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Management, Biodiversity and Plant Phenology Are the Most Important Predictors of Forage Provision and Erosion Regulation in West African Grasslands

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Abstract

The ability of grasslands to provide vital ecosystem services (ES) depends on ecosystem functioning, which is interactively driven by abiotic and biotic factors. The relative importance of these factors for ES supply in West African grasslands is still poorly understood, hampering the design of appropriate land management strategies.

Taking a macroecological perspective, we aimed at detecting broad and consistent patterns in ES drivers and supply, focusing on the provisioning ES 'forage' (proxies: aboveground herbaceous biomass – AGB; metabolisable energy – ME; metabolisable energy yield – MEY) and on the regulating ES 'erosion control' (proxy: cover of perennial plants in grass layer – PC). This study which is part of an interdisciplinary project addressing climate change adaptation and mitigation in West Africa (www.wascal.org), covered almost the entire climatic gradient of West Africa's Sudanian savannahs, and reached from northern Ghana to central Burkina Faso. We used linear mixed-effect models and model selection procedures to test effects of eighteen biotic and abiotic drivers on ES proxies, and bootstrapped final models to quantify bias. We found that biotic factors (related to management, biodiversity and plant phenology) were generally more important than abiotic factors (related to climatic aridity, topography and soil characteristics). Grazing pressure and litter cover were the most important management-related factors while species richness and the relative abundance of three functional groups (e.g. tall perennial grasses) were the most important biodiversity-related factors. Increasing grazing pressure (quasi-) linearly reduced forage AGB and MEY while increasing forage quality (ME). The effect of grazing on AGB and MEY was modulated by phenology. Our study established the first predictive models of vital ES in West Africa's Sudanian savannahs. The finding that management and biodiversity related drivers are more important for ES supply than climate implies that ecosystem-based adaptation strategies could mitigate potential negative effects of climate change. This is of great value for land management planning in the region.

Keywords: Abiotic, biotic, ecosystem services, forage, grasslands

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