

Fig. 1: Dominant land cover classes produced by an unsupervised classification approach which was based on phenology metrics derived from 16-day MODIS EVI time series covering the observation period 2000 to 2011.

Table 1: Proportions of dominant land cover types within the FORA (Future Okavango Research Area).

Land cover class	Area (km ²)	Percent
Miombo forests	58,752	25.76
Miombo forest with <i>Cryptosepalum exfoliatum</i> ssp. <i>pseudotaxus</i>	29,811	13.07
Miombo forest dominated by deciduous tree species	13,805	6.05
Miombo forest dominated by <i>Julbernardia paniculata</i>	15,135	6.64
Woodlands on Kalahari Sands	68,046	29.83
<i>Baikiaea-Burkea</i> woodlands (dense)	3,417	1.50
<i>Baikiaea-Burkea</i> woodlands (medium dense)	16,512	7.24
<i>Baikiaea-Burkea</i> woodlands (open)	28,377	12.44
Mixed <i>Burkea</i> woodlands (with <i>Terminalia sericea</i>)	19,741	8.65
Other woodlands	15,365	6.74
Mixed Kavango woodlands (including <i>Colophospermum mopane</i>)	7,526	3.30
Open and degraded woodlands (on sandy soils)	7,839	3.44
Thornbush savannah	29,177	12.79
Thornbush savannah (with seasonally dense grass layer)	3,641	1.60
Thornbush savannah (medium dense)	9,612	4.21
Thornbush savannah (open)	10,161	4.45
Sparse shrublands, fields or urban areas	5,763	2.53
Shrub- and grasslands	40,098	17.58
<i>Burkea-Baphia</i> shrublands	17,069	7.48
Open shrublands on sandy soils	13,141	5.76
<i>Parinari capensis</i> grasslands (on humid soils)	738	0.32
<i>Cryptosepalum maraviense</i> grasslands (on ferralitic soils)	4,595	2.01
Forest grassland ecotone (with <i>Cryptosepalum maraviense</i>)	4,555	2.00
Wetlands	16,667	7.31
Seasonally flooded grasslands and reedbeds	12,906	5.66
Wet grasslands and peatlands	3,761	1.65
Total	228,104	100.00

Based on the Moderate Resolution Imaging Spectroradiometer (MODIS) earth observation time series, phenological parameters were derived for the Okavango Catchment covering the time period from July 2000 to July 2011 at a pixel resolution of 250 m by 250 m. This analysis was based on 16-day-composites of the Enhanced Vegetation Index (EVI) that is related to vegetation cover and density (Fig. 1 of the Electronic Appendix; Jönsson & Eklundh 2002). According to the information gathered from the phenological analysis, an unsupervised classification was performed to identify the spatial patterns of major functional vegetation types within the observation period. The nomenclature of the resulting 20 classes was performed knowledge-based on extensive field work in the Okavango region aiming at identifying the dominant vegetation type that each class represents. The resolution of MODIS and as well the limited number of 20 classes includes the shortcoming that the actual

vegetation cover might locally differ from the nomenclature in the map.

The land cover map (Fig. 1) shows a gradient in land cover classes from the upper catchment with high rainfall amounts compared to the downstream areas. The northern part of the catchment is dominated by Miombo woodlands. These woodlands are traversed by river valleys feeding the tributaries of the Okavango River. Open grasslands, often accompanied by dwarf shrubs, dominate these valleys. The middle reaches are characterized by extensive woodlands on Kalahari sand. The delta area with low precipitation is surrounded by mixed woodlands on the eastern side (including *Terminalia* and *Mopane*), whereas on the western side thornbush savannah represents the main vegetation type. The Okavango Panhandle and Delta form a special ecosystem. Here, land cover is governed by inundation rather than the amount of rainfall and is dominated by seasonally flooded grasslands and reedbeds. Table 1

summarizes the proportion of each dominant land cover class.

An important landscape forming factor is the fire regime. Based on the MODIS burned area product that provides regular information on fires since April 2000, fire frequency (Fig. 2) as well as the main season of fire occurrence (Fig. 3) were calculated for the entire catchment. Fires are occurring in most parts of the catchment (Fig. 2), being most frequent in the fluvial valleys of the upper catchment as well as in the savannah regions. In Miombo forests and large parts of the Okavango Delta, fires are infrequent or even non-existent during the observation period. In Angola, the fires in the river valleys are mainly occurring in June/July whereas the main fire season in the savannah is August to September (Fig. 3). If the Miombo forests are affected by fires, these are usually occurring from September to October.

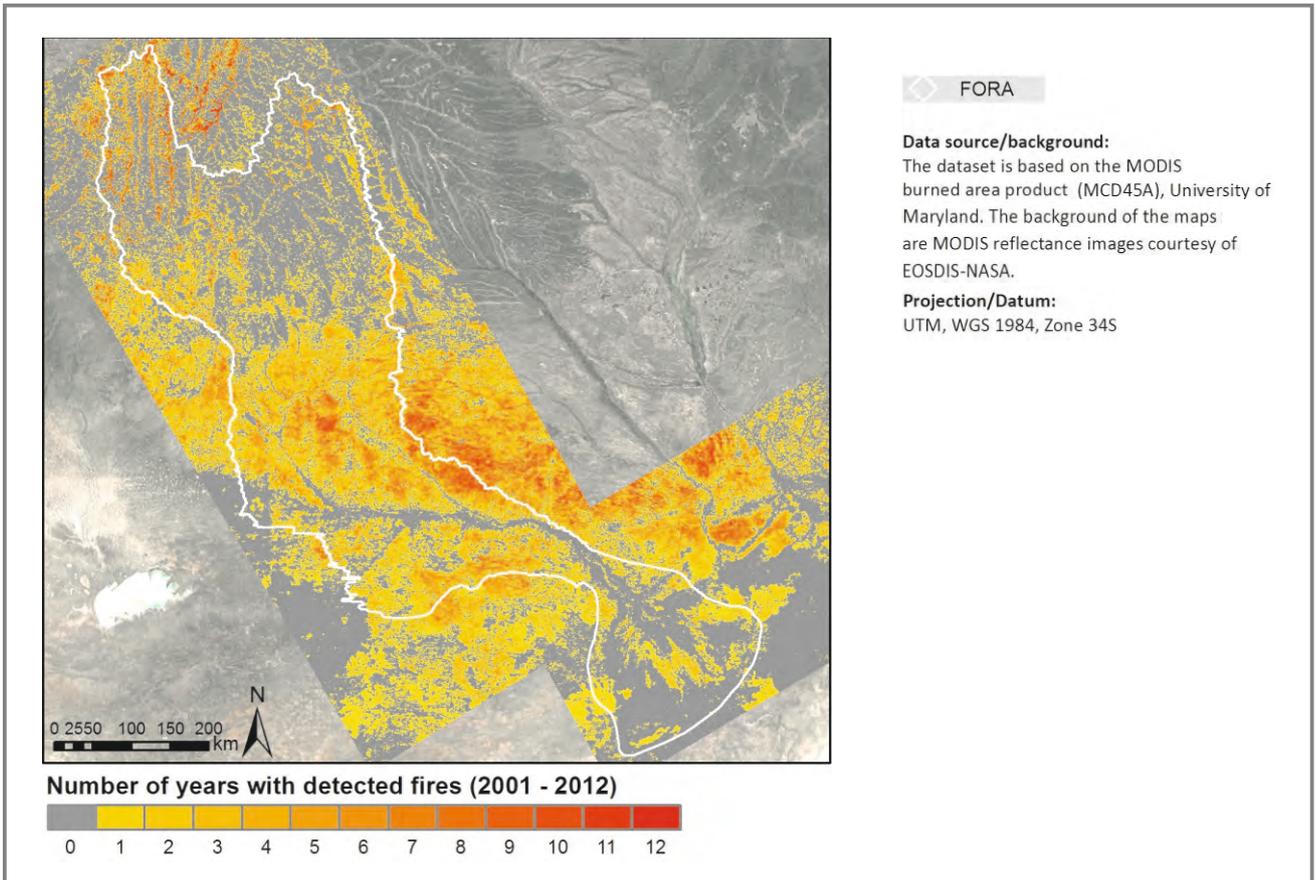


Fig. 2: Number of years with detected fires within the observation period 2001 to 2012. The map is based on the burned area product (MCD45A).

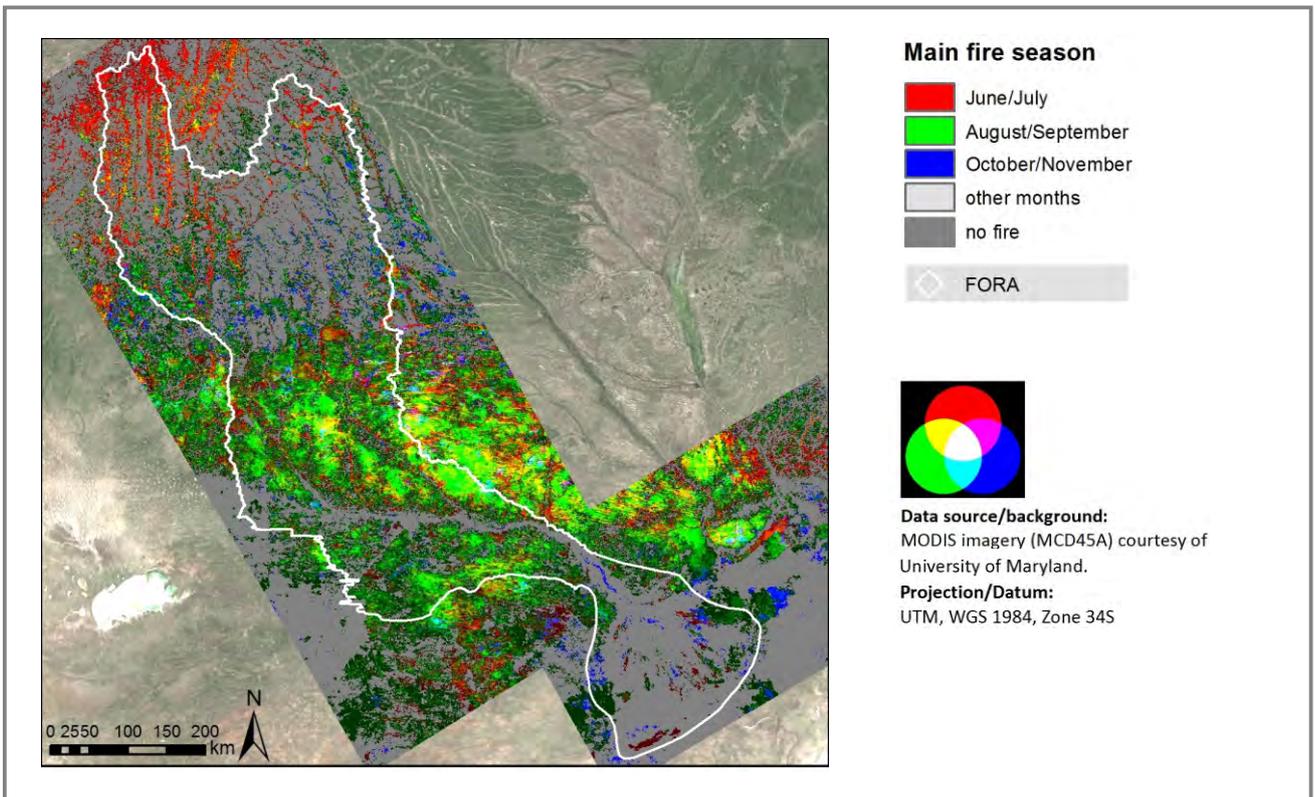


Fig. 3: Main fire season within the FORA covering the observation period 2001 to 2012. The main fire season is illustrated as a Red-Green-Blue (RGB) false colour composite, where red colours correspond to the main fire season in June/July, green colours in August/September and blue colours in October/November. Yellowish and cyan colours result from the combined occurrence of fires in different periods, where yellow results from fires in the period June to September and green colours from fires during August to November. The brightness of the colours is related to the frequency of fire events. The product is based on the burned area product (MCD45A).

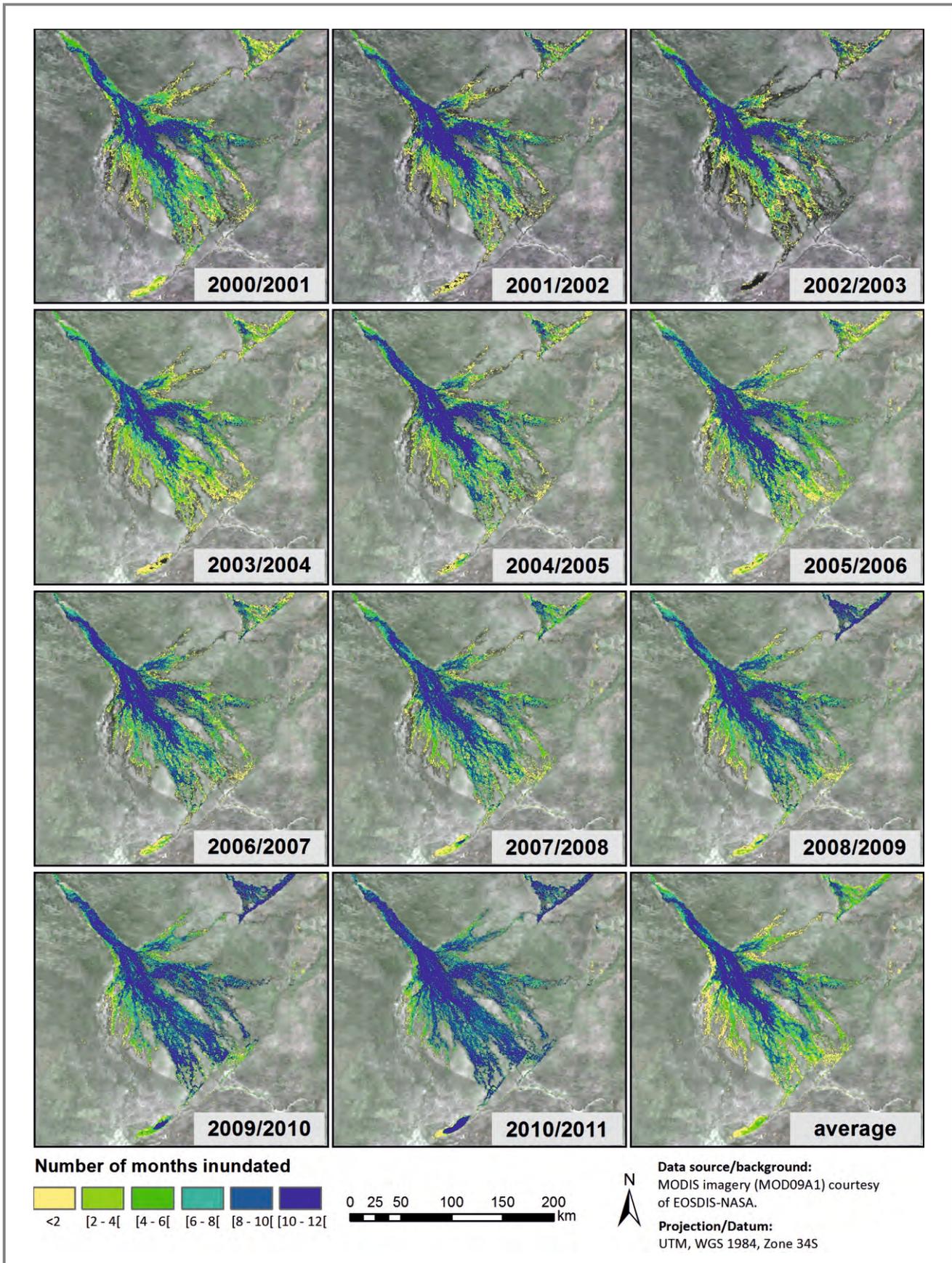


Fig. 4: Estimated number of months inundated within the Okavango Panhandle and Catchment covering the observation period from 2000 to 2011. The dataset is based on 8-day reflectance data of the MODIS sensor (MOD09A1).

Inundation of the Delta (Fig. 4) was monitored by implementing an expert based decision tree derived from a time series of MODIS reflectance data (MOD09A1) similar as described by Murray-Hudson (2009). Problems can arise when inundated areas are also densely vegetated, because the spectral mixture impedes the mapping of the flooding extent. The inundation map shows the annual duration of the flooding from 2000/2001 to 2010/2011 as well as its overall mean. The annual maps (Fig. 4) show that the duration of inundation is spatially very different. Moreover, there is a marked interannual variation in the extent of the overall flooded area. Mean

inundation area of the Panhandle and Delta as derived with the implemented method is around 9,000 km². Rainfall was abundant in the years 2009-2010 (Weber 2013) and during that period Lake Lage Ngami, close to the southern margin of the presented subset to be permanently flooded again.

Acknowledgements

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