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Ecological Modelling of Tree Patterns and Diversity as a Means of Classifying Savannah Landscapes: Remote Sensing and GIS-Based Mapping

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Abstract

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 savannah 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 30 m by 30 m on regular intervals of 1km. Within each quadrat, parameters measured were individual tree position, tree height, DBH (Diameter at Breast Height), crown cover/depth and species scientific name. Similarly, information on soil type and land type were collected and compiled in a GIS database. The ecological modelling of spatial tree patterns was based on Poisson and Negative binomial distribution models. Tree species diversity estimates were computed according to Shannon-Wiener and Simpson indexes; species richness was estimated by Jackknife and Rarefaction models. Relationships between tree species, vegetation, soil and land types were analysed through contingency coefficients. Test of non-similarity of savannah types were done by ordination methods. The supervised classification was done using Landsat Enhanced Thematic Mapper Plus scene (ETM+ scene) 196/52 of October 2002, pixel size of 28.5 m. Validation was done by ground truthing and the final map was designed using the soil map of the region to adjust and validate the phytoecological zones.

The final results revealed that the nature reserve provides a habitat for 70.9 (± 1.9) tree species spatially aggregated but randomly distributed within each clump. The tree community was organised according to three main vegetation types such as tree, shrub savannahs and gallery forest detailed in an accurate classification map (i.e. overall accuracy = 98.8 %) which was used as basis for the phytoecological zones map. The second map summarises relationships between savannah physionomy, phytosociology, soil and land types.

Keywords: Biodiversity, ecological modelling, phytoecological zone, remote sensing GIS, semi-arid land, Volta Basin, vegetation classification, West Africa

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