

Overgrazing



Sheep overgrazing has caused massive erosion, Patagonian Chile. Source: C. Michael Hogan



Overgrazing of arid scrubland prairie has stripped this now unproductive land in the Middle Atlas of Morocco. Source: C. Michael Hogan

Overgrazing is herbivory (animal consumption of plants) that extracts an unsustainable yield of floral biomass from an ecosystem; however, the term is most often applied to the actions of wild or domesticated ungulates. While this relatively intensive practice may apply to livestock or native species. It is most commonly used to describe such human-tended domestic grazers as cattle, sheep and goats. Estimates of overgrazing worldwide are on the order of one third of all rangeland (Cunningham and Saigo^[1]). Manifestations of overgrazing in landscapes composed largely of native species include reduction of species richness, loss of biodiversity, desertification, loss of native topsoil and increases in surface runoff. In fact, overgrazing can be considered the major cause of desertification in arid drylands, tropical grasslands and savannas, worldwide. Overgrazing of historic human-created pastureland, especially irrigated or non-native grasslands, may lead to soil compaction, reduction in long-term grazing productivity and loss of topsoil.

Syndromes leading to overgrazing



Overgrazed prairie below the Vermilion Cliffs of northern Arizona. Source: C. Michael Hogan

The most common practices that produce overgrazing are: (a) excessive animal density on the land; (b) lack of rotation or residence time of grazers on a sub-plot of the landscape unit; (c) grazing at inappropriate times relative to the flora productivity cycle. In the case of essentially native landscapes, there is an additional cause of inappropriate species introduced into the landscape. A common syndrome in lesser developed countries is the intensive use of marginal rangelands when historically productive adjacent range has become overgrazed and unproductive. In a number of these regions land ownership and grazing rights are blurred, such that the often poor agriculturalists drive their animals onto range areas that are poorly suited to grazing, but where trespassing violations are unenforced.

In many parts of Africa subsistence farmers practice high density animal occupancy that produces sub-optimal yields per animal, with high, even if unsustainable, yields per hectare. Some argue that there is remarkably little reliable data available to fully understand the syndromes of overgrazing, and that some of the most complex issues are in Africa, where data is most scant (Adams[2]).

To complicate the understanding of overgrazing are the complexities of seasonal variation of plant productivity, especially in landscapes with high variations in seasonal precipitation. In the case of certain North American temperate grasslands, overgrazing can be seen by wild ungulates, where top-level predator populations have lost their robustness; in particular, wolf, bear and puma populations have generally declined to the point of being ineffective regulators of ungulates over large areas, including some major national parks (Jacobs et al., 2000[3]). This chain of events has led to a virtually permanent impairment to temperate grassland productivity; beyond the impact to biodiversity, the loss of vegetative carbon sink value of this impairment is likely a major driver of global warming.

Phenomenology

The steps involved in overgrazing are more intricate than one might expect. Placement of high densities of ungulates on a grassland clearly removes poaceae and other forb biomass at a rapid rate. Concomitant effects are the residual plant litter or thatch declining in mass density, such that surface water infiltration is reduced and ground surface temperatures increase. Also, these localized surface temperature increases exaggerate the amount of evapotranspiration and hence increase aridity. All of these effects contribute to elevated measured values of near surface temperatures and, therefore, will suggest contributions to global warming. Also, while this phenomenon will increase reported global warming incidence, it may in fact overstate the true earth warming impact, since a proper energy balance analysis may show the surface temperature alteration is simply a thermocline distortion, not a real net increase in effective added heat content to the lithosphere. In addition, overgrazing has a characteristic effect of reducing root depths, since photosynthetic activity is reduced in the growing season when roots are normally propelled to greater depths. Prairie flora, therefore, have impeded water uptake from the soil, and a non-linear positive feedback loop of growth retardation is established. The process of overgrazing often leads to lowered vegetative densities and soil disturbance that induce a new seral community; not only is such seriation potentially damaging to ecosystem functioning and habitat continuity, but the alteration may provide an enhanced avenue for invasion by Alien species and subsequent biodiversity loss.

Ecological impacts

The chief ecological impacts of overgrazing are loss of biodiversity, irreversible loss of topsoil, increase of turbidity in surface waters and increased flooding frequency/intensity. It has also been suggested that overgrazing is a significant driver of climate change (Golub[4]) by reduction of the global photosynthetic carbon dioxide sink; by increasing the production of the potent greenhouse gas, methane; by altering retention of surface waters; and by increasing the albedo of the earth's surface by altering the reflective

electromagnetic spectrum. In the case of carbon sink reduction, this effect is amplified by a chain-reaction loss of carbon sink from corresponding reduction in obligate fungal species biomass that rely on grasses and forbs.

The impacts to biodiversity and topsoil loss are of most concern, since they are effectively irreversible. Species loss removes a resource that has a regeneration time of millions of years, while significant topsoil loss has a regeneration time scale of tens of millennia. In tropical grasslands and savannas overgrazing induced desertification is considered the greatest threat to the integrity of these ecosystems; (Jacobs et al.^[5]) moreover, in arid and semi-arid drylands around the globe overgrazing is the major cause of desertification (Miller^[6]).

References

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