A CASE STUDY FOR THE OKAVANGO DELTA WETLAND: USING MODIS TIME SERIES OBSERVATIONS TO ASCERTAIN FLOODING REGIME DYNAMICS FOR IMPROVED METHANE EMISSION MODELING INPUTS

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Abstract

Remote sensing plays a significant role in the estimation of methane and monitoring wetlands flooding duration and extent [1]. Methane is the second largest contributor to the present day greenhouse gas effect [3]. However there are considerable uncertainties in the magnitude of this biogenic emission [2]. For instance, the amount of methane emissions from the Okavango Delta is not known, which makes it difficult for Botswana to present a comprehensive report to the UNFCC on greenhouse emissions budgets. Therefore, this study presents a method for mapping temporal inundation patterns for improved methane emission estimates in the Okavango Delta using MODIS data. It is the first time that MODIS data is used for this purpose. Previous researches in the Delta relied on Landsat data that has a fine resolution but less temporal coverage as compared to MODIS. Even though MODIS data has a courser resolution (250-1000-meter), it is better suited to map intra-annual and inter-seasonal inundation variations especially since the imagery is acquired near to daily and only one image scene covers the whole Delta. The

data is freely available online, but without the necessary pre-processing tools it is not possible to make correct scientific conclusions from the time series data, since the standard MODIS compositing algorithm does not preclude 'noise' effects related to cloud, cloud shadow and BRDF. We derived a contextual algorithm using local near infrared minima over one year and combined this with an index function between the maximum chlorophyll active vegetation stage in the wetland, using the NDVI band, and low NIR metrics in the maximum flooded season. The resulting inundation length and wetland morphology map was used to determine areas within the delta where field measurements on methane fluxes will be used set up. As a result we attained methane emissions results for each flooding regime class, based on intra-seasonal dynamics of water inundation levels and wetland vegetation morphology.

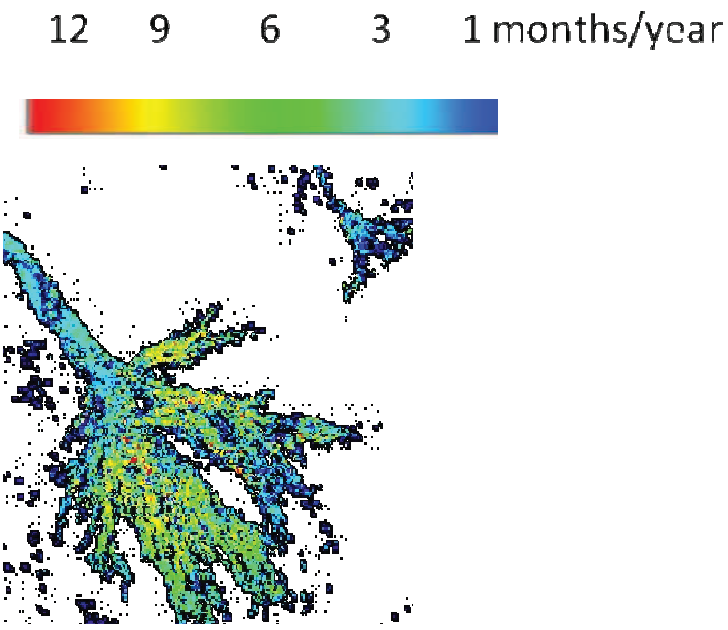
Method

The TiSeG program (Time-Series Generator) for preprocessing MODIS data was optimized to suit the 'noise' conditions found over the Okavango Delta. The program uses an linear interpolation algorithm to correct for clouds and other noise effects in time series data. The 250-meter near infrared (NIR) band was used for mapping spatiotemporal inundation patterns over the study area as this spectral wavelength is most sensitive to the presence of water. The 250-meter NDVI data was used for mapping photosynthetically active vegetation over the area. Field survey results and contextual knowledge of the Delta were then used to develop wetland flooding regime classes from the MODIS spectral index and the flooding regime algorithm output. We used the MODIS results to select representative areas for in situ methane measurements using gas trapping boxes and a gas chronometer. The in situ and satellite derived results were integrated into a GIS model to infer methane flux dynamics over the delta.

Results and conclusion

Four major flooding regimes based on the length of the flooding period (see Figure 1 below) were obtained over the Delta: 9-12 months, 6-9 months 3-6 months, 1-3 months. Usually the Delta is simplified into three flooding regimes, which are: permanently flooded, seasonally flooded and occasionally flooded [4] without a given time frame. The results attained herein allow for a more finer stratification of flooding regimes and as a result methane fluxes over the Delta, The methane flux dynamics provide a good basis for large scale and rigorous methane inventories over larger and remote areas such as the Okavango Delta.

Fig. 1. MODIS derived flooding lengthover the Okavango Delta for the year 2006. Red pixels in the NIR 250-meter data exhibit areas where the inundation period is nearly 12 months/year; blues pixels are areas where the flooding period is under 2 months/year.



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