

Archer, S. 2010. Rangeland conservation and shrub encroachment: new perspectives on an old problem. *In: Rangelands or Wildlands? Livestock and Wildlife in Semi-Arid Ecosystems* (Johan du Toit, R. Kock, J. Deutsch, eds.). Blackwell Publishing Ltd. In Press.

Summary

Rangelands support the majority of the world's livestock production and provide important wildlife habitat. Their airsheds and watersheds influence the health and well being of the 30% of the world's human population that live in them. Woody plant proliferation has emerged as a major issue in managing many of the world's rangelands. This phenomenon is a stark contrast to deforestation, which has received considerably more attention. Traditional concerns about this change in land cover were narrowly focused on impact related to livestock production and management of wildlife valued for sport hunting. We have only recently begun to explore the implications of this widespread change in land cover on ecosystem goods and services that arise from the changes in biogeochemical cycles and land surface-atmosphere interactions that accompany the conversion of grasslands to shrublands or woodlands.

In arid and semi-arid regions, woody plant encroachment represents desertification and is accompanied by accelerated rates of water and wind erosion. The latter has known impacts on ocean productivity and snow pack persistence. Pollen and dust production triggered by encroaching trees and shrubs can contribute to human health problems across large areas far downwind. Thus, the replacement of grasslands by shrublands in arid lands has potentially far-reaching ramifications.

In semi-arid and sub-humid regions, primary production, nutrient cycling and soil organic matter accumulation may be promoted by woody plant proliferation but possibly (though not necessarily) at the expense of stream flow, ground water recharge, livestock production and biological diversity. Shifts from grass to woody plant domination has major implications for the global carbon cycle and carbon sequestration. Available evidence generally indicates increases aboveground net primary production and carbon pools; but these are at risk for rapid depletion by fire or drought. Effects on the much larger belowground carbon pools are equivocal, with available evidence suggesting soil carbon pools may increase, decrease or remain unchanged. Thus, we cannot yet reliably predict consequences of woody plant encroachment for ecosystem carbon storage. Tree and shrub proliferation also has the potential to stimulate trace gas and volatile organic carbon emissions from plants and soils and thus influence greenhouse gas concentration and lifespan and tropospheric ozone production.

Increases in woody plant abundance has fundamentally altered land surface-atmosphere interactions to potentially influence weather and climate. However, robust generalizations of the regional and global consequences of these phenomena are not yet possible. From a conservation biology perspective, woody plant proliferation represents a major threat to the preservation of grassland and savanna ecosystems. In some cases woody plants form virtual monocultures; in other cases they may have no net impact or they may promote numerical diversity. However, in such cases, we are losing grassland and savanna ecosystem types and the plants, animals and microbes endemic to them.

It is now clear that policy and management issues related to grazing land conservation extend well beyond the traditional concerns of livestock production and game

management (wildlife valued for sport hunting) to include potential effects on hydrology, carbon sequestration, biological diversity, atmospheric chemistry and the climate system. The research community is challenged with quantifying and monitoring these varied impacts; and the management community with devising approaches for creating or maintaining woody-herbaceous mixtures in spatial arrangements that satisfy competing conservation objectives. The latter will require spatially explicit integrated brush, weed, and invasive (non-native) plant management approaches that articulate the type and timing and spatial location of follow-up treatments.

It is important to keep in mind that our understanding of ecosystems and the causes and consequences of woody plant encroachment in grasslands and savannas is largely based upon modern observations. Near-term shifts in climate, coupled with non-native species introductions, increases in atmospheric carbon dioxide concentrations and nitrogen deposition, are likely to trigger a reshuffling of organisms. Novel communities with a composition unlike any found today are a very likely possibility. These novel communities will present novel challenges and will require new perspectives for conservation and management.