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Can We Restore Highly Grazed Land in the Kalahari Desert?

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Introduction

The Kalahari is a vast arid ecosystem of southern Africa, which has been a home for animals, notably ungulates and humans alike. Restoration of this environment may be increasingly important so the Kalahari can maintain its resilience as it has for centuries, providing wildlife habitat as well as land for domestic grazing. Human settlement in the Kalahari Deserts can be challenging due to the low, but variable rainfall, although, some tribes such as the San have adapted to this climate. The Kalahari has been used for domestic grazing grounds for centuries, but the push outwards into the desert has caused problems since European colonial times. In addition, the Kalahari is now separated into grazing sections that are overstocked, causing degradation. The grazed lands have changed from perennial grasslands to ephemeral, bush encroached landscapes; consequently causing the ground to flourish during plentiful rains, but produces little forage during drought (Able and Blaikie 1989, Harrison and Shackleton 1999, O'Connor and Roux 1995, Thomas et al. 2000, Walker 1981). Due to the arid ecosystem, management strategies must be implemented to foster vegetation recovery in the Kalahari.

Location and Description

The Kalahari spreads over one thousand kilometers from the fourteenth longitudinal to the thirty-fourth longitudinal degrees on the southern hemisphere, crossing between the twenty-fifth and twenty-sixth degree eastern parallel (Goodall et al. 1986). It spreads across portions of Botswana, Zimbabwe, Namibia, and South Africa. The Kalahari can be divided into three different sections: the Namib, Southern Kalahari, and the Karoo. The annual rain averages from 200 to 400 mm isohyets in the Karoo and the Namib the south western border in South Africa (Goodall et al. 1986).The weather is dominated by circulating weather patterns, which cause rain to appear in the during the winter (Goodall et al. 1986). Droughts occur frequently on a biennial and/or twenty year patterns (Goodall et al. 1986). During these droughts little to no rain falls, that which falls evaporates, and temperatures rise 40 degrees Celsius during January. The average temperatures range from 2 to 5 degrees Celsius in July and 32 plus degrees Celsius in January (Goodall et al. 1986). Evapotransporation exceeds 3x the amount of precipitation in the Kalahari and can exceed 3000 mm (Goodall et al. 1986). The

evapotransporation leads to an annual water deficiency of 800 to 1000 mm (Goodall et al. 1986). According to Thomas (2002), the water table in the Kalahari has notably decreased since the nineteenth century, and water recharge has not occurred for twelve thousand years. Due to the lack of vegetation and degradation of the Kalahari, the soil is highly eroded. It is brown to grayish brown in color consisting of a calcareous sand or sandy loam over calcrete, interspaced by lithosols (Goodall et al. 1986, Thomas et al. 2000).

Evolving Management and Impacts

Disruptive cultural practices, such as, overgrazing and borehole induced bush encroachment have led to the degradation of the Kalahari landscape. According to Able and Blaikie's research (1989), herd density is the key issue. "[A]s grass cover decreases, erosion rate rises and the output per head of cattle falls as stocking rates increase… Thus a 'tragedy of the commons' ensues, in which individual herders increase their herds because the individual gains all the marginal benefit (extra stock) while sharing the marginal cost (rangeland degradation and reduced grazing) with other herders (Able and Blaikie 1986)."

Most of the Kalahari, which was self-sustaining during nomadic hersmanship, has changed dramatically due to cultural practices. The Kalahari was historically grazed by stock of nomadic herdsmen and by native ungulates (Thomas 2002, Perkins et al. 2002, and Walker 1981). Due to the nomadic grazing practices, the land was resilient to sporadic seasonal use (Thomas et al. 2000, Walker 1981). Tribes, such as the Bechuana and Batau developed their own form of nomadic pastoralism. Nomads managed herds without permanent dwellings and used animal migrations determined by the needs of the herd, which left large areas unused over large territories (Perkins et al. 2002 and Thomas 2002). Fire was used by tribes as an important tool in grassland management and conservation, but when Europeans settled in southern Africa they banned fire use (Perkins et al. 2002). Transhumance pastoralism, the second form of pastoralism, involved migrations between two regular encampments often with permanent housing. This form of management evolved, in the Kalahari, by allowing the cattle to enter the peripheral parts of the Kalahari, only when resources (water) permitted its use (Thomas 2002). Cattle posts were established in the mid nineteenth century by Tswana groups.

Through European colonialism the Kalahari changed from a wilderness into cattle-posts and ranches. Through national independence the nations in the Kalahari brought landscape changes as new land policies were implemented in the cattle-post ranching systems. In Botswana, a Tribal Grazing Land Policy was implemented in 1975. Through this policy, land was tenured and sectioned off. The policy planned to alleviate social and environmental problems in Botswana, by encouraging people to move further into the Kalahari (Thomas et al. 2000). The government established rules and regulations to control the sections; for example, only one borehole could be sunk every eight kilometers. Enforcement of these regulations was weak and positive incentives, to comply, were minimal. Fencing and the sinking of boreholes is a sensitive issue because, affluent ranchers were able to create more fencing and sink more boreholes to raise the

herd numbers. Soon, larger commercialized ranches were established featuring high persistent stocking levels and rotational grazing (Walker 1981). Through ranch management schemes the grazed lands were highly productive for the cattle during the average to wet years, but degraded during the dry years. (Walker 1981)

Outbreaks of veterinary disease also profoundly changed grazing practices. A large outbreak of foot and mouth disease occurred in 1950, dramatically reducing domestic herds and creating financial hardship for ranchers (Perkins et al. 2002). The most important carrier of the disease is thought to be the wild buffalo (*Syncerus caffer*) which also lives and migrates across the Kalahari (Perkins et al. 2002). The solution to control the spread of the disease was to completely isolate the cattle from the buffalo by erecting large veterinary fences (Perkins et al. 2002 and Thomas 2002). The fences have caused harm during ungulate migration and remain an important issue in the Kalahari, concerning both wildlife conservation and the economic viability of livestock operations (Perkins et al. 2002 and Thomas 2002).

The greatest change to grazing management occurred when fencing and borehole techniques were introduced in the 1950's (Thomas 2002). Borehole grazing techniques opened the desert up to intense grazing by providing the limiting agent, water. Fencing also, allowed farmers to section off boreholes (i.e., water holes) for individual use. Borehole grazing allowed the herdsmen to collect the cattle at night to protect them from predators and release them in the morning after milking. After the establishment of this technique consequences were observed as more land became barren around the borehole and shrubby thickets established themselves (Perkins 1996).

Problems such as water availability are associated with the sinking of boreholes. Many ranches in the Kalahari have installed more boreholes than permitted. More bore holes are being sunk to provide for the higher grazing numbers (Thomas 2002). The increased use of boreholes has caused ground water levels to decrease and likely diminished flows in the natural permanent water features. According to Thomas (2002), the water table in the Kalahari has substantially decreased since the nineteenth century; the water table can not easily be replenished since water recharge in the Kalahari has not occurred for 1200 year due to precipitation deficiencies (Goodall et al. 1986).

Borehole pastoralism has caused heavy rangeland degradation. Cattle impacts have been described by Perkins (1996), as five overlapping zones including boreholes. In the borehole zone, which extends from the water to 50 meters in circumference there is irreversible damage done to the soil by trampling and a build up of an excess amounts of nutrients resulting from dung and urination, causing soil toxicity. The next impact zone occurs extends from 50 to 400 m from the borehole. The vegetation in the zone is also thoroughly destroyed but the soil degradation is primarily due to wind erosion. The previous zone then transfers into a nutritious grass zone existing 200 to 800 meters from the borehole. The soil is slightly changed in this area and usually contains a monoculture of palatable grass, often *Digitaria eriantha* or *Cynodon dactylon* (Perkins 1996). The bush encroachment zone fallows from 200-2000 meters. This zone consists of an impenetrable thicket unusable to cattle. The zone which extends further is called the

grazing reserve. Most grazers do not affect the land further than 2000 meters (Perkins 1996).

Ecosystem Change

As borehole grazing increased, it caused destruction of the Kalahari, which lead to biota to alter into an unpalatable grazing land. Rangeland, livestock production caused the soil to erode and change its structure. This reduced its infiltration, decreased nutritious palatable species (including perennials/forbs), and increases the amount of annuals (ephemeral) which provide poor dry-season food (Abel and Blaikie 1989, Harrison and Shackleton 1999, O'Connor and Roux 1995, Thomas et al 2000). For example, on some ranches, exposed plant tufts and sand of these dry years has caused the disappearance of the Red Lark, *Certhilauda burra* (Milton and Dean 2000). The dune grasslands (primarily *Stipagrostis)* on these ranches are also being replaced by ephemerals due to overgrazing (Milton and Dean 2000). Ephemerals are plants which grow and flower following intense rains. These plants have underground organs such as corms or tubers which produce foliage and flower in a short amount of time and die back into the ground storing energy to use in the next breading period. Increases in ephemerals indicate overgrazing of perennial grasses (Milton and Dean 2000). Compared to perennial grasses, ephemerals do not provide comparable nutritious forage. Perennial grasses are quite resilient during drought but when overgrazed, dry conditions can lead to their destruction (Milton and Dean 2000).

Invasive species also tend to dominate disturbed sites, often out competing native vegetation and colonize areas. Prickly pear is an example of an easily dispersed seed that can grow in the Karoo region of the Kalahari. The prickly pear (*Opuntia ficus-indica*) is usually found along river beds and roads (Dean and Milton 2000). Recently, the prickly pear has been turning up under windmills, telephone poles, and cliff edges. Dean and Milton (2000) studied the dispersal of the prickly pear and found that the cape crow (*Corvus capensis*) and the pied crow (*Corvus albus*) eat the fruit and consequently disperse the seeds through their droppings.

Another example of changing biota, resulting from de-vegetation, involves the introduction of the alien mesquite tree (*Prosopis glandulosa* var. *torreyana* and *P. veluntia*) (Dean et al 2002). Mesquite trees are invasive along drainage lines and arid areas disrupting stream flow, native plant communities, and nutrient cycling (Dean et al. 2002). Compared to *Acacia karoo* trees, the mesquite is shorter and has a higher stem density. Mesquite trees allow for a low herbaceous cover and have little to no fleshy fruited plants to attract birds to nest and feed (Dean et al. 2002). Mesquite trees also establish in disturbed soil, such as cleared woodlands, dry land agriculture, and overgrazed sites (Dean et al. 2002). According to research done by Dean et al. (2002), there are a lower number of frugivore, granivore, inceptivore, and raptor species living in the Mesquite trees, lessening bird habitat.

Restoration Strategies

Even though the Kalahari landscape has changed from domestic grazing, promising research shows that after grazing pressure is lessened vegetation is able to reestablish (O'Connor and Roux 1995). Some researchers believe that the best method to reconstruct the Kalahari involves land protection from grazing (Milton and Dean 2000). However, limiting grazing may not be possible since many individuals would be displaced.

Abel and Blaikie (1989) think the best way to rejuvenate the land would be to regulate grazing land policy in compliance to the previous year's rainfall. This would encourage managers to keep cattle after a wet year and slaughter cattle after a dry one. Regulating the grazing during the dry years would allow perennials to survive until a wet year occurs. If the perennial grasses are allowed to rebound each year it would cause the land to revert to a natural setting.

Reintroducing a controlled fire regime could also help the Kalahari return to a grass dominated ecosystem (Dougill 2002). Implementing a fire regime would reduce bush scrub and burn existing fuel, preventing large devastating fires (Perkins et al. 2002). Timing fire before the rainy season would allow bush dieback, encourage grass regrowth (as rain falls), and seed germination (Dougill 2002). By using fire herd managers would encourage grass growth and reduce bush scrub, therefore creating a better rangeland (Dougill 2002).

Rangeland could also be converted into wildlife management areas (WMA). David Thomas (2002) believes that WMAs are an excellent form of sustainability because many native ungulates require less water per head than cattle, alleviating the need for extensive borehole systems (Goodall 1986). The table below (Table 1) represents species which are independent and dependant on water that could be used in WMAs.

Table A: This represents water dependant and independent ungulates which can be implemented into wildlife management areas (Goodall 1986).

Water Independent	Water Dependant	Adapted to Saline Water
Klipspringer (*Oreotragus oreotragus*)	Vaal ribbok (*Pelea capreolus*)	Steenbok (*Raphicerus campestris*)
Steenbok (*Raphicerus campestris*)	Blue wildebeest (*Connochaetes taurinus*)	Gemsbok (*Oryx gazelle*)
Springbok (*Antidoricas marsupialis)*	Domestic Cattle	
Eland (*Taurotragus oryx*)		
Gemsbok (*Oryx gazelle*)		
Red hardebeest (*Alcelaphus buselphus*)		

This WMA farming can open up opportunities for tourism and hunting. It also give farmers a chance to breed and sell ungulates to major national parks and game farms.

Conclusion

The Kalahari ecosystem supports a diversity of plant and animal interactions while sustaining its self on small amounts of rain. Greater grazing has caused the land to shift from a natural grassland biome into bush encroached sites (Perkins 1996). Livestock management evolved as fencing and borehole were introduced allowing cattle herds to increase. Droughts have caused the grazed areas to be abandoned due to the lack of vegetative productivity and bush encroachment. Government policy also needs to incorporate development strategies which can increase sustainable development. Sound management methods must be adapted and available to managers to inform them of detrimental practices and how to reduce and reverse bush encroachment. Pastoral strategies, such as fire regimes and wildlife management need to be used to insure increased rangeland resilience.

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