2

The Soil Problem

> [A river] can be considered a body of flowing sediments as much as one of flowing water.
>
> —PATRICK MCCULLY[1]

If a river is a body of flowing sediments, as Patrick McCully puts it in the epigraph for this chapter, then producing water requires its separation from sand, silt, and clay, particle by particle. And, yet, soil erosion and reservoir sedimentation appear in almost none of the engineering and planning literature for the Lesotho Highlands Water Project. How could it be that a multibillion-dollar water storage and export scheme came to be sited in a notoriously erosive country—literally a global testing ground for soil erosion mitigation techniques?[2] And, why would it ignore the problem?

The previous chapter showed how water is being conceptually transformed in Lesotho to facilitate export production. That meant the development of a concept of "national water"—a water that is abundant and locally emplaced; one that is spatially even across the territory and across time; one full of elisions and omissions. Now, I turn to those elisions and omissions, and to the pedagogical work that seeks to address them. National water is essentially volumetric,[3] and therefore it clashes with fluvial water, which is defined by its patchiness, its punctuated temporality, and its destructive movement over land. Fluvial water shifts across rainy years and dry years, with droughts broken by storms, coursing sometimes riotously from hillslope to river to reservoir. Its material properties are surprising and suspect. In this collision of volumetric and fluvial water, we can see just how scrambled and contradictory conceptions of Lesotho's water have become. At the very moment that water is established as an export commodity, its nature is called into question, asserted, contested, and reasserted.

Whereas in chapters 3 and 4 I'll describe *solutions* developed by conservation bureaucrats to tackle soil erosion, this chapter critically examines the *problem*. I start by explaining how the problem of soil erosion and sedimentation manifests for water engineers, before outlining what is known about the threat it poses to water export. I show how conservation bureaucrats have sought to develop a fluvial pedagogy—teaching rural people how to identify soil erosion and to diagnose its causes—implicitly and explicitly blaming livestock owners for sedimentation. They do so in the absence of adequate measuring and monitoring of soil erosion, however, leading them to rely on a "sentinel device": dwarf shrubs.[4] Shrubs are put forward as a way to see soil erosion and its relationship to livestock grazing, but as we will see these relationships are subject to a wide diversity of interpretations.

The soil problem is serious, and it demonstrates the extent to which producing water cultivates a fluvial imagination, or a sense for how water flows over land and why. It educes theory about the landscape, generating an attention to such fine-grained processes as the movement of different sediment particles down a slope, how they weather in the face of cold or heat, how they pass through different kinds of vegetation, and the ways they aggregate together and slump within a reservoir. This chapter adopts that same attention.

A PROBLEM OF OPERATIONS

"Are your concerns primarily related to water quantity," I asked two water engineers I'll call Thomas and Selemo, "or water quality?" They worked for the Lesotho Highlands Development Authority (LHDA), the administrative body responsible for building and maintaining the water project.

Throughout much of my research, that was how I thought of the LHWP's sediment problems. That is, I assumed sedimentation was either a problem because it cuts into storage capacity (i.e., the quantity of water available for transfer) or because it adds organic matter to water that compromises water purity (i.e., the quality of that water). It was late in my research, and I was surprised by their answer.

"Neither," they explained. "Sedimentation is first and foremost a problem of *operations*." By this, they meant that sedimentation circumscribes their ability to manage water levels at the reservoirs. From an "operations perspective," their mandate was to plan properly to provision water at an agreed-upon rate to South Africa. I didn't quite get it.

Thomas zoomed out on the problem for me. The LHWP consists of essentially three reservoirs. In the mountains, the Mohale Reservoir flows by tunnel into Katse Reservoir. From there, water enters another tunnel and flows into the 'Muela Reservoir, passing through hydroelectric turbines just before it arrives (see map 2). Engineers' work consists of managing the levels of these reservoirs to ensure that they maintain a steady passage of water through the turbines and on to South Africa, the issuance of which must happen according to agreed-upon schedules for a given month and year. They also try to ensure a consistent production of electricity, without which Lesotho must import additional electricity for national use. They can surpass these minimum production requirements when water is abundant (provided there is space available downstream in South Africa's Vaal Reservoir to receive the water), but the important part is to make sure enough water sits in the mountain reservoirs to meet these regular requirements even during the dry season or periods of drought.

From an operations perspective, Selemo said, two related issues threaten their mandate—one inside the reservoir and one above it. The first, he said, is sedimentation from soil erosion. With increasing sediment levels at 'Muela, the water quantity in the reservoir is smaller, narrowing their flexibility in managing reservoir levels. The room for maneuver is reduced. The second, he said, is the degradation of alpine wetlands. The wetlands' function is to store water and release it slowly downstream. If the wetlands don't store water, then the water flows out of them too quickly. This increases the risk of sedimentation from flooding, but it also reduces the evenness of water's flow into the reservoir—too much in the rainy months and not enough in the dry ones—meaning again that their ability to manage reservoir levels is diminished. If the river systems upstream carry water slowly and evenly into the reservoirs, then reservoir levels will be predictable.[5] If levels were poorly managed, a period of significant rainfall could overflow the dam walls, meaning a loss of water to the project.

We were seated in an LHDA office building, and I pointed to a framed picture on the wall behind them: the iconic image of an overflowing Katse Dam that proclaims Lesotho's water abundance, printed on a thousand different postcards, calendars, billboards, and government reports (see fig. 6). "So, the overflow of Katse Dam in that picture," I asked, "represents a failure of management rather than a success?"

They agreed and we had a laugh. If that water were instead being stored in the wetlands or rangelands above, then it would be released later when the reservoir level had diminished from water transfers.

The LHDA's icon of water abundance, it turns out, is an index of land degradation and poor reservoir management for these engineers.

Thomas drew a profile of the reservoir on the whiteboard to edify me. He said the first thing to know is that the issue of sedimentation only comes into play for transfer capacity when it crests the line between "dead" and "live" (or, "active") storage. Dead storage refers to the water beneath the transfer intake tunnel, which can't be transferred and is therefore "dead." If sediment accumulates to an elevation higher than the intake, it will begin cutting into the overall transfer capacity. Shrinking the dead storage is an issue for "operations," however, because it narrows their management options. It is also a problem if it accumulates against the dam wall where the downstream outflow is. Unfortunately, he said, there is no sediment outflow valve for Katse or 'Muela, though there is talk of putting one in for the Polihali Dam. There are outflow release valves on both dam walls, he explained, but they are designed only to allow for the release of water downstream

FIGURE 6. Overflowing Katse Dam. Photo by author.

to promote river ecological function. Sediment can only pass through specially designed outflows—its abrasiveness would destroy the outflow valves at Katse or 'Muela.

I asked if they knew the actual sedimentation status of these various reservoirs. Was there a monitoring program in place? Unsure and unaware of such a program project-wide, they suggested I send a data request to the CEO's office. (I did, but received no response after numerous follow-ups.) For 'Muela, however, they did have data. In fact, on the very same whiteboard they drew my attention to some figures scrawled in an equation, at the end of which was the figure "0.725," with "12%" scrawled beside it. Thomas explained that 0.725 million m3 of sediment were currently in the reservoir. The reservoir's total volume is 6 million m3, meaning that it was 12 percent filled.

I asked if they knew of any efforts to model sediment accumulation in the reservoirs, but they knew of none. Selemo said that he wouldn't really believe the models if they did. This is because of the nature of Lesotho's soils. He said that all the soil might wash away to bedrock, but then more soil could form in the next coming years—the amygdaloidal basalts in the highlands weather easily. So, it's very difficult to predict sedimentation rates, he said.

Selemo then drew our attention from the reservoir back to the upstream catchment. One of the key issues today is that wool production has taken off in such a big way. Because of the boom in wool production, he said, overgrazing has led to a reduction of the ground's capacity to store water. The reservoirs at Katse and Mohale are much larger than 'Muela's, he said, so he felt the sedimentation problem there was not particularly pressing. However, he added, it is a problem in the long term, so they are very concerned about it. He asked us to consider Matsoku Weir, situated in a neighboring valley to the Katse Reservoir and connected to it by a diversion tunnel. The weir had become so clogged with sediment that it is almost non-operational. The cost of dredging it might be too expensive to be worthwhile.

In a separate conversation, another water engineer emphasized the significance of the lands above the reservoir. The sediment problem at Matsoku Weir, he said, originates from people ploughing on steep slopes and grazing too many livestock. The LHDA hopes to create protected areas in the upstream catchment so that they can enforce rangeland conservation, perhaps near Mont-Aux-Sources. The core issue, he said, is that the catchment health is not simply the interest of the two to three people whose animals graze in a given area, but rather "the interest of the nation." It is a "national priority," he said, reframing these landscape processes so they might become visible as national problems. It was a kind of (ethno-) fluvial geomorphology.[6] These engineers taught me how to envision the flow of water and sediment from wetland to reservoir in relation to the nation: a national fluvial imagination.

FLUVIAL THEORY IN HISTORICAL CONTEXT

Lesotho has long been known as a global soil erosion hotspot.[7] It's the kind of thing one might even read in a *Lonely Planet* travel guide or in an encyclopedia entry for the country. In the early twentieth century, agricultural journals, and South African farmers, as well as British conservationists,[8] began drawing attention to gullies and flooding in the Lesotho lowlands and the Afrikaner farming stronghold across the border, the Orange Free State.[9] All across Southern Africa, in fact, concerns about soil erosion had gathered pace in the years following the United States' Dustbowl crisis, when soil erosion expertise flourished and expanded across the globe.[10] In Southern Africa, the interest in soil erosion stemmed largely from concerns over future declines in production on white-owned farms rather than degradation in "native areas," but the specter of African agricultural collapse also loomed in the minds of settler colonists.[11]

In the Orange Free State Province, however, the concerns were particularly acute. They focused primarily on flooding and sediment loads. The Orange River, which originates in Lesotho (where it is referred to as the Senqu River), passes through the Orange Free State en route to the Atlantic Ocean. The Orange Free State—today, a South African province called the Free State—was and is the site of some of South Africa's best agricultural land. It was also where white Afrikaners settled after the "Great Treks" from British-controlled Cape Province in the nineteenth century, as I described in the previous chapter.[12]

These farmers, a powerful constituency in the Union of South Africa of the twentieth century, complained to the British colonial authorities of Basutoland (nowadays the independent nation of Lesotho) that overgrazing in the Maloti Mountains was rendering the land incapable of holding water and leading to destructive floods downstream. The floods were alleged to carry so much silt it would compromise any attempt to dam the Orange River for use in irrigation.[13] After repeated calls by South Africa for British action to stem erosion and overgrazing, including by afforestation and drastic reductions in livestock numbers, the British colonial authorities began to fear that the Union of South Africa would use this issue to pressure them to cede control of Basutoland and the two other British High Commission Territories, Bechuanaland (now Botswana) and Swaziland (now eSwatini). The British even prepared a draft white paper in case South Africa submitted a formal application for transfer.[14] The incorporation of Lesotho on these grounds was popular among South Africa's white electorate during Jan Christian Smuts's first term as prime minister (1919–24). As South African pressure continued to increase, the British proposed a set of dams in the Basutoland mountains to address the problem of mountain erosion and sedimentation. It bought the British time.

In the meanwhile, as feasibility studies were carried out to scope where such dams could be built, how much they would cost, and so on, the colonial administration determined it needed to know more about the precise *extent* of land degradation and the value of Basutoland territory as a colonial holding. It solicited a comprehensive review of the natural resources of the territory and the political institutions that manage them by Alan Pim in 1930. Pim's task was to advise the administration on how to increase the long-term profitability of the colony. His 1935 report came to a dramatic conclusion: "The problem of erosion in its many aspects is in fact the most immediately pressing of the many great problems which now confront the Administration."[15] Pim was echoed by Smuts, who said in 1936 that "erosion is the biggest problem confronting the country, bigger than any politics."[16] They envisioned a future Basutoland incapable of feeding its inhabitants and washing away down ever-expanding gullies. These assessments were energized by the racial politics of the time. The soil scientists Graham Jacks and Robert Whyte wrote in 1939 that, having conquered people and territories in Africa, the "white man's burden in the future will be to come to terms with the soil and plant world."[17]

The Pim report recommended the institution of country-wide soil conservation projects that included the construction of buffer strips and contour banks around agricultural fields. The program would later be praised in 1944 by Hugh H. Bennett, head of the U.S. Soil Conservation Service, when he visited South Africa amid escalating fears about soil erosion in the region.[18] But it was subsequently criticized as a failure immediately after independence and later by the environmental historian Kate Showers,[19] whose close study showed that the programs used untested soil conservation strategies that not only failed to diminish rates of erosion, but actually *increased* them. Put another way, Lesotho was used by

Britain as a testing ground for experimental conservation solutions. Rather than arrest these erosion gullies, which the British described as emblematic of Basotho mismanagement, British mismanagement had expanded them.

As I noted in the introduction, concerns from Afrikaner farmers eventually diminished. By midcentury, South Africans became more interested in problems of water security for the Johannesburg-Pretoria area than about preventing sediment-heavy floods in the Orange River. But in the course of transforming the dam project into a water-export scheme, how did the architects reconcile their plans with Lesotho's reputation as a supremely erosive country, where erosion was "bigger than any politics"?

One way was by erroneously presuming that dams in the high mountains would be free of the problem. Another was by disregarding it. In the following section, I take a closer look at that presumption, the threat that sedimentation might pose to the LHWP, and the measures so far taken to assess or address it.

ASSESSING THE THREAT OF SEDIMENTATION

Soil erosion poses a threat to all dam projects. Sediment deposited behind dam walls diminishes reservoir capacity and, once it reaches intakes for turbines or irrigation, can threaten a dam project in its entirety. Such dams will eventually be decommissioned or even removed. While all dam reservoirs have a "dead storage" area below the intake, that area is crucial to reservoir management, as the engineer Thomas explained earlier in this chapter. And, sediment eventually cuts into "live storage." Because it accumulates irregularly in reservoirs, it can do so much sooner than is often acknowledged by dam proponents.[20]

A 1951 feasibility report by the civil engineering firm Hawkins, Jeffares, and Green stated that there was too much silt in the lower reaches of the Orange/Senqu River and suggested that dams be built in the basalt areas upstream instead.[21] The lowlands feature sandstone, sedimentary soils. These soils have a "duplex" formation that makes them susceptible to piping—the development of subsoil water passages—and, subsequently, gully erosion.[22] The highland soils by contrast are formed on basalt parent material. The cold temperatures in the mountains mean that these soils generally have a higher organic matter content than those in the lowlands and therefore resist deterioration.[23]

But while the lower erodibility of the soils themselves was taken by Hawkins, Jeffares, and Green, as well as others,[24] to mean that sedimentation in the highlands was insignificant to the dam project, a range of evidence suggests otherwise. First and most obvious is the fact that concerns about highlands erosion were longstanding, as described in the previous section; Pim's erosion control efforts, for example, were not confined to the lowlands but rather were rolled out across the highlands.[25] It is true that highland soils are often relatively thin and undeveloped (except for the very limited peat histosols in the alpine wetlands), oftentimes featuring few or no diagnostic subsurface horizons. Yet, because of the steepness of highland slopes, and because of their high amount of exposed, unvegetated soil, they are vulnerable to rain splash erosion, sheet erosion, and even mass movements.[26] And, while cold temperatures can promote soil aggregate stability, it is also true that the freezing and thawing leads to cryogenic weathering.[27] Two of the four varieties of basalts found in the upstream catchment of Katse are especially susceptible to disintegration, too, including the olivine basalts and those with disseminated clay spots.[28] This is because secondary materials in the basalt, such as smectitic clays like montmorillonite, swell with moisture. That is what the engineer explained earlier in this chapter—that even though the highland soils are generally thin, the bedrock degrades easily. Nearer to the valley floor, too, soils get deeper, and gullying is widespread. After heavy rainstorms, huge amounts of sediment are sometimes washed across roads, requiring clearance by excavators for cars to pass safely.

Just a few short years after the LHWP Treaty was signed, the most prominent soil scientist in the country, Qalabane Chakela, found that "[Lesotho has] the highest erosion hazard of any single country in southern and central Africa."[29] On account of "the steep slopes; high total quantities of rain; poor lithosols; and only average vegetation covers . . . [t]he conventional view that the mountain areas of Lesotho are less prone to erosion is unsupported."[30] That is, the lower inherent erodibility of highlands basalt (relative to lowlands sandstone) is offset by the highlands' precipitation, topography, land cover, and secondary materials such as the expanding clays. Besides, the 'Muela Dam, through which all of the LHWP's water flows, is sited in the sedimentary zone, where dam reservoirs "have a very short useful life."[31]

Nevertheless, the LHWP Phase 1 *Feasibility Study* stated that, "based on a limited number of existing field observations and also taking account of published sediment yields for adjacent catchments in South Africa," the transfer tunnel intake in Katse Reservoir "would remain free of sediment for at least 50 years and it would be many more years before there could be any significant loss of active storage."[32]

The LHDA has not made much data publicly available on the issue of sedimentation.[33] One study analyzing erosion hazard, by Smith et al.,[34] contradicts the findings of Chakela, Molapo, and Putsoane,[35] and finds no serious issue posed by sedimentation. That study was funded by the Lesotho Highlands Water Commission, the binational body that oversees the LHWP. I have no evidence of deliberate misinformation. But a long history of "corporate science" in the assessment of natural resource extraction impacts,[36] by which consultancies can solicit future contracts from enterprises like the LHWP, raises doubts about the impartiality of their results. A separate attempt at modeling the risks of reservoir sedimentation was made by Jehanno et al.[37] The authors modeled sediment deposition in the Katse Reservoir and found that the water intake would not be affected until at least fifty years after impoundment, affirming the *Feasibility Study*. However, their model only included sand particles and omitted silt and clay—two smaller classes of mineral soil particles—meaning that their figures underestimate sedimentation rates. Further, the French SOGREAH consultancy responsible for the Jehanno et al. study was found in a criminal court in Lesotho to have bribed the CEO of the LHWP, Masupha Sole, in order to solicit contracts. Sole served nine years in prison.

The paucity of research on the problem posed by sedimentation is shocking—a multibillion-dollar project upon which the regional economy depends, but without serious commitment to ensure its longevity. Water engineers have not been completely blind to this problem, however. In 1995, the LHDA engineer Stanley Hirst authored a position paper to rouse his organization into action.[38] Hirst pointed to internal dissent, explaining, "Soil erosion in project catchments and the associated sedimentation of operation reservoirs has been a subject of longstanding discussion and some discord" within the LHWP. "Since 1990," he went on, "a number of proposals, from in-house and from outside consultants, have been made to mount a study of erosion and sedimentation in the LHWP Phase 1A catchment. For a variety of technical, budgetary, and procedural reasons, none of these have found their way through the approval process."[39] The lack of knowledge about the issue was particularly vexing for him: "No detailed pre-project baseline studies appear to have been done for the LHWP."[40] Not only that, but "None of the engineering feasibility or design studies for Katse and 'Muela dams (LHWP Phase 1A) specifically included collection and analysis of sediment samples."[41] After the project was underway, a vegetation baseline was begun, but no data gathering was included specifically for erosion and sedimentation. There are not even "substantiated estimates," he said, for rates of soil loss or sediment yield in project catchments. The same ignorance prevailed for the Mohale Dam (Phase 1B), which was in planning stages at the time of his writing. For that catchment, an automatic sediment sampler had been installed on the Senqu River downstream from Mohale, he wrote, but "only one year's data will be available for engineering design and that for a likely drought-stricken year" (i.e., a year in which sediment movement would be limited).[42]

Actual rates of sedimentation in Lesotho's reservoirs are poorly understood for two main reasons. First, soil erosion is difficult to measure, typically requiring field study and long-term monitoring. Gullies are the most evident index of erosion, though they only occur where soils are deep and where runoff force is sufficiently strong to dislodge soils and channelize water. Moreover, gullies often form during dramatic flood events, and can remain stable for another decade or more, until a storm of that magnitude occurs again. Areas of exposed bedrock can also be an indication that erosion has taken place, though this phenomenon, too, is highly localized, confined primarily to steeper slopes where soils are thin. In areas where soil is thinly vegetated, a significant amount of sediment movement can take place without leaving much of a trace: when rainsplash dislodges particles of exposed soil, for example, they are later entrained downslope by concentrated runoff water. Measuring the increase in gully size or the rates of sheet erosion (i.e., the more or less uniform loss of soil across a surface) requires precise and regular measurements. Even when river monitoring captures changes in the bedload and the suspended load of sediments that ultimately make their way into the river, these describe only the effects of the most recent rains and must be measured over longer time periods in order to derive acceptable estimates of long-term changes and their causes. The LHWP's limited field observations therefore call into question the accuracy of models that came to optimistic conclusions about projected rates of sedimentation.

The second—and most important—reason that rates of sedimentation are unknown has been the lack of will to know them.[43] This is because the principal concern of dam builders—the government officials, politicians, contractors, and others with a stake in these high-profile projects—is simply building the dams. This helps explain why no comprehensive study has been undertaken, despite numerous pleas,[44] and why "no measured soil loss data from runoff plots exists in the Lesotho Highlands."[45] Steps to address erosion—not just to measure it—are often seen as peripheral to dam builders, perhaps partly because, while they maintain reservoir capacity (and water quality) in the long term, they can in fact diminish water yield. Afforestation, for instance, leads to the retention of infiltrated water which is lost to the reservoir by plant uptake and evapotranspiration.[46]

The LHWP would not be alone as a water project that ignores its social and environmental impacts,[47] but the specific ignorances of this project are stunning.

A pair of bathymetric sediment surveys in 2003 and 2019 at the 'Muela Reservoir, a small but critically important LHWP reservoir, is a rare exception. And the case is telling. In 2003—just six years after the completion of the 'Muela Dam wall—the first survey found that 7 percent of the reservoir volume had already been filled with sediment. By 2019, it had become 12 percent filled.[48]

After having resisted the move for many years, the LHWP took tentative steps to address the erosion issue in the early 2000s. It did so by implementing Integrated Catchment Management (ICM), a set of soil conservation programs that ostensibly takes a holistic approach to managing the catchment-scale dynamics that drive erosion and other kinds of land degradation.[49] The program was established for a five-year period between 2005 and 2010, to be rolled out in each of the (then) three catchments of the LHWP: Katse Dam, Mohale Dam, and 'Muela Dam. These programs continue at the time of this writing, albeit in diminished form, and plans are underway for another concerted effort, including in the catchment of the future Polihali Dam. I describe these programs in the next two chapters.

For now, let me turn to describe the fluvial pedagogy that is emerging to square national water with fluvial water—to square water production with livestock production in the absence of real measuring and monitoring of the problem. This pedagogy is not unlike the pedagogy of water meters described by Antina von

Schnitzler in neoliberal South Africa.[50] Instead of reading a water meter, however, rural people are taught to read the landscape. With evidence of soil loss having been so poorly recorded, this pedagogy is shrouded in confusion and uncertainty. Nevertheless, it is instructive. The effort to instill the public with this fluvial imagination shows how a dam project doesn't want or need just any kind of water, nor just any kind of soil, nor just any kind of citizen. It wants a water that moves slowly through the soil. It wants a soil that captures and slows water's flow. And, it wants a rural citizenry that cares about erosion for the sake of the nation's reservoirs, not only their livestock or agricultural fields—teaching them to become better citizens through improved natural resource stewardship.

FLUVIAL PEDAGOGY

The soil problem is an ontological one. The nature of soil and the water that flows through or over it have become scrambled. Lacking adequate documentation and understanding of sedimentation, a class of plants—the dwarf shrub—has come to be used by conservation bureaucrats to make erosion visible to the naked eye. If, in the semiotic world of conservation bureaucrats, wetlands symbolize water storage, then dwarf shrubs symbolize erosion.

One dwarf shrub species has cut a particularly dramatic figure, transposing issues of desertification and erosion onto issues of livestock grazing (see fig. 7). Known in Sesotho as *sehala-hala* and in English as bitter Karoo bush, *Chrysocoma ciliata* (Asteraceae) has been identified with livestock overgrazing since at least the 1870s, when farmers and conservationists in South Africa reported its invasion into heavily grazed sheep pastures.[51] They are essentially unpalatable, so they are unwelcome competitors to the forage grasses that livestock desire. *C. ciliata* was despised for its fecundity and for the difficulty in eradicating it—a mature plant produces more than one thousand wind-dispersed seeds each year; they can grow in extremely disturbed settings such as along the roadside; and they can regrow from basal meristems if burned in a fire.[52] Because it is known as a desert shrub (i.e., "Karoo bush"), it is seen by conservation bureaucrats as having desert provenance and therefore indicating not only overgrazing but also soil erosion and desiccation—an increasing water scarcity.[53] Livestock owners and herders I spoke with also envisaged a kind of desertification through reference to the shrub. For them, however, the shrub was not an indication that overgrazing was *bringing about* desert-like conditions, but rather an indication that an increase in droughts was favoring shrubs over grasses. Though these associations between shrubs and erosion antedate the LHWP, they are drawn into its orbit in contemporary Lesotho.[54]

Do they actually signal erosion? The positions among conservation bureaucrats and the LHWP are contradictory, variously arguing that shrubs are indicators of erosion or desiccation, that they stabilize soils, or even that they actively encourage erosion. Consider the landscape theory-work done in this Basutoland colonial

FIGURE 7. The dwarf shrub *Chrysocoma ciliata.* Photo by author.

report from 1948, which moves a reader from the selective grazing of livestock, through shrubs, to soil erosion:

> The northern, northwestern, and north-eastern slopes of the mountains were originally covered with sweet (Themeda) grass, while the colder slopes grew "sour" grasses of which *Festuca caprina* was the dominant species. Stock naturally congregated in the sweet grass, with the result that this has been slowly eaten or trodden out and its place has been taken by useless scrub, *Chrysocoma* [*ciliata*] predominating. The grazing value of these slopes has consequently steadily deteriorated. Chrysocoma also offers little resistance to soil erosion. In this way a very large percentage of the mountain slopes has been damaged and it is considered to be a matter of the most urgent and vital importance that these slopes should retain their former grass covering.[55]

Elsewhere, conservation statements suggest that they might prevent erosion, but that their proliferation is a sign of generalized desiccation. A Convention on Biological Diversity report suggests that the, "Karoo [Desert] species like *Chrysocoma*" are spreading and, though they might help prevent soil erosion by providing ground cover, they are "a sign of increasing desert-like conditions. In essence, Lesotho is progressively becoming a desert."[56]

There is no clear evidence that shrubs are linked to soil erosion, and some observers suggest that they actually prevent it, including even the LHWP. In the *Feasibility Study* for Phase 1 of the LHWP, shrubs are depicted as soil-stabilizing agents, but ones that are disappearing rather than proliferating: "The shrubs are

FIGURE 8. Shrubs stabilizing a roadside. Photo by author.

. . . deeply rooted and contribute to the control of soil erosion even on steep and heavily grazed slopes. The shrubs are, however, in strong demand for fuel and in some areas they have virtually disappeared."[57]

I am sympathetic with the view that shrubs stabilize soils, having noticed very few sites where gullying had exposed the root systems of these shrubs, for example. Instead, one can easily find eroded hillslopes that appear to be held in place by shrubs (see fig. 8). They do increase with grazing where soil conditions are favorable, though this is somewhat separate from the question of whether they are a sign of erosion.[58] It is because of the association of shrubs with grazing—and the presumed relationship between grazing and soil erosion—that shrubs have become equated with erosion.

These associations between vegetation, erosion, and landscape history can be disorienting, but let me provide a few brief stories that will give a sense as to how they operate in the everyday life of soil conservation for the water-export economy.

Story 1: "The Place of Shrubs"

In March 2014, I visited the Khubelu Valley in the Mokhotlong District with a civil servant named Sechaba from the ministry to observe a meeting of a local grazing association. The civil servant had, in fact, called the meeting to encourage them to better manage grazing in the high plateau areas that were technically under control of their association. The massive Polihali Dam is currently being built lower in the valley. Conservation bureaucrats are concerned about livestock-induced degradation of the upper catchment, as noted above, and were promoting grazing associations that might help prevent more wetland degradation. These are community-run cooperatives, comprised of members who pay dues and collectively manage rangeland access on behalf of chiefs. (I'll return to discuss chiefs and grazing associations in chapter 4.)

The slopes rose steeply upward, the more so as we neared the meeting, and they were covered mostly in dwarf shrubs. Sechaba pointed out the shrub-covered pastures to me and shook his head. "Do you see that? These people are ruining their pastures."

Shrub-dominated landscapes told a story for Sechaba of the failure of rangeland institutions and the obstinacy of rural livestock holders. We parked the car and walked up the hill to the meeting. It was held at the chief's place, as with most open-air meetings in Lesotho, called *lipitso*. And, like all *lipitso*, people came and went throughout the meeting, some of them never clearly in attendance. Mostly young and old men, they leaned up against the stone kraals of the chief's compound. They were no doubt curious about what was to come of this meeting, on the heels of several others that took place there recently, since the wetlands conservation project associated with the LHWP began its attempt to resurrect this particular grazing association.

When the chair of the association got up to speak at the outset of the meeting, he spoke at length about the importance of protecting the rangelands in their area, especially the wetlands on the plateau that, he said, produced a large amount of water which Lesotho sells to South Africa. I have seen these speeches many times before. It is a performance honed through years of experience with civil servants like Sechaba, as well as others in the conservation-development industry.[59] It is a genre of speech, not exclusive to Lesotho, that is notable for its overly optimistic and moralizing tone, and its disregard for the challenges that both speaker and audience know to stand in the way. There was no mention, for example, that the principal chief of the area is rumored not to care about wetland degradation or managing the use of rangelands in general; or that Sechaba's ministry fails to provide the association with the grazing permit forms that it's supposed to issue to all livestock owners grazing in association pastures, forms that affirm the association's legitimacy through their materiality and bureaucratic authority.

Sechaba, in his capacity as technical advisor to the local chief and the grazing association, stood up next to deliver an impassioned speech of his own, this one also honed through years of standing in front of Basotho crowds to upbraid them about their rangeland management practices. Like most civil servants—or "conservation bureaucrats," the term I'm using to refer to ministry officials, LHWP conservation workers, and those from foreign-funded conservation NGOs—Sechaba was from the lowlands of Lesotho, so he knew little of the local context. He had only been in this valley a handful of times and had never visited the rangeland areas that were at issue that day. Sechaba began, customarily, by telling the group his full name and the village where he was born, in the urban lowlands of Leribe District. He explained that people from Leribe refer to this mountain district of Mokhotlong as *lihlahleng*, the place of shrubs. The crowd erupted in shock and some laughter, with shouts of disbelief and offense: *Haibo! Aikona!* Hey! No way! And Sechaba continued for another ten minutes, chastising them for their lack of organization and lecturing them on the importance of protecting the range.

As we drove back to town, I asked Sechaba, "Is that true? Do people in Leribe really call this area *lihlahleng*?" I had never heard that.

"No," he said, throwing his head back and laughing. "That's just motivation."

In a joke, then, a landscape.

Playfully riffing off of half-serious rivalries between Lesotho's districts, and especially rivalries between the highlands and the lowlands, Sechaba sought to orient us to this landscape, to author a landscape history that derived process from form: a pattern of shrubby vegetation (the form) became an index of years of poor management (a process). And, therefore, the situation was a threat to the water project. He was trying to cultivate in them a fluvial imagination, and the figure of the dwarf shrub ushered us along a semiotic chain, drawing connections between livestock management, soil erosion, water, and the nation. Ultimately, it was a conduit for urban prejudice against rural people.

Story 2: A Bald Man's Head

The traffic across this semiotic chain flows in more than one direction—not just from the state to the public.[60] Just a few days before standing with Tankisi at his cattle post, which I described in the introduction to this book, I had asked him about the condition of those cattle post areas while sitting out front of his house. He said that the condition was not good. The rains were arriving too late in the summer, and there is a problem with the hydrologic cycle (*lebili la pula*). The water is pulled up from the ocean and for whatever reason is not reaching Lesotho as it once did. The cycle is broken, he said. According to Tankisi and many other rural people I spoke with, the rains used to fall more commonly as day-long drizzles that infiltrate the soil (*pula ea molupe*). These days, the rains are not only much delayed, but when they finally arrive, they fall as destructive, thirty-minute torrents (*pula ea sekhahla*). Pointing up the valley from his house, he said these days in the summer rainy season it's common to see rain far away in that direction, but it doesn't move this way as it once would have. Or, if it does manage to arrive at his village, the strong rains he saw up the mountain might have diminished to simply a sprinkle (*mofafatsana*).

Swiveling our gaze in the opposite direction, he pointed to the hillslope beneath a wool shearing shed that was in our view a kilometer or so away. Pointing out the shrubs that he said had colonized the pasture just below it, he argued that their presence was a consequence of this changing rainfall regime. This was in contrast to Sechaba, then, who invoked shrubs as a consequence of overgrazing and poor land management. Tankisi explained that these new, more destructive rains don't soak into the soil. Instead, they move across the surface "like water on a bald man's head." This favors shrubs, he said, whose thick roots and stems are better adapted to drought than grasses.

The very next day, I walked with a ministry official named Tefo through a shrub-encroached pasture that surrounded an alpine wetland. The wetland looked horrible; worse than it did the last time I saw it just a few years prior. It might be described as dead or dying. Whereas a healthy wetland features continuous grass and forb cover, with hummocks covered in rare and delicate wetland plant species,[61] water-logged and squishing as you walk across it, degraded wetlands are edged by dwarf shrubs, pockmarked with the hooves of animals and the burrows of ice rats (*Otomys sloggetti*), dry, and silent—almost hollow-sounding.

Tefo explained that there is too much grazing here, and it has led to the incursion of dwarf shrubs. He did so by mobilizing the same metaphor as Tankisi, but to do different theoretical work. More than merely an index of something else (i.e., overgrazing, climate change, etc.), shrubs for Tefo were in fact *agents* of poor water flow. Shrubs don't hold soil or water as well as grass, he explained, so that when you see a place like this with shrubs edging the wetland, the water doesn't seep into the soil but rather just courses over it. Think of it, Tefo said, like water falling on a bald man's head. If there were hair on it, water would be retained; if not, it would simply run off.

Story 3: The Shrub Silt Trap

As I've said, the LHWP's sedimentation problems are especially pressing near the 'Muela Dam in the lowlands of Lesotho. Speaking with a councilor (an elected, local government official) named Ntsikeng from a village near 'Muela one day, he told me how he and some other councilors were taken by a conservation NGO to the highlands for a training. Led by two white people whom they were told were experts in range management, he said, this was not so much a "workshop" (*thupelo*), he said, as it was a "demonstration" (*pontšo*).

I was surprised to hear that they were taken to some of the same places where I had been conducting fieldwork for the previous five months. One was a hillslope where soil had completely washed away, leaving only the bedrock exposed. Silt traps called *metsele-tsele* (known in vernacular English as "stonelines") were being built there: long rows of stones running perpendicular to the slope. They were told that the stonelines would help soil to accumulate so that plants could recolonize the area. Using a Sotho proverb, Ntsikeng explained that the experts' rationale for showing them the site was as a cautionary tale: *ho haha serobe phiri ese jele*, which translates literally as, "to build a chicken coop after the chickens have already been eaten by a hyena." That is, they wanted to caution against attempting to correct problems after it was already too late.

FIGURE 9. Rows of uprooted shrubs. Photo by author.

The councilors were also taken to a place called Motšerimeli, where the government had been paying rural people to uproot shrubs to allow for grasses to grow (see fig. 9). He spoke with admiration for the condition of the pasture and the large rows of uprooted shrubs that he described as "shrub silt traps" (*metsele-tsele oa sehala-hala*). Indeed, the rows of shrubs did look like silt traps from afar, and driving by Motšerimeli on public transit, I had heard several people refer to them in that way. This always struck me as funny because trapping sediment is not their goal or function. It was simply for the purpose of piling them up in an orderly way.

He and the other councilors learned during this demonstration that the presence of grass was preferable to shrubs, not simply because grasses are forage for livestock and shrubs are unpalatable, but also because the grass *sieves* the water (*joang bo sefa metsi*) and, when shrubs dominate, the water simply runs down slope (*metsi aa matha feela*). It was a way of understanding the flow of water through an attention to the morphology of different plants.

Standing with a ministry official one day in the pasture where shrubs were uprooted, he pointed out a pickup truck that passed by on the road below with frustration. It was carrying bales of uprooted shrubs to town where they would be sold as firewood. I was confused as to why he would be upset. The program was implemented on the notion that demonstrating a healthy pasture would compel people to improve the rangelands, but also that it would allow rural people to earn money: first, by working to uproot the shrubs, and second by selling the shrubs as cooking fuel. A sign at the bottom of the pasture explaining the program exclaimed in all caps: "cash for assets!"

The official told me, however, that recently the ministry had ordered that the shrubs be left in the "stonelines" formation so that they might slow down the flow of water.

Once misrecognized as silt traps from passing buses, conservation bureaucrats leaned into this misrecognition, transforming them into *actual* silt traps.

Dwarf shrubs acted as powerful but confused boundary objects between rural people and conservation workers, a site for interpretive work in the historiography of the fluvial landscape. Shrubs had long embodied land degradation and desertification, but after having been uprooted to exemplify a pasture through which water flowed well, rows of uprooted shrubs *became erosion control structures*. Like the physical conservation works I'll describe in the next chapter, the very presence of these shrub silt traps, so visible from the roadside, would testify to passers by that rural people were mismanaging their pastures and that government agencies were taking action. They were devices for knowing and manipulating water, as well as for disciplining the interpretation of landscape patterns.[62]

CONCLUSION

This chapter has presented a paradox: a dam project originally aimed at trapping sediment and controlling floods was transformed into a water-export project in spite of that sediment. Alarm about soil erosion in Lesotho has been a consistent refrain for a century. But in the planning and implementation of the LHWP, it was ignored, and ignorance about the specific nature of this threat bodes ill for the water-export economy's future. Sediment haunts the futures of residents of the Lesotho highlands and of urban South Africans alike.[63] It's worth noting, too, that while the accumulation of sediment behind the dam walls is a problem for water export, starving the downstream ecosystem of these mineral and organic materials is also a problem for ecosystem health.[64]

National water, presented in the previous chapter, is portrayed as being spatially and temporally even across the territory, but that territory in fact is characterized by a patchy rainfall regime, full of drought and punctuated storms. These rainfall patterns are becoming even more acute than in the past. Producers of national water, while at first disregarding this problem, have in recent years begun developing a fluvial imaginary that draws upon long-standing ideas about rural land mismanagement. Theirs is a landscape through which water flows too quickly, and rural people, said to have a poor sense of this fluvial water and its national stakes, must be educated.

Because erosion can be difficult to see, and because not enough work has been done to know the causes and extent of soil erosion, recourse has been made to an indicator species for landscape interpretation. Yet, a common interpretation of their significance is lacking, as can be seen in the three stories I presented. For Sechaba, the shrub was a consequence of overgrazing and poor land management; for Tankisi, a consequence of changes in the rains; but for Tefo the shrub was actively shaping the ways water flowed across land—an agent of fluvial problems rather than a reflection of them. Later, the rows of uprooted shrubs were left to serve as silt traps, transfigured from being indices of erosion to being erosion control structures. Landscape theory swirls in the void left by the LHWP's ignorance.

Whereas this chapter has showed how conservation bureaucrats and water engineers understand water's flow and seek to impose that understanding upon rural people, the next two chapters will show how they translate that fluvial imaginary into action. Conservation bureaucrats have taken broadly two approaches to slowing the flow of water across the landscape: the construction of physical conservation works (chapter 3) and social transformations within rural society (chapter 4). These efforts illustrate how fluvial imaginaries in Lesotho, as hinted at above, are hitched to ideas about a state's obligations to its citizens. I'll describe in chapter 3, for example, how soil conservation is used as a means of redistributing national wealth to the poor. The upstream social and ecological engineering carried out to produce water commodities, then, is not just about disciplining rural populations. It is also a means of diffusing some of the "pressure"[65] of Lesotho's precarious political economy: to resolve contradictions of the water-reservoir era, namely that water export generates government revenue but no long-term employment.