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Ecological modeling of tree patterns and diversity as a means of classifying savanna landscapes: Remote sensing and GIS-based mapping

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Through its control of energy fluxes over substantial portions of the land surface, vegetation is an important component of the global climate system. In semi-arid regions, issues of rainfall reduction, climate change, and water scarcity are aggravated by the increasing disturbance of the natural relationship between vegetation and climate. Even the role of disturbing dominant vegetation types has not yet been comprehensively studied. The current paper focuses on the spatial distribution of the savanna physionomy and phytosociology in relation to environmental factors such as soil types and land units, to establish an accurate classification map and phytoecological zones of the vegetation landscapes. Tree biometric measurements were conducted in the Bontioli nature reserve, in Southwestern Burkina-Faso with systematic sampling based on quadrats (plots) of 30m by 30m on regular intervals of 1km. Within each quadrat, parameters measured were individual tree position (use of GPS), tree height, DBH, crown cover/depth (use of Sunnto and Distance meters) and species scientific name. Similarly, information on soil type and land type were collected and compiled in a GIS database. The ecological modeling of spatial tree patterns is based on Poisson and Negative binomial distribution models. Tree species diversity estimates are computed according to Shannon-Wiener and Simpson indexes; species richness is estimated by Jackknife and Rarefaction models. Contingency coefficients are calculated by the software SPSS to analyze associations between tree species, vegetation, soil and land types. Test of non-similarity of savanna types are done by ordination methods. The supervised classification based on NDVI image is done by remote sensing using Landsat ETM+, scene 196/52 of October 2002, pixel size of 28.5m. Validation of the classification is done by ground truth investigations and the final map is de-

signed by GIS, using the soil map of the region as reference shapefile layer to adjust and validate the phytoecological zones. The final results reveal that the nature reserve provides a habitat for 70.9 (ś 1.9) tree species spatially aggregated but randomly distributed within each clump. The tree community is organized according to three main vegetation types such as tree, shrub savannas and gallery forest detailed in an accurate classification map (i.e. overall accuracy = 98.8%) which is used as basis for the phytoecological zones map. The second map summarizes relationships between savanna physionomy, phytosociology, soil and land types. The detailed maps can be used as baseline for scaling up vegetation water release in the atmosphere from whole plant tree water use, or can be used in multi-agent research in need of small scale classification maps. At a broader level, the results contribute to the understanding of vegetation dynamics in the global change, help to answer similar question: how vegetation cover dynamics significantly affect the Earth's environment?

Abbreviations: DBH = Diameter at Breast Height; NDVI = Normalized Difference Vegetation Index; ETM + = Enhanced Thematic Mapper Plus; GPS = Global Positioning System Key-words: Biodiversity, Ecological modeling, Phytoecological zone, Remote sensing and GIS, semi-arid land, Volta Basin, Vegetation classification, West Africa