Geophysical Research Abstracts
Vol. 14, EGU2012-10514, 2012
EGU General Assembly 2012

Contribution of MODIS satellite imagery in modelling the flooding patterns of the coastal wetlands of the Tana River, Kenya

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In sub-Saharan Africa, much of the arid and semi-arid lands are used by pastoralist groups as seasonal grazing zones. In such a context, wetlands are a vital resource as they act as retreat zones during the dry seasons when water and fodder resources are scarce. At a larger scale, wetlands also render numerous services including groundwater recharge, water quality improvement and climate regulation. As regular floods are the underlying factor determining the healthiness of wetland ecosystems, it is important to understand their dynamics for a better water resource management at the catchment scale in the context of increased water abstraction and hydroelectric infrastructure development.

Yet, this is challenging in many places because of scarce or poor quality data and a often difficult access to the zone. In tropical or coastal areas, frequent cloud cover can also limit the use of remote sensing data. The MODIS instruments on board the Terra and Aqua satellites offer high temporal resolution images at a moderate spatial resolution in the visible and infrared spectrum. In particular the MOD09A1 and MYD09A1 500m, 8-day synthesis products select the best possible observation for each 8-day period thus decreasing poor quality pixels due to cloud cover in an image while retaining a high frequency coverage. Here we assess their potential use to monitor floods in the Tana River Delta (TRD), Kenya. In this study, all 8-day synthesis products from 2001 to 2011 were screened and selected for low cloud cover. The total flooded surface was then extracted from each image using the Normalized Difference Moisture Index (Xu, 2006) to obtain time-series inundation maps from 2002 onward. In a third step, the images were used, combined with river-flow data, to analyse the hydrological system of the area.

The maximal extent, start and end inundation dates were determined for the major floods of the past decade. There were major differences in these characteristics for medium to large-scale flooding as well as differences between the long and short rainy-seasons. We also show that the total flooded surface was mainly correlated to upstream river-flow data and not local rainfall nor evaporation. The inundation maps were then used to construct a simplified hydrological model of the zone in order to 1/ further characterize the major processes that determine flood extent and duration and 2/ assess whether there have been temporal and spatial changes of the latter in the past decade.

As such, MODIS products have proved useful in understanding the seasonal inundation dynamics in the TRD. The calibrated hydrological model will provide insight on how new hydroelectric infrastructure will impact the water resources and the associated ecosystem services of the delta. These high temporal and medium-range spatial resolution satellite imagery provide a free-of-cost and rapid solution in monitoring water distribution and environmental changes in tropical, coastal or semi-arid areas.