Large scale wetland mapping in semi arid Africa using 250-meter MODIS phenology metrics and topographic variables

Tobias Landmann[1], Andreas Dietz[1], Stefan Dech[1, 2]

[1]University of Wuerzburg
Department of Remote Sensing
in cooperation with the DLR
Am Hubland,
97074 Wuerzburg, Germany
Contact: tobias.landmann@uni-wuerzburg.de

[2]German Aerospace Center (DLR) –
German Remote Sensing Data Center (DFD),
Oberpfaffenhofen, 82234 Wessling, Germany

This paper describes a unique space borne methodology to capture the flooding regimes and resulting wetland classes based on standard Land Cover Classification System (LCCS) codes. The wetland types according to flooding regimes are derived from daily and well corrected 250-meter reflectance metrics for several years (2003-2005), topographic variables such as streamline and pit features and TRMM rainfall observations as a surrogate for water availability related to the onset of rainfall intensity/duration. Primary aim of the paper is show how primarily 250-meter MODIS metrics can be optimally used to accurately map wetland types over larger areas, based on flooding regime and basic life form classifiers. Specifically a new index from MODIS data is utilized. The new wet-Index uses the relationship between wetland vegetation chlorophyll activity (NDVI) from the dry season, and corresponding near infra-red (NIR) reflectance due to flooding from the wet season. Before using the Wet-Index and analyzing the MODIS metrics we rigorously calculated harmonic vibrations/frequencies from 16-day Normalized Differential Vegetation Index (MOD13-NDVI) 250-meter data composites and from 8-day near infrared (NIR) reflectance (MOD09) time-series 250-meter composites. After the data pre-processing, the index values calculated and allocated to wetland features; this information was paired with the length of the inundation period using NIR reflectance minima in a contextual window. The topographic features were further used in hierarchical clustering to segregate areas where water can potentially collect. The study site, 125.000 km^2 in extend, is located along a rainfall gradient from Southern Burkina Faso to Southern Mali in West Africa, covering both the *Sahelian transitional savanna* as well as the *Guinea savanna woodlands* in the South.

Wetland management in Africa has been confounded by the absence of adequate environmental monitoring data on wetland occurrence and wetland heterogeneity. Thus monitoring of wetland in Africa is essential and pertinent, also in the context of capturing baseline data, so as to assess if changes in flooding regime and wetland vegetation are due to natural or anthropogenic pressures and also to measure/ascertain the progress of wetland restoration programs.

Up to 6 broad wetland features classes were mapped over the extend of the study area. The following LCCS compatible wetland feature classes were mapped and assessed for their accuracy; permanently flooded, semi-permanently flooded wetlands, and temporarily/seasonally flooded wetlands. The aerial extend of LCCS coded wetlands make up 9350 km², corresponding to 2,6% of the total area of the study area. The accuracy assessment using contemporary 30-60-meter Landsat time series and field data observations over two sites in Mali and Burkina Faso respectively, showed an overall accuracy of 73,6% and a Kappa Coefficient of 0,589 for the three

LCCS coded wetland types. The same reference data was used to ascertain the homogeneity of the three LCCS classes in the MODIS resolution. Between 43,8 and 64% wetland coverage could still be mapped in the 250-meter MODIS data, using the 60-meter Landsat data as reference data. The minimum mapping unit for the MODIS mapped wetland classes were thus determined as being between 2,3 and 3,3 ha.

We conclude that well processed MODIS metrics are useful for effectively mapping LCCS coded wetlands in West African savannas. The accuracies and homogeneities show the limitations of the approach and the sensor resolution, but overall the result is acceptable.

Information about the author; Dr. Tobias Landmann is a senior scientist in Remote Sensing at the Remote Sensing Unit of the German Aerospace Centre (DLR), based at the University of Wuerzburg in Germany. Dr. Landmann completed his PhD in satellite remote sensing of fires, in the context of the SAFARI2000 project and through the University of Goettingen (Germany) and the Council for Scientisfic and Industrial Research (CSIR). After working for CSIR he worked for FAO at the Global Land Cover Topic Centre in Florence, Italy.