

Abstract

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This thesis discusses the dynamics of savanna ecosystems and management in southern Ethiopia by investigating the roles played by rainfall variability and the impact on cattle population under the communal rangelands and ranch system. The thesis considers the variability in terms of impact of multi-year droughts on livestock of different reproductive classes and their recovery patterns, comparing the traditional and ranch management systems. The thesis also investigates the importance of using herder environmental knowledge in understanding historical changes in patterns of land use and shifts in vegetation, with implications for pastoral production. Using herder concerns about shifts in grassland vegetation to bush encroachment, the thesis presents studies that examine the ecological mechanisms of bush encroachment in relation to protection, grazing and time of protection. The studies demonstrate the control of bush encroachment and evaluate the responses of individual woody and herbaceous species using six demonstrations.

This study is based on ecological models, focusing on the equilibrium and non-equilibrium models. The thesis seeks to understand the drivers of change behind cattle population variability, mechanisms of bush encroachment and effects of control demonstrations on woody and herbaceous plant species in Borana. Traditionally, the Borana land use system involves extensive livestock production based on mobility between the key and non-key resources. The thesis uses household interview and field based data collected between 2002 and 2005. Household cattle data (21 years) and the ranch cattle data (15 years) were related to long-term rainfall variability.

Breeding cows in the key resource *tula* well rangelands showed longer reproductive life than the non-key resource pond-water rangelands. Average calving rates were greater in the communal rangelands than in the ranch system. Severe mortality and greater reduction in calving rates during multiple droughts resulted in reduced herd growth potential. Inter-annual variability in rainfall seems to have a considerable effect on cattle populations compared to density dependence. The combined effects of variable rainfall and increased bush cover might lead to risks of drought induced herd dieoffs. Specifically, herder perceptions indicated that the emergence of range enclosures and expansion of crop farming have reduced the extent of grazing, while fire suppression has promoted bush encroachment.

Furthermore, the study found greater densities of invasive woody species in enclosures as opposed to the open grazed areas. This implies that additional causes might be involved in the process of bush encroachment apart from grazing. The use of the state-and-transition model showed complex successional pathways of changes with regard to variability in rainfall, management interventions and

timescales (i.e. the age chronosequence of enclosures) that are relevant for making management decisions.

The thesis suggests that protection from disturbance promotes bush encroachment. It was found that four out of the six bush control methods substantially reduced bushy plants, with varied effects on individual species. Overall, the tree cutting, fire and grazing treatment was more effective in controlling coppicing after disturbance. Different woody species showed varied adaptation strategies in response to disturbances by either adapting to increased seedling recruitment or coppicing after disturbance.

The disturbance control treatment had no advantage in terms of herbaceous biomass and basal cover over other treatments, while herbaceous species richness was enhanced. This thesis suggests that grazing with bush cover greatly reduces herbaceous biomass. Generally, tree cutting and fire seemed superior in terms of herbaceous biomass, while fire and grazing, and tree cutting are recommended for the conservation of herbaceous species diversity. The outcomes in terms of herbaceous biomass and

species diversity have important policy implications for bush encroachment control and public education. This thesis emphasizes the importance of the fire and grazing method which can reasonably be recommended for control of bush encroachment with the overall objective of promoting herbaceous biomass and species diversity.

Results presented in this thesis suggest the following views: (i) The study acknowledges the evidence of density dependence at the level of local land use, but overall density independence at the regional level. The findings further confirm the failure of ranch management in reducing herd mortality and signify the role of rainfall variability even under a controlled system. The need for drought management, focusing on post-drought herd rehabilitation through the distribution of bulls, depends on the breed conservation ranch and is important for the maintenance of the Borana cattle breed; (ii) The use of communities' environmental knowledge as a framework for understanding the impacts of land use change on the environment, may provide a strong foundation on which to reconstruct scientifically and culturally acceptable methodological approaches. Sustainable use of the savannas of southern Ethiopia in the future will require paying greater attention to regulating expansion of enclosures, crop farming and ranching, as well as re-introducing fire, where necessary, to control bush encroachment; (iii) The state-and-transition model is appropriate for describing the mechanisms of bush encroachment; (iv) Responses of individual woody and herbaceous species to bush control methods have important implications for management, conservation policy and public education which in the future should be promoted through public education and extension.