nomenclature defined in collaboration with the users and modellers. Landscape **seasonal monitoring using decadal vegetation** anomalies as derived from time-series of biophysical SPOT VGT products (i.e. Fraction of Vegetation Cover (FCover), Fraction of Absorbed Photosynthetically Active Radiation (FAPAR), and Leaf Area Index (LAI)).
- **High resolution land cover and land cover change** mapping for water management related land cover classes in South Africa and land cover change mapping for the retreat area of Lake Chad based on SPOT, RapidEye and Landsat data
  - Detailed mapping and monitoring of open **small water bodies** and their seasonal changes in the northern part of the Volta basin.
  - A **flood mapping system** consisting of two products: the **historical flood mapping** product for the Komadougou-Yobe sub-basin in the Lake Chad catchment, the Lake Tana region and the Gambella region based on Envisat ASAR data and the **dynamic flood mapping** product for the Zambezi Flood Plains in Caprivi in Namibia, the Eastern Nile and Lake Tana and the Gambella region based on Radarsat-2 and RapidEye tasking.
  - Preliminary **hydrological model** versioning using the semi-distributed, physically based hydrological simulation software SWAT (Soil and Water Assessment Tool), developed by the US Department of Agriculture, and extended with an operational simulation and forecasting workflow. The hydrological forecast model is currently being setup and tested for MAWF, LCBC and DWA.
  - Mapping and modelling tool to estimate the water demand for **water supply and sanitation** associated with urban environments in Africa based on very high resolution satellite imagery land cover data and census data for N'Djamena, Chad.
  - Mapping and monitoring of historic long term (2 wet seasons in time) and seasonal extent and variation of major **wetland areas** (Sudd, Baro-Akobo-Sobat and Kagera wetlands) in order to better understand and quantify the water balance of wetlands.
  - Modelling of medium resolution, anthropogenic caused **erosion potential** for the Lake Victoria catchment and Kagera area in the Nile Basin based on land cover, rainfall, soil data as well as on a digital elevation model for the slope to identify highly potential erosion areas and changes for prioritizing watershed restoration activities and planning.

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The first results of several product developments look very promising as can be observed in the following figures.

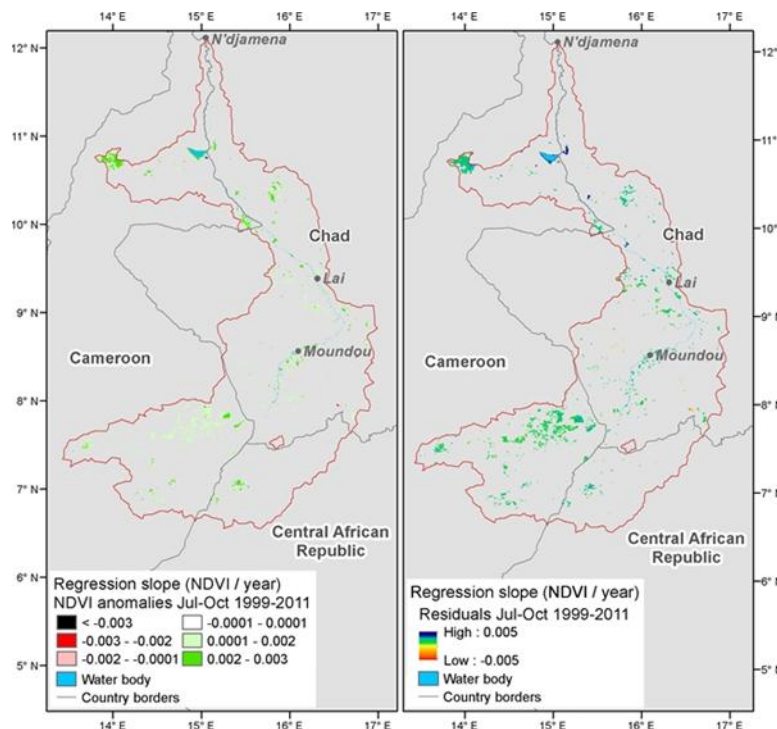


Figure 2: Land degradation assessment

In the figure on the left side an example of a land degradation assessment based on trend analysis of SPOT VGT NDVI data is shown with linear trends (i.e. regression slopes) of NDVI (left) and of the residual NDVI for 1999–2011 based on regression analysis of NDVI and 3-monthly rainfall sums (right). The time series feeding into the analysis included only data for the months of the growing season (July–October) for 1999–2011. Only statistically significant slope values are displayed ( $\alpha=0.05$ ).

The figure below presents an example from experimental analysis carried out in Kavango Basin. The left panel shows a recent land cover map produced from multi-temporal MODIS data. In the middle a binary change mask derived from image differencing (i.e. mean annual NDVI in 2012 minus the mean annual NDVI in 2005) can be seen and the right panel the 2005 land cover map produced from multi-temporal MERIS FR data is displayed.

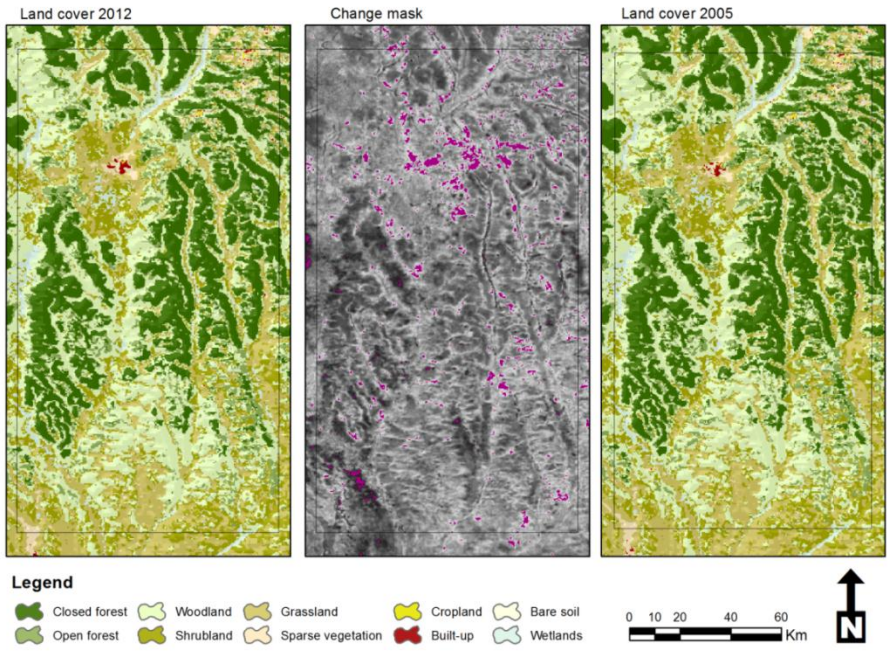


Figure 3: Medium resolution lands cover characterization

The figure on the right side demonstrates the first version of the Soil Loss Potential product requested by NBI, for which the latest version of the USLE model was implemented. USLE stands for Universal Soil Loss Equation and is based on rainfall data, soil and land cover data as well as a DEM to calculate the exposure due to the slope. The different colours show the soil loss potential in tons per ha per year. In a next step the land degradation product (Figure 2) will be integrated.

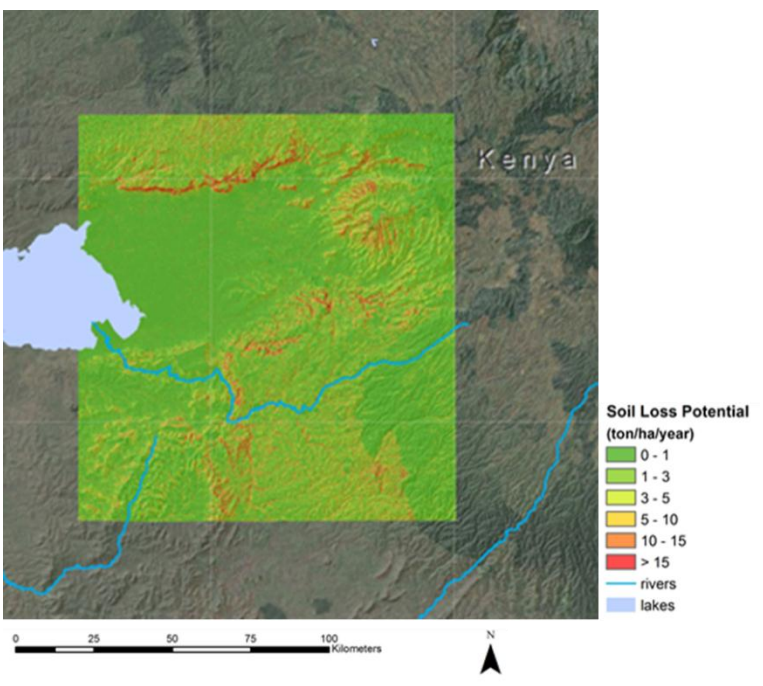


Figure 4: Medium resolution lands cover characterization

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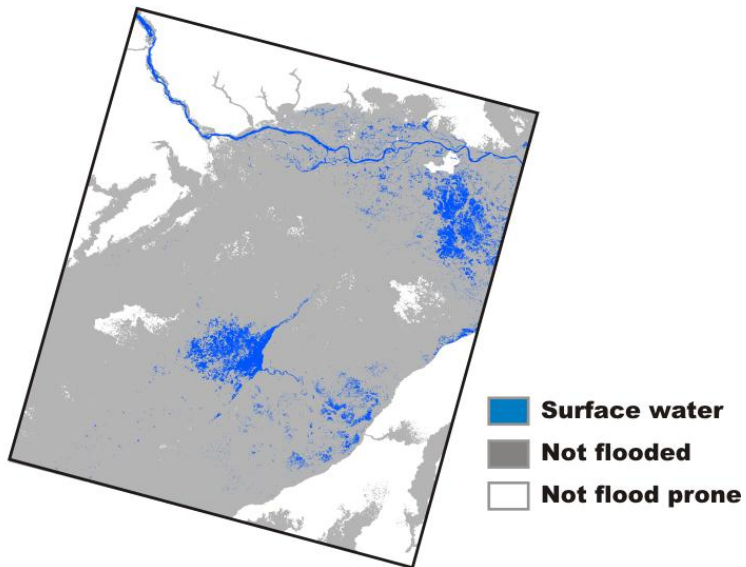


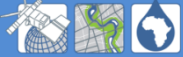
Figure 5: Initial results of the fully automatic Flood Mapping System workflow using RADARSAT-2 imagery in the Caprivi region in Namibia

The figure on the left side shows an example of the initial results of the Flood Mapping System using RADARSAT-2 imagery in the eastern-most part of the Caprivi region in Namibia. Locations not expected to be flood prone were identified using the Height Above Nearest Drainage (HAND) index (Rennó et al. 2008) computed from the hydrologically conditioned HydroSHEDS Digital Elevation Model (Lehner et al. 2008). Surface water and non-flooded pixels were classified in an automatic workflow using Otsu's threshold based classification method (Otsu 1979) complemented with a tile-based approach for improved threshold estimation.

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