Fire, Smoke, and Expertise in South Africa's Grasslands

Simon Pooley

Email: s.pooley@bbk.ac.uk

Abstract: Fire as a management practice in South Africa's grasslands inflamed heated debate throughout the twentieth century. Imported ecological ideas meshed with home-grown sectoral land management traditions to reinforce a powerful anti-burning narrative among experts. Farmers, however, developed their own theories on burning, and the history of fire research, policy, and management reveals a series of entanglements between ecological theory, management policies and recommendations, and practice, which complicate narratives grounded in historiographical traditions focussed on critiquing settler and colonial expertise. This paper recommends three distinctions to make when thinking about the history of scientific expertise: first, between an individual's abstract theorizing and their "thinking in the field;" second, between the influence of accepted scientific findings, and the thinking guiding official policies of land management sectors; and third, between official policies and actual land management practices. This paper provides overviews of long-term fire use in the country's grasslands, the ecology of grasslands and fire in South Africa, of early debates over fire, and scientific fire research and management in the country. It assesses the contributions of key actors to developing knowledge and policy on the ecological effects of fire in grasslands, using their trajectories as a means of reconsidering scientific expertise in light of recent developments in South African historiography in particular, and in the "new imperial history" more generally. The paper

provides a more nuanced view of the development of fire research, policy and management practice in South Africa's grasslands over the course of the twentieth century.

Introduction

Cambridge educated Scottish botanist John Bews introduced American ideas about vegetation succession and fire into South Africa in the 1910s, thereby providing a theoretical framework for an anti-burning narrative developed by local experts. Bews and several South African researchers including John Phillips, James (Hamish) Scott, and Winston Trollope tested and modified these ideas over the next half century in local grasslands. While Phillips in particular concluded that fire was a natural and not necessarily destructive ecological agent in grasslands by the 1930s, foresters and agricultural officials, influenced by colonial traditions of forestry and botany, opposed burning, which they linked to vegetation degradation, soil erosion, and desiccation.

The idea that anthropogenic burning had converted large areas of forest to grasslands or savanna, and that many of the country's grasslands were human artefacts and did not constitute a "natural" biome, persisted into the 1980s. From the 1920s, this anti-burning narrative was reinforced by concern over desiccation during extended dry periods, and later by fears that a natural disaster on the scale of the American Dust Bowl might occur in South Africa, a fear shared by British colonial experts in other parts of Africa. Farmers hotly debated the pros and cons of burning, and most continued to burn despite expert disapproval. Experimental studies began in the 1920s, which included testing different approaches to burning as a grazing management practice. By the late 1930s some of these showed that in some grasslands burning

was an acceptable management practice, but it took another 40 years for this to be officially adopted as policy (rather than a sometimes "necessary evil").

A study of the evolution of grassland science, policy, and management in South Africa over the twentieth century reveals the complex interactions of scientific theories, experimental investigations, land management traditions, sectoral goals, and the interactions of land management bureaucracies, experts, and the farmers they were meant to be influencing. Several of the most influential experts worked in several contexts, as theoreticians, policy and management advisers, and researchers. Narrating this history requires engaging with the contradictions and accommodations these experts made as they moved between these operational modes and contexts and provides an opportunity to reflect on how historians write about experts and expertise in general.

The history of the importation and misapplication of Western scientific ideas in colonial territories figures prominently in environmental historiography. Many of these narratives focus on foresters, commercial farmers, and agricultural experts and criticize their imposition of inappropriate land management techniques or their uncritical adoption in the southern hemisphere of ideas developed in the northern hemisphere. These studies frame science and expertise primarily in terms of relations of power between colonial authorities and the oppressed and have their roots in critiques of modernist and nationalist narratives emerging from African Studies and South Asian Subaltern Studies in the 1970s and 1980s.[1] As Jane Carruthers has shown, the environmental history of South Africa follows this pattern, with roots in a radical Marxist history that emerged in the 1970s, and used class relations as a lens to reinterpret the subjugation and dispossession of Africans. As the country approached the transition to democracy in the early 1990s, the analytical emphasis shifted toward ecosocial themes, notably

studies of how colonial and Apartheid-era interferences in, and regulations of, space and natural resource use resulted in inter- and intraracial social conflicts and disruption.[2] Both historiographical strands, however, contributed to a focus on environmental justice, largely presenting experts and expertise as the instruments of oppression.

William Beinart has since challenged the assumptions underlying such portrayals. In a 2009 paper with Karen Brown and Daniel Gilfoyle, he sought to broaden debates over colonial (and postcolonial) science and expertise by moving beyond narratives of the short-sightedness of experts mobilized by authoritarian states, instead encouraging an interdisciplinary effort to understand the science and document the production of scientific knowledge and ideas.[3] This is a much more useful approach for understanding historical interactions between scientific research, expertise, policy, and management and the many other social and ecological factors which shape how land is actually managed. Reappraisals of the complicated chronologies that have shaped present day land use can provide useful context for developing future environmental policies, even when they don't aim to extract "lessons learned".[4]

Models for such reappraisals preceded Beinart's call. Richard Grove, in his writing about the Cape and on imperialism more generally, already advocated in 1995 for a reconceptualization of environmental expertise, introducing the notion of "green imperialism" and questioning the centrality of the metropole in the development of global environmentalism and environmental science.[5] Since 2003, Beinart has reappraised the careers of South African veterinarians, agricultural officials, and modernizing farmers, focusing on the positive contributions they made to land and livestock management, based on long careers spent developing expertise grounded in local knowledge.[6] Later work by Bennett, Kruger, and Pooley has further explored the

sophistication and diversity – and also limitations – of the intellectual engagements of scientific foresters, botanists, and agricultural experts in the region.[7]

Collectively, this research reveals the ways in which scientific theory, policy, and management were imbricated with social, cultural, environmental, and economic factors. It does so by focussing on the activities, influence, and circulation of individual experts in specific contexts and within polycentric networks. This more nuanced approach chimes with developments in the history of science characteristic of the "new imperial history."[8]

One way to capture this complexity is to think about three distinctions when reconstructing histories of scientific expertise. First, we must not assume that an individual's abstract theorizing (as expressed in academic journals) necessarily chimes with what might be termed their "thinking in the field." Second, we should not confuse (or overstate the influence of) accepted or published contemporary scientific findings with the thinking guiding official policies of land management sectors. Third, we ought to distinguish between official policies and actual land management practices.

This paper explores these distinctions in the context of the history of grasslands fire management in South Africa in the twentieth century. It reconsiders the contributions of some key figures in the history of grassland research. Of these, only Phillips is now relatively well known in the historiography, figuring prominently in books by Anker, Bennett and Kruger, and Pooley. Phillips played an important role in the history of ecological thinking in South Africa and has been discussed in terms of both his commitments to ecological science and also to what Saul Dubow has called the South Africanization of science. While a history of ideas approach is valuable here, it also has its limitations when writing about researchers who got their boots dirty in the field, and routinely considered both policy and practice in their work.[9] This paper is also a

contribution to the historical literature on fire in Africa, which – Stephen Pyne's summary comments on fire in Africa and the growing literature on fire in the southwestern Cape's fynbos biome, notwithstanding – is woefully small considering the scale of burning that occurs across Africa's grasslands (and savannas) and its rich history of fire management by indigenous people and settlers.[10]

Grasslands and fire

Pollen data indicates that grasslands have been present in South Africa throughout the Holocene, when they occupied roughly the same region as they do today, and were even more extensive during the Pleistocene.[11] The grassland biome falls mainly east of 25°E and between 25°S and 33°S in South Africa. With the exception of the high Drakensberg, it is dominated by C_4 grass species (more efficient at higher temperatures and light intensities than C_3 species[12]), with the characteristic species being *Themeda triandra*, which is primarily adapted to defoliation by fire.[13] The region's grasslands may be divided into semi-arid regions, with 550mm Mean Annual Precipitation (MAP), mesic (735mm MAP), and montane (1380mm MAP). This biome is very rich in species diversity at 1000m^2 scale, but research has hitherto focused on grass species valuable for livestock production, rather than the plants that constitute this species diversity.[14]

Farmers and agriculturalists have customarily divided the grasslands into "sweet" (dry) and "sour" (moist) grasslands. As a rule, sweet grasslands occur in areas with MAP below 650mm, often at lower elevations, where growing conditions are highly variable, linked to less predictable rainfall. The grasses are more palatable to livestock all year around because they have low fibre content, and maintain above ground nutrient content in winter. The off-take (by

grazing, fire, or other means) removes a large percentage of production, except in years of exceptionally high rainfall. Changes in biomass are largely driven by rainfall rather than fire, which is relatively infrequent under natural conditions and which has little effect on grass composition. Sweet grasslands are thus climate-dependant. By contrast, sour grasslands (with a mean annual rainfall above 650 mm), are often found at higher elevations and along the Indian Ocean Coastal Belt where growing conditions are seasonally relatively fixed, making the grass unpalatable in the dry, dormant season. The offtake removes only a small percentage of production, with a natural fire frequency of 1–3 years. Fire exclusion results in changes to grass composition and invasion by trees and shrubs. Sour grassveld is thus more fire-dependant.[15]

<<Figure 1 about here>>

Hominins have been present in southern Africa for ~3mya, but the available evidence suggests that although modern human hunter-gatherers used fire for hunting and fire-stick farming (burning to encourage and discover protein-rich tubers) for at least 100,000 years, the practice had little impact on the vegetation.[16] Early Iron Age Bantu agropastoralists moved down the east coast from c. 1700 BP, along the humid low-lying coastal plain (east of the 400mm isohyet) into what are now KwaZulu-Natal Province and the Eastern Cape. They used fire for hunting, clearing land for agriculture, and iron smelting, and burned grassland and savanna to create fresh grazing for their livestock. The Highveld in the interior plateau of South Africa (above 1200m above sea level) and its montane grasslands were settled later, from around 700 years BP, possibly as a result of increasing domestic stock numbers and resource depletion on the moister coastal lowlands. The key impacts during the Early Iron Age in the eastern region were clearing and cultivation in the rich soils of valley bottoms, with lasting impacts on vegetation structure and composition, notably patchiness in savanna regions. By the late Iron

Age, settlements shifted to the hilltops and the interior treeless grasslands, and regional economies developed where political power and wealth were linked with cattle. This resulted in overgrazing in some (notably the northern) regions of what is now South Africa.[17]

Under colonial rule, livestock farming with sheep, cattle, and goats became the main land use practice in regions too dry for agriculture, resulting in land degradation in some areas. In grassland regions suitable for agriculture, extensive areas were converted to maize and cereal crops, particularly in the former Orange Free State and Transvaal provinces to supply the burgeoning urban centres developing around diamond and gold mines. From the mid-1800s sugar cane was planted in the coastal lowlands of KwaZulu-Natal on the east coast. Plantations of introduced trees (mostly pines and eucalypts) were planted to supplement the country's meager timber resources, first by state foresters in the Cape Colony in the 1860s, and then in the moist upland grassland regions of what are now KwaZulu-Natal, Mpumalanga, and Northern Province following the creation of a national forestry department in 1910.[18] Private wattle (Acacia) plantations were established in Natal from the 1860s.[19]

Fire, Farmers, and Expertise, c.1898-1926

For European settlers in the region, the cultural legacies of the anthropogenic transformations of the grassland and savanna biomes included both extensive use of burning by farmers, and colonial experts' hostility to burning practices, in particular botanists and foresters in the Cape Colony, and soil conservationists, all of whom regarded burning as a primitive and destructive practice (whether practiced by indigenous peoples or Europeans). These experts believed that most bush fires (uncontrolled fires in vegetation) were anthropogenic, and resulted

in the desiccation of the land, destruction of the indigenous flora (in particular forests), favored less palatable grasses and scrub, and resulted in soil erosion.[20]

Analysis of the agricultural journals published in the Cape, Natal, and Transvaal colonies and territories (1898–1910) of what became the Union of South Africa in 1910, up to 1926, reveals the major debates about veld burning before prolonged scientific studies were set up. There were many rhetorical appeals to the authority of science, and concepts borrowed from the emerging science of ecology were used to justify a variety of opinions. Only after the First World War, however, did South African scientists begin to publish some preliminary findings on fire and pasture management derived from experimental research.[21]

There was fierce controversy among farmers over the costs and benefits of using fire to manage veld, with the majority of farmer correspondents to the journals in favor of controlled burning.[22] Department of Agriculture officials and editors of the journals advocated new and improved methods to replace the need for veld burning, but acknowledged that most of these were simply too expensive for the average farmer.[23] South African farming mechanized late with tractors widely adopted by white farmers only after the Second World War.[24] A 1932 report on the country's grasslands acknowledged that research into "artificial pastures" and "grass silage" were in their infancy.[25] In the meantime, judicious veld burning was a cheap and effective, if imperfect, method of veld management requiring no special equipment and no sustained use of labor.

The main reason given for burning by farmers recorded in the agricultural journals was to get rid of old dry grass, which was useless as fodder, and force up new grass, which was edible and nutritious for livestock. Farmers often burned to provide grazing for the dry months, particularly in sourveld.[26] Farmers also argued that old dry grass was a fire hazard when

wildfires swept through their land. The central argument of the anti-burning camp (mostly experts, with some farmers, often from climate rather than fire dependent ecosystems) was that veld burning led to the "coarsening of veld grasses," resulting in reduced stock carrying capacity.[27] Experts also argued that destruction of the vegetation and humus layer by fire led to a denudation and hardening of the soil, thereby reducing its capacity to both absorb and hold moisture.[28] The bare, hard soils, they maintained, were also more prone to soil erosion, and overall these evil effects of burning contributed to the general desiccation of the country, negatively impacting climate (rainfall in particular).[29]

Expert opposition to fire informed by the rhetoric of science began with concern over its desiccating effects, notably by the Cape Colony's official botanists Ludwig Pappe and John Croumbie Brown during periods of drought in the Cape Colony in the mid-1800s. Key Afrikaner agricultural bureaucrats trained in the US following the South African (or Boer) War (1899-1902), became influential after Union in 1910. They drew on ideas about vegetation and pasture science developed in the prairies of the American Midwest. The period from 1918 throughout the 1920s was very dry in South Africa, and a Drought Investigation Commission was convened, reporting in 1923. They concluded that the ongoing desiccation of the country was the result of bad farming practices, including veld burning, rather than declining rainfall.[30]

Commissioners of this influential Drought Investigation Commission drew on current ideas about successions to climax vegetation, influenced primarily by climate, to argue that "[g]rass-veld which grows so vigorously that it cannot be grazed down by full stocking is naturally tree-veld rather than grass-veld," and that farms that could only be rendered fit for stock farming by burning should possibly be given over to timber production.[31] By transposing arguments about (climate-driven) sweetveld onto (fire-driven) sourveld areas, they obscured the

natural dynamics of fire-regulated sourveld areas. While it is true that fire exclusion would result in a shift to scrub and trees, fire exclusion was not "natural" in most sourveld grassland areas. As noted above, grasslands have been present in South Africa since the Pleistocene and thus fires must have been present before humans arrived on the scene, and further, colonial records indicate that settler farmers have been burning grass since the seventeenth century, and learned the practice from indigenous herders.[32]

Between 1900 and 1913, farmers and officials had frequently speculated that impoverishment of the soils and thus the veld by burning caused animal diseases including *lamsiekte* (which was actually botulism in phosphorus-deficient cattle from ingesting carrion and bones infected with clostridial toxins) and gallsickness (in reality a tick-borne disease).[33] In the Transvaal, it was believed that burning could eradicate growths of "moulds and bacteria … one of which, *Bacillus botulinus*, may cause deaths amongst cattle."[34] Albert Mogg of the Division of Veterinary Services concluded that *dunziekte* (emaciation, caused by ingesting plants of the genus *Senecio*) and *stijfziekte* (an unidentified viral disease) were associated with burning and overstocking.[35] He was obliquely correct in detecting links between changes in botanical composition and *dunziekte*.[36]

Many African and white farmers saw burning as a valuable way of purifying or sanitizing the veld through controlling pests such as "vermin, snakes, ticks, etc., by removing the cover."[37] In 1899 Magistrate F.Y. Gibson of Nongoma District in Zululand advocated not burning grass routinely because grass burning could then be deployed against locusts.[38] Fire was used to destroy cichlid moth larvae, believed to poison cattle.[39] By the 1930s, most scientific authorities had discounted veld burning as an effective means of eradicating ticks and instead favored dipping. This is more expensive, however, and African farmers in the Maluti/Drakensberg area

and in Eastern Pondoland still list pest control (especially ticks) as a reason for controlled burning.[40]

Some correspondents to the agricultural journals argued that burning encouraged weeds and invasive plants, to the detriment of nutritious grasses.[41] Several stressed the destructive effects of veld fires on trees, offering suggestions on prevention and fire-fighting.[42] Agricultural experts acknowledged the problem of dealing with weeds with inadequate labor on terrain unsuitable for mowing. It was no use trying to change "the cultural custom of four or five generations" without offering "a sufficient substitute for the [condemned] practices," wrote Charles Eustace Pillans of the Cape Department of Agriculture. He proposed a system of paddocking combined with systematic weed eradication and cultivation of useful stock-food-plants.[43] H.J. Choles, an editor for *Agricultural Journal of the Union of South Africa*, recommended slowly phasing out burning, replacing it with heavy stocking and grazing as a means of veld management.[44]

In sum, in the period prior to scientific experiments on the effects of burning, farmers had built up a body of (contested) expertise on the use of fire in grasslands, the main reason being to provide fresh grazing, but also to prevent dangerous late season fires, purify the veld of disease-causing vermin, and control locusts. Agricultural officials opposed burning, fearing its desiccating effects and worrying that it resulted in inferior grazing and soil erosion. They assumed that anthropogenic burning led to environmental degradation, ignoring the long history of veld burning in the region's grasslands.

Fire historian Stephen J. Pyne has critiqued fire research in general for focussing on the technical study of fire behaviour (led by foresters), and neglecting the social dimension.[45] There is much truth in this. However, agricultural researchers in South Africa in the early 1900s were

well aware of the socio-economic constraints on good farming practice, and therefore why farmers resorted to veld burning. In 1913 Choles observed that:

> The firing of the veld is a time-honoured custom in South Africa, and dates from the first days of great, poorly stocked farms when, as is still sometimes the case, holdings were beyond the capacity of the limited number of stock they carried to keep the grass short; and as the grass shot up in the late summer months and dried out into coarse, unpalatable herbage, it was necessary either to mow it or burn it off to provide for succulent young shots for the impoverished stock in the spring. Mowing was quite out of the question over the extensive areas that had to be disposed of; burning was cheap, rapid, and immediately as satisfactory. The ultimate effects were not contemplated in the grim struggle for existence.[46]

In the early twentieth century, however, the promotion of enclosure and a progressive reduction in size of farms affected established farming methods. The Fencing Act of 1912, amended in 1922, provided white farmers with subsidies for fencing.[47] Farmer M.J. Beukes noted that "in the good old days," when farmers had huge farms, it was acceptable to burn because it was the only way to get rid of "rank and coarse" grass and control ticks and other insects; in more modern and "civilised" times of smaller farms, however, "other methods of farming must be adopted, whether one likes them or not."[48] Farmer C.R. Prance worried that while it was feasible for his contemporaries to send their cattle to bushveld farms (in savanna, at lower elevations) while they waited for the "brand" (green grass after a burn) to come up on their home farm, "the next generation will have to share our farms – and then what?"[49] Such fears over the future of farming in South Africa were shared by the government of the newly formed Union of South Africa (1910), led by two Afrikaner farmers and statesmen, Louis Botha and Jan

Smuts, the latter of whom was a grass aficionado and keen botanist. Through into the 1940s, the government feared the effects of unprofessional land management in the face of the South African frontier closing.[50]

Botany and ecology

Developments in scientific botany influenced agricultural experts' and drought commissioners' views on the effects of fire on vegetation. During the first decades of the twentieth century, botany professionalized in South Africa, and ecological ideas became influential in the discipline, informing ideas about natural resource management more generally. A key figure, John William Bews, travelled from Scotland to take up the first professorship of botany at Natal University College in 1910. Bews's "An Account of the Chief Types of Vegetation in South Africa, with Notes on the Plant Succession" (1916) was the first survey to apply an overtly ecological approach to South African vegetation and was informed by Frederic Clements's ideas about vegetation succession.[51] Clements argued that vegetation progresses linearly through a series of increasingly complex stages towards a stable climax community, which is in equilibrium with the prevailing environmental conditions. Climate drives a linear unidirectional succession towards a single vegetation type, but a variety of disturbances (notably fire) may inhibit or temporarily reverse this progression.[52]

This theoretical framework had two important implications for thinking on grasslands and fire. First, Bews included in his vegetation classifications "changed" or "false" formations that were not in equilibrium with prevailing climatic conditions and which he believed were created and maintained by overgrazing and human use of fire. This included extensive grassland areas east of the Drakensberg Mountains in what is now KwaZulu-Natal Province. He thought

that the destruction of the bush by wild fires and human burning practices was contributing to the desiccation of South Africa, particularly on the Highveld.[53] Second, Bews argued that burning sets back the plant succession. He theorized that in "primitive" or semi-open grassland, burning prevented the plant succession from progressing to a more nutritious type, and should be banned.[54] The idea that anthropogenic burning had converted large forested areas to grassland, and thus that much of the country's grassland was a secondary and somehow unnatural vegetation type, remained influential in South African scientific thinking until the 1980s, when pollen records showed that the grasslands of the moist eastern region were of great antiquity.[55]

However, Bews was also developing his understanding both of the local flora in Natal, and of local agricultural needs. Rather than adopt a purely anti-burning stance – and while he argued that in more advanced, stable grassveld, the grasses should be grazed down and not burnt – he made an exception for situations where the succession appeared to be progressing towards scrub or forest. Where shrub or forest was encroaching on grassland, Bews encouraged veld burning – should grazing be the desired land use. Bews rated investigations into the plant succession and principles underlying it to be "one of the most important economic results of our study of ecology in Natal," because based upon this knowledge accurate guidance on the use of veld burning could be given, tailored to specific conditions and kinds of veld.[56]

Other major writers on veld burning in this period cited Bews's interpretation of the South African flora through the ecological concept of succession. From 1927–31, John Frederick Vicars Phillips worked on tsetse eradication in Kondoa Irangi in Tanganyika under Charles Swynnerton, where he observed the use of fire to combat tsetse flies, and the practices of indigenous pastoralists and settler farmers. In 1931 he returned to South Africa to begin work as Professor of Botany at the University of the Witwatersrand in Johannesburg (a post he held until

1948). Here he worked with Dr T.D. Hall, Agricultural Adviser to African Explosives & Chemical Industry, and J.D. (Hamish) Scott to develop Frankenwald, the estate bequeathed by the gold and diamond magnate Alfred Beit. Phillips made Frankenwald a center of ecological research, notably of problems relevant to pasture management and conservation. In the post-war period he trained nearly 200 returning veterans in Soil Conservation on his "Donga Doctors" course, and his students dispersed all over the British territories in Africa.[57]

Phillips had just published the first review of scientific research on fire in southern and eastern Africa. He noted the efforts of "scientific workers" to educate the public "of the manifold evils following in the wake of fire," pointing out that "little scientific experimentation [had] been brought to bear" upon these "problems." He believed that both natural lightning fires and anthropogenic fires had swept the regions' grasslands and savannas since prehistoric times, and he stressed the need to understand local conditions including climate, soil, and vegetation type, before deciding on regional fire policies.[58]

Historian Peder Anker has portrayed Phillips as an ideologue, particularly as he perceives a link between Phillips's championing of the ecosystem as a holistic concept, and the political holism advocated by Phillips's mentor Jan Smuts.[59] However, this alleged political idealism should not overly color portrayals of Phillips as a scientist. Influenced by Clements, with whom he corresponded, Phillips also stressed the importance of contingent factors including the successional stage of the plant community, and the nature of the season in terms of moisture and temperature. He was in fact wary of trying to generalize from basic scientific principles, or from localized findings in an unsuitable way. He wrote cautiously, "I feel it desirable to urge *the need of our carefully considering all regional circumstances in the light of scientific experience,*

before we definitely decry the practice of firing. Possibly I may be criticised for this statement, but in making it I consider I have but done my duty"[60] [Phillips's italics].

As noted, the government was concerned over the future of farming in South Africa, and the Great Depression exacerbated this as the economy suffered a dip in mining returns and economists worried over the small internal market for manufacturing. The government looked to farming as a promising avenue for improvement through modernization. Scientific research and management was deemed required to save the land and improve agricultural output, and pasture research was institutionalized. The first pasture research stations were opened in 1934.[61]

The University of Pretoria and African Explosives and Chemical Industry (a fertilizer producer) convened a Grassland Research Committee, which issued a report in 1932. They argued that overgrazing and burning were resulting in the impoverishment of the naturally nutritious grasslands characterized by grasses like *Themeda triandra* ("rooigras"). Burning also destroyed the humus and the soil became less able to absorb water, resulting in increased runoff during heavy rains, and consequent soil erosion.[62] By the mid-1930s veld burning experiments, notably those at Potchefstroom in Transvaal Province, were suggesting that annual burning in the Highveld – in sweetveld and semi-arid regions – created good grazing in the short term. However, over the long term, burning resulted in reduced grass cover and soil erosion.[63] In contrast, experiments at Cedara in the Natal Midlands showed that in high rainfall areas, in sourveld, burning was an acceptable management practice.[64]

Despite the positive findings for burning in certain conditions and regions, in 1936 Phillips published a major paper on fire entitled "Fire in Vegetation: A Bad Master, A Good Servant, and a National Problem." His choice of title reflected his assertion that "the man in the street has been instructed in print and by lecture that firing of vegetation is always highly

destructive, and is to be considered as an act of vandalism against the national heritage." Phillips agreed that burning in the wrong season could allow in undesirable weeds and encourage inferior grasses, but argued that burning at the right time could actually reduce undesirable grasses and encourage more nutritious ones. Not burning at all could lead to a deterioration of the veld and scrub encroachment. Thus burning could be good farming practice in grasslands or savannas. Phillips was at pains to point out that "the management of grazing after fire is so important that investigation of influences of firing, not taking cognisance of this, and not providing for the control of this process, must largely prove abortive."[65]

This was seemingly confirmed by experiments set up following severe droughts in 1932 and 1933, which drastically affected water supplies in the Natal midlands. It was popularly believed at the time that veld burning in the mountains was the cause of the water shortage, and that if the Drakensberg Mountain Range was protected from fire, this would solve the problem. In 1936, land for two research stations was acquired, one traversing savanna thornveld and grassland on commonage leased from the Borough of Estcourt, and the other in highland sourveld at Tabamhlope. Two experiments were set up in tall grassveld, the first to measure the effects of burning at different times, excluding grazing, the second to test the optimum burning treatments, with grazing. The main conclusions drawn from the first experiment, as interpreted by Hamish Scott in his 1948 doctoral thesis, were that total protection from fire led to a deterioration of the grass sward, increased runoff, and increased risk of accidental fires that would damage the grass cover and soil. Burning in the wrong season could be harmful, however, and the least harmful time to burn was in spring, after the first good rains.[66]

The second experiment somewhat modified the earlier findings. It showed that the grass sward would decline in quality if old vegetation was not removed. However, the average weekly

increase in live weight of grazing animals was higher on mowed than on burned veld. This was a more critical view of burning, but the management implications were that, where mowing was not possible, burning was necessary to remove old ungrazed grass. Rather than specify a rigid, "correct" interval between annual spring burns, Scott advocated judging how often to burn by observing the accumulation of dead grass.[67]

Pragmatism, Ideology, and Limits

Bews's and Phillips's Clementsian framework for thinking about vegetation succession did not blind them to local conditions. Phillips advocated an ecological approach influenced by succession theory, but advised against generalizations from basic scientific principles, or from localized findings. He and his protégé Hamish Scott recommended experimental studies that took into account climatic conditions including seasonal fluctuations, soils, the state of the vegetation, and grazing and farming practices. They did not regard fire as an unnatural disturbance to African grassland and savanna ecosystems, but did criticize what they regarded as harmful burning practices.

However, although experimental studies at Cedara, Estcourt, and Tabamhlope showed the positive effects of properly applied veld burning for sourveld pastures, many officials remained opposed to the practice. Advice published in the Department of Agriculture's journal *Farming in South Africa* grudgingly acknowledged the potential advantages of appropriate veld burning, but presented the practice as a "necessary evil."[68] In 1932 Illtyd Buller Pole Evans, Chief of the Union's Department of Botany and founder of the Pasture Research and Veld Management Section in the Division of Plant Industry, had advocated the adoption of the "ingenious system, known as Deferred Grazing" employed in the USA, citing Arthur Sampson's

1923 book *Range and Pasture Management*.[69] Over the course of the twentieth century in South Africa, this system developed into ever more sophisticated systems of rotational grazing, despite (some argue) a lack of conclusive evidence of the superiority of well managed rotational grazing systems to well managed continuous grazing.[70] These systems of rotational grazing were designed to make veld burning unnecessary.

Soil conservation officials in particular, influenced by narratives of desiccation and soil erosion current in colonial Africa and the USA in the 1930s and 1940s, resisted the findings of early experimental studies on fire which suggested it could be a good management practice. As David Anderson has shown, the American Dust Bowl experience, along with the Depression of the early 1930s, raised concerns over the environmental impacts of rapid increases in human and stock populations in African Reserves in the context of the apparently more frequent droughts afflicting east Africa. These factors meant that soil conservation became a central concern of the British colonial authorities and spurred them to intervene directly in African farming practices. They drew on both South African and American recommendations and expertise.[71]

Colonial experts attributed desiccation and soil degradation to veld burning in this period. Foresters (in all colonial territories) were particularly opposed to fire and veld burning, and in the 1930s this was the subject of a bitter dispute between agricultural and forestry experts in South Africa.[72] At the fourth British Empire Forestry Conference convened in South Africa in 1935, the agriculturalist R.W. Thornton asserted that "burning on a gigantic scale takes place throughout the grass veld and savannah areas of this continent ... which has denuded the country of vegetation." He argued that such burning removed trees that could restrict winds and, thus, contributed to wind erosion and high evaporation. "This is not only a South African question: it is an international African question," he maintained.[73]

An expert narrative linking the drying up of the country to veld burning thus developed in South Africa during the 1920s and 1930s, exacerbated by droughts. The Drought Investigation Commission report of 1923 concluded that the country was drying out due to bad farming practices including veld burning, and there was particular concern over the alleged expansion of the arid Karroo region. The report warned that failure to take action would result in "'The Great South African Desert' uninhabitable by Man." In 1924, a symposium focussed exclusively on veld burning was convened, at which prominent botanists criticized the practice.[74] In 1932-33, at a time when the American dustbowl was much in the news, there was a severe drought in Natal Province, and in 1934 Parliament passed a resolution to investigate the effects of veld burning on water supplies and soil erosion in mountain catchment areas. This was debated in the parliamentary capital, Cape Town, which experienced very high fire incidence in 1934. As a result, the state began acquiring private properties in mountain catchments, to be managed by the Division of Forestry. Foresters were of the opinion that the key management action in these regions was prohibiting grazing because "wherever grazing is allowed the veld is burned as almost all owners of stock consider that annual burning of the veld is necessary to provide adequate pasturage," and thus they began to impound the cattle that farmers grazed in these areas, particularly in times of drought. This considerably inflamed the controversy over burning.[75]

Official disapproval of veld burning hardened into concerted opposition in the context of heightened emotions surrounding the outbreak of World War Two. Jan Smuts set up a National Veld Trust in 1943, And Hugh Hammond Bennett, Chief of the Soil Conservation Service of the US Department of Agriculture, toured the Union of South Africa in August 1944, noting widespread soil erosion and condemning "indiscriminate" veld burning."[76]

During and after the war, soil conservation officials discouraged all burning. The Soil Conservation Act of 1946 restricted burning on private mountain catchment land by creating Fire Protection Districts, managed by Fire Protection Committees. Grassland scientists worked within a highly charged political and policy environment that linked poor land management practices to treason.[77] In the post-war period, forestry and agricultural researchers gradually came to believe that burning could be safely applied. However, they deemed this permissible only under stringent restrictions, mainly relating to the presumed least ecologically harmful time of year to burn. An interdepartmental committee appointed by the Soil Conservation Board surveyed the country's catchments from December 1952. Their report, published as the Ross Commission, carefully considered arguments for and against veld burning. They concluded that, while burning was a major factor contributing to catchment degradation, and should be forbidden in drier regions with vulnerable soils, in some humid catchments it was an acceptable farming practice.[78]

Following high fire incidence in the Cape mountain catchments in 1961, and a huge fire in July 1962, the Department of Forestry decided to investigate controlled burning in earnest. Fire protection (prevention) was simply not possible in these upland grasslands. The Department also faced rising criticism in this period from farmers who alleged that its plantations (expanding eastwards into the country's inflammable grasslands) were drying up water supplies. An interdepartmental inquiry was convened, reporting in 1968. The commissioners argued that protecting natural vegetation from fire in fact reduced stream flow. This was because fires lower average veld age, reducing water use and evapotranspiration.[79]

South African experts were not developing their thinking on fire either exclusively in association with the colonial metropoles, or American experts. The Southern African Regional Committee for the Conservation and Utilisation of the Soil (SARCCUS) was born out of post-

war European colonial efforts to coordinate technical cooperation in sub-Saharan Africa, notably an Inter-African conference at Goma in Belgian Congo in 1948 focussed on soil conservation and land utilization. It worked in collaboration with the Commission for Technical Co-operation in Africa south of the Sahara (CCTA), active from 1950, which was a joint venture of the Belgian, French, Portuguese, and British colonial authorities together with Southern Rhodesia (Zimbabwe) and the Union of South Africa. A 1974 review of the SARCCUS programme noted the importance of training and expertise to this enterprise, emphasizing the importance of "expert personnel with a lifetime of local experience."[80]

The 1948 Goma Conference called for the experimental study of fire, lamenting that "running fires annually devastated the whole of tropical Africa, causing a deterioration of the vegetal protecting mantle of the soil and exposing them to all forms of erosion." Aware that fire was central to many "primitive" African land use practices, however, it was judged pragmatic to "temporarily tolerate" such fires but regulate them on areas of particular value. Further, given the difficulty of combating bush fires, they advocated "the palliative of early fires ... at the commencement of the dry season, under the control of qualified services," but "insisted that these tolerant measures ... must not obscure the final goal, most vital for Africa, of the total suppression of bush fires."[81]

A decade later, however, SARCCUS experts accepted that the use of fire is necessary in some systems of veld management for grazing animals. The question then is: at what time of year and under what ecological circumstances is it best to burn? The total exclusion of fire or even restriction of burning to defined seasons was deemed "extremely difficult." Propaganda and education about good burning practices, rather than control through legislation, was advocated. The recommendation for motivating African farmers to practice better fire control was to

encourage tree planting and improve their pastures. Experts acknowledged that "in the use of fire there is a conflict between the aims of the forester and the grazier ... reflected in legislation and in official recommendations." In countries where grazing interests were paramount, farmers practiced late burning at the end of the dry period just before spring growth. Where forest growth was important (West Africa and Malawi for instance), land managers practiced early burning, at the beginning of the dry period when forests were still moist.[82]

By the 1970s, fire was believed to "[minimise] the evils of selective grazing" in sourveld, prevent "the accumulation of old grass and ... [improve] the quality of the herbage and [reduce] the hazard of accidental fires." In South Africa, sheep farmers in the Orange Free State, Natal, and Transvaal Highveld burned in late summer to stimulate green leafy herbage and in late autumn (this was frowned upon) and winter to stimulate growth in early spring (and provide enhanced protein and phosphate content of the herbage). SARCCUS experts acknowledged that "the most desirable time for burning [in sourveld] is still a matter for controversy."[83] The difficulty of delaying burning through the dry months was that it was hard to prevent runaway fires. The summary of advice on burning (1974) noted irritably that "it seems to be impossible to generalise from region to region about burning," but concluded hopefully that increases in the price of land and more intensified farming practices would lead to the abandonment of large scale burning, and autumn burning on South Africa's Highveld.[84]

The Natal School

When Hamish Scott became first professor of pasture science at the University of Natal in 1948, he took the helm of an institution founded to tackle soil erosion and improve veld management. In 1950, Scott set up and went on to maintain the now longest running fire

experiments in South Africa, at Ukulinga, designed to work out the best approach to burning and grazing the veld (fig.2). At the same time, he worked on rotational farming methods to replace the necessity for burning. He had to combine scientific experiment with the requirements of state and provincial agricultural bureaucracies, who wanted tight restrictions on when fires could be lit, and ultimately (and fruitlessly) to replace fire altogether.[85]

<<Figure 2 about here>>

In South Africa, veld burning had become widely accepted as a management strategy in higher rainfall regions by 1970. Administration of the Fire Protection Committees, which had resolutely opposed burning, was transferred to the Department of Forestry in 1970. The Department adopted a policy of controlled burning, formalized with the passing of the Mountain Catchment Areas Act 63 of 1970.[86] However, tight guidelines were issued, for example burning was only allowed between late July and October in Natal. Burning in August was permitted only after at least 15mm of rain in 24 hours, but for the remainder of the period of legal burning, no rain was required beforehand. Permission from the local Soil Conservation Committee was required for any burning outside of this period.[87] In 1977, a South African program on the ecological effects of fire was initiated as part of a wider program of the international Scientific Committee on Problems of the Environment (SCOPE), an initiative of the International Council of Scientific Unions (ICSU). This South African SCOPE program stimulated both broad reviews and specific studies of key questions about ecological processes and management strategies. The first phase synthesized ongoing work on long-term experiments.

For the grassland biome in South Africa, the surviving long-term experiments drawn on were at Ukulinga and in the Drakensberg catchment areas.[88] Neil Tainton was responsible for writing up a comparative review of the results of 28 years of burning treatments in grassland at

Ukulinga.[89] Tainton grew up in the Eastern Cape, trained at the University of Natal, and became a lecturer in the Department of Pasture Management and Soil Conservation there in 1959. After a period in Wales and New Zealand, he returned to the University of Natal, becoming Professor of Grassland Science (his preferred term) in 1979.[90] The results of Tainton's analysis of the long term treatment data were striking. Analysis of plots burned biennially or triennially showed no long-term influences of the preceding burning season. The authors concluded that:

> In the long term the effect of veld burning *per se* is little different irrespective of whether the veld is burnt in the dormant season and whether it is applied annually, biennially or triennially. In practice, however, different burning times and frequencies are associated with different grazing practices and it is this difference in post-burning management which is likely, in practice, to be the main contributory factor to differences in the response of veld to differing burning schedules.[91]

This was revolutionary, upending theories on when to burn, all the (shorter-term) experimental findings, and the persistent prescription to farmers to burn after the first spring rains.

Grassland research in South Africa's KwaZulu-Natal Province during the twentieth century generated a cogent and coherent approach to understanding and managing humid grassland, one that integrated fire as a useful tool. The continuity of ecological and management thinking on fire is remarkable, certainly when it comes to when to burn. Recommendations first recorded in the Natal Colony's agricultural journal in 1899 are essentially those laid down by the Department of Agriculture in 1999. Ecological principles laid down by Bews and Phillips and related conceptions of rangeland succession still form, with due modification (and incorporating Trollope's work on fire behaviour, discussed below), the basis of research and management thinking. On the other hand, considerable progress was made in understanding *why* different

burning treatments affect grass composition and productivity in the ways they do. This knowledge was disseminated throughout South Africa in a series of influential books and the *Journal of the Grassland Society of Southern Africa*.[92]

Despite this, Kirkman and Morris could still write in 1999 that "the role of fire and grazing procedure ... as management tools are probably the most contentious issues regarding grazing management recommendation in South Africa."[93]

Winston Trollope (fig. 3), the son of an Eastern Cape farmer, graduated in grassland science after being inspired by Hamish Scott at the University of Natal in the 1970s. He landed the position of senior lecturer in pasture science at the University of Fort Hare (formerly the South African Native College) in 1970. His aim at Fort Hare was to develop farming methods appropriate for African farmers who had few resources: "it's no good coming along with some weedicide or mechanical techniques; you've got to come along with something that doesn't cost them any money." Bush encroachment (notably by *Acacia karoo*) was a serious problem in the region, and in his experiments on grassland he had found that fire was the most practical means of dealing with it – and it was cheap to apply.

<<Figure 3 about here>>

Perhaps Trollope's major contribution to South African fire science was his realization of (and subsequent research into) the importance of fire intensity, previously ignored by South African researchers.[94] Based for his entire academic career (1970-2005) at the University of Fort Hare in the former Homeland of the Transkei (now Eastern Cape Province), Trollope drew on Australian field-based research on fire intensity, U.S. laboratory studies, his own fire experiments, and African communal burning practices and goat-keeping to devise an effective and affordable means of veld management, in particular for controlling bush encroachment. Still

active in fire research and management, Trollope recently concluded that research has proven that "indigenous fire management has demonstrated the advantage of using fire to remove moribund grass material and stimulate the growth of highly nutritious grass forage that should be grazed as soon as possible after the fire … provided the veld is given periodic extended rest periods." He observed that he and other range scientists had condemned this practice for decades.[95]

Setting aside theorists, experts, and officials, then, what of the farmers? In 1999 Kevin Kirkman, professor of grassland science at the University of KwaZulu-Natal, admitted that most sourveld farmers had ignored the rotational grazing system for so long advocated by the Department of Agriculture. Part of the reason for this was the tension between the ecologically sensitive flexible management approach pioneered by Scott, and policy requirements for fixed dates and rules. However, financial constraints were found to be farmers' chief consideration when choosing a veld management strategy. By the end of the century many of South Africa's large-scale commercial farmers were in financial trouble, and small-scale commercial farmers and communal farmers had always had limited access to capital. Burning is cheap and labor efficient.[96]

Conclusion

This history of the use of fire in South Africa's grasslands reveals a chronology complicated by interactions between a range of intellectual, institutional, and managerial factors and shaped in important ways by a series of individuals who adapted their thinking as they moved between different modes of expertise. They developed their thinking across a range of professional and ecological contexts and in response to sometimes conflicting sectoral traditions

and priorities. Attempts to fit them into a Procrustes' bed of colonial or settler expertise obscures the diversity and range of their professional and personal trajectories and influence. It should be clear, for instance, that neither Bews's Clementsian account of the structure of vegetation in South Africa, nor Phillips's theoretical publications on the ecosystem concept or his Clementsian influences, meant that either man was incapable of adapting his thinking to local ecological circumstances and particular practical land management challenges. Bews acknowledged that different land management goals required different fire management strategies, and Phillips was explicit about the need to be careful when generalizing from basic scientific principles, and to always consider local ecological context, including land use (especially grazing after burning).

South African farmers and officials had well developed ideas about veld burning before the advent of experimental work. When the first results of scientific research on burning became available, they were both unsuitably generalized (from sweetveld to sourveld), and also resolutely ignored by agricultural and soil conservation officials who feared the desiccating effects of burning. Researchers were well aware they were operating in a highly charged political context. They worked in parallel on schemes to eradicate fire and on projects to manage grasslands with fire. The predominant focus in grassland fire research on water supplies, soil conservation, and grazing management for commercial farming precluded research on African fire management and also meant little work was done on grassland biodiversity. This latter omission is part of a global conservation science culture that has ignored tropical grasslands in favor of forests, some assuming that grasslands are a successional stage towards forest, and others that many types of grassland are of anthropogenic origin.[97] Whatever the advice and policies of state and provincial officials, in many (probably most) cases, farmers ignored official attempts to restrict and replace burning with other techniques. For many farmers, the alternatives

were simply impractical (on stony or steep land), and too expensive or labor intensive. If history is to speak to policy (and it needn't), then it seems beneficial to explore the actual entanglements that inform or hinder policy development and implementation. It is not sufficient to separately study histories of scientific theory, research, sectoral institutions and their policy and management recommendations, or the practices of the land managers they are meant to influence.

Simon Pooley is the Lambert Lecturer in Environment (Applied Herpetology) at Birkbeck University of London. He has published a monograph *Burning Table Mountain* on the fire history of South Africa's Cape Peninsula, and papers on invasive plants and animals. He has taught conservation science at Imperial College London and is a visiting researcher at WildCRU, University of Oxford, where he brings a historical perspective to human wildlife conflict research. He serves on the IUCN's Crocodile Specialist Group and Task Force on Human Wildlife Conflict.

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Notes

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[8] On new imperial history, see: Joseph Hodge, "Science and Empire: an overview of the historical scholarship," in *Science and Empire: Knowledge and networks of science across the British Empire, 1800-1970*, ed. Brett Bennett and Joseph Hodge (London: Palgrave Macmillan, 2011): 3-29.

[9] Peder Anker, *Imperial Ecology: Environmental Order in the British Empire, 1895–1945* (Cambridge, Massachusetts: Harvard University Press, 2001); Saul Dubow, *A Commonwealth of Knowledge: Science, Sensibility, and White South Africa 1820–2000* (Oxford: Oxford University Press, 2006).

[10] See S.J. Pyne, et al., "Introduction", in *Wildland Fire Management: Handbook for Sub-Sahara Africa*, ed. J.G. Goldammer, C. De Ronde, (ed.s), (Freiburg, Global Fire Monitoring Centre, 2004): 1–10; Simon Pooley, *Burning Table Mountain.*

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[30] William Beinart, *The Rise of Conservation*; Simon Pooley, *Burning Table Mountain*.

[31] *Journal of the Department of Agriculture* (*JDA*), XI, No.5 (November, 1925): 391.

[32] William Beinart, *The Rise of Conservation*; S. Pooley, *Burning Table Mountain*.

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