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Vegetation structure and land dynamics in Southern Africa's Savannas: Multi-scale earth observation data for ecosystem and biodiversity monitoring

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Changing climatic conditions and increasing human induced land cover conversions cause increasing pressure on the Earth's living recourses. Particularly in Africa land cover alterations have major consequences on human welfare and food security. In the arid and semi-arid environments of Southern Africa, human activities have strongly affected the natural ecosystems during the last decades, both directly through for example deforestation and indirectly through human induced climate change and land use shifts. The consequence are change processes like bush encroachment and rangeland degradation leading to a destabilization of the affected ecosystems, to an alteration of biodiversity patterns and to a decrease in rangeland productivity.

Regarding the pronounced landscape complexity and spatial heterogeneity in Southern Africa's savannas, vegetation maps based on field surveys describe a detailed picture of Namibia's biota only on local scale. Beside the global land cover characterizations several botany-based studies give a coarse description of the major vegetation types of Namibia. Recently no area-wide vegetation maps are available including detailed information on species composition and their vulnerability to climatic or anthropogenic change processes.

The aim of this study is to generate fuzzy vegetation maps between 2000 and 2008, detect change and modifications and estimate indicators for major land change pro-

cesses in north-eastern Namibia. We present an environmental monitoring approach for semi-arid ecosystems based on multi-spectral and multi-temporal satellite observations. In-situ land cover information following the FAO's Land Cover Classification Scheme (LCCS) is used to retrieve the major vegetation types and species communities. Vegetation structure on local scale is derived from very high resolution SPOT-5 and Quickbird imagery using segmentation techniques. Downscaling analysis are applied to combine vegetation composition on high spatial resolution (Quickbird 2,4m, SPOT-5 2,5m and Landsat 30m) with its temporal dynamics using MODIS time series data (250-500m). The Time Series Generator (TiSeG) is applied on the MODIS data to improve data quality in terms of atmospheric and view angle effects. Non-parametric classification approaches are used to generate annual vegetation structure maps from the improved MODIS time series. Major land change processes and indicators can be estimated using socio-economic and climate data.

Our studies emphasize that MODIS derived NDVI time series as vegetation type specific phenological signatures can serve as useful input parameter for vegetation classification. Transition zones between landscape units are well represented using a fuzzy classification approach. In Northern Namibia land cover modifications from natural vegetation to agricultural land could be detected caused by population increase in the recent years. However, detailed studies of change processes and drivers of change are complicated by the high natural inter-annual precipitation variability in semi-arid regions. These limitations have to be approached in future in-depth combined analyses of remote sensing, climate and socio-economic data.