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Linking vegetation databases and phenological metrics of MODIS time series to predict plant species richness of the Okavango Basin

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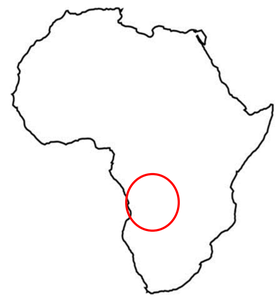

Introduction

The Okavango River Basin shared by the countries of Angola, Namibia and Botswana is a hot spot of accelerated land use change with cascading consequences for ecosystem service delivery and biodiversity. However, baseline information on ecosystem properties such as species density is missing for most parts of the river basin. Especially the dry tropical woodlands of the Angolan part of the Basin are understudied due to four decades of civil war. Within the framework of The Future Okavango (TFO) project an extensive vegetation survey was carried out to fill this gap. We present an approach on how to combine information from the TFO vegetation data base with medium resolution remote sensing time series to predict species density of the Okavango Basin.

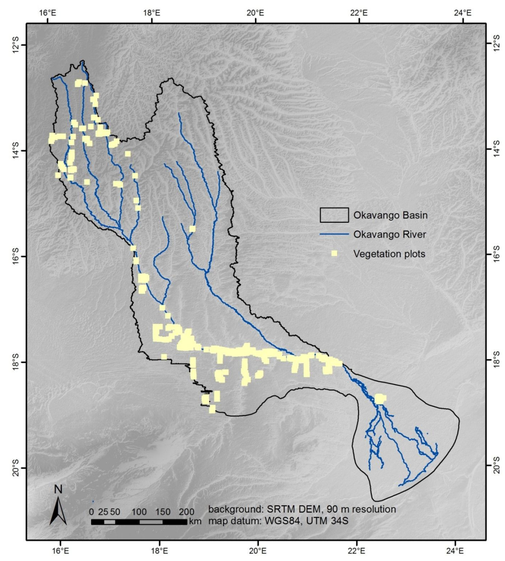

Fig. 1 Location of vegetation plots

Tab. 1 Results of model validation on test data

	Correlation (r_p)	RMSE	R^2
BRT	0.697	11.0	0.486
RF	0.704	10.9	0.495

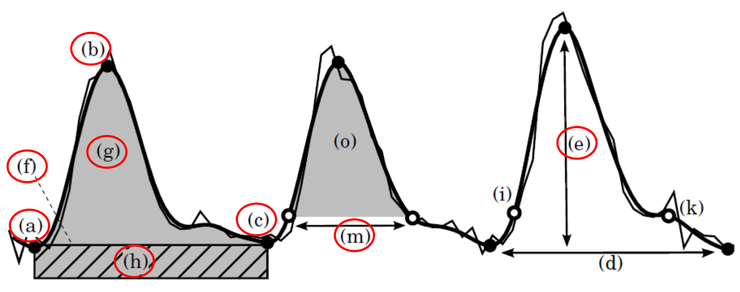

Fig. 2 Illustration of phenological metrics of three years of EVI time series of MODIS, figure taken from Mader (2012); metrics circled in red were used in modelling: Large integral (sum of g and h), base value (f); season end (c), amplitude (e), season start (a), season mid (b), season length (m)

Data

Response variable:
Species density derived from 999 vegetation plots sized 20 m x 50 m covering all major vegetation units of the Okavango Basin (Fig. 1).

Predictor variables:

- phenological metrics of the EVI averaged over 12 years based on MODIS imagery using the software SpliTS (Mader, 2012; Fig. 2)
- topographic attributes derived from the SRTM: *topographic wetness index, topographic ruggedness index, topographic position index*
- bioclimatic data derived from the CRU TS2 and ARC2 data sets were tested as additional predictors.

All data was resampled to the resolution of MODIS (250 m x 250 m).

Methods

Model algorithms: two statistical models compared: boosted regression trees (BRT) and random forest (RF)
Predictors: screened for mulitcollinearity
Model validation: data split into training and testing (ratio 80:20); performance criteria: Pearson correlation (r_p), RMSE, R^2
Software: all analyses done in R using the libraries 'caret', 'gbm', 'randomForest', and 'raster'

Results and Discussion

BRT and RF performed almost equally on testing data producing realistic maps (Tab. 1, Fig. 3a). Inclusion of climate data lead to increased model performance. However, the resulting patterns of species density seem overdetermined by patterns of climate data (Fig. 3b). Therefore, the impact of local topographic and edaphic differences are blurred, especially in the Highland in the NW.
The species density maps show that the Miombo woodlands of the Angolan Highland feature the highest species density with a decreasing trend southwards. The lowest values are predicted for the Acacia communities in the Okavango Delta area. At the same time this area has the lowest number of plots and therefore results need to be treated with caution.

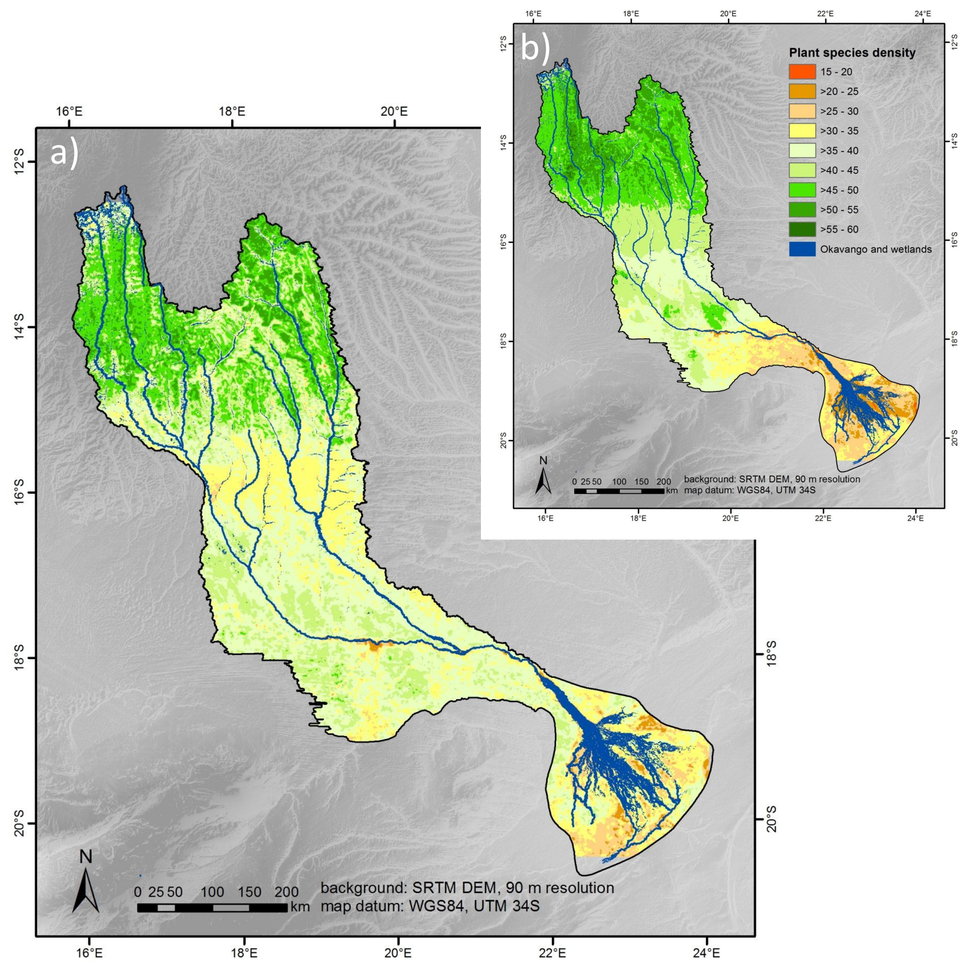

Fig. 3 Modelled plant species density of the Okavango Basin
a) Using MODIS time series of EVI and topography
b) Predictor variables same as in a) plus climate data

Mader, S. (2012): A Framework for the Phenological Analysis of Hypertemporal Remote Sensing Data Based on Polynomial Spline Models. Dissertation, University of Trier.

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