A Cost-Effectiveness Framework for Landscape Rehabilitation and Carbon Sequestration in North Kenya

Principal Investigator:
Corinna Riginos, *Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ*
Collaborators:
Jayne Belnap, *USGS, Southwest Biological Science Center, Moab, UT*
David Kimiti, *Mpala Research Centre, Nanyuki, Kenya*

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Abstract

Large portions of Africa's rangelands are degraded, typically because they have lost grass cover and fertile topsoil. Less grass and less fertile land mean less forage is available to livestock – and less food and income available to people who rely upon livestock. There is an urgent need to find practical, simple, and cost-effective approaches to putting back grass cover and arresting erosion. We have demonstrated that simple erosion barriers can be highly effective at creating new patches of grass in barren landscapes. With only a small amount of effort and no special tools or supplies, pastoralists and other land managers can incrementally put back lost grass and, in time, a lost forage base for livestock.

Cost-Effectiveness of Simple Technologies to Reduce Erosion and Promote Grass Establishment

Background

An estimated 74 percent of Africa's arid and semi-arid rangelands can be considered partially or severely degraded, yet very little research focuses on how to restore these lands. Restoring degraded lands is critical to increasing (or in many cases just maintaining) their ability to provide ecosystem services such as forage production, clean water, and carbon sequestration – and ultimately their ability to support people and livestock.

Current restoration practices in eastern Africa often involve resource-intensive interventions such as furrowing with a tractor-driven "ripper" and seeding. While this approach may be practical on resource-rich commercial ranches, it is not practical for pastoralist communities – many of which endure a marginal existence on some of the most degraded lands in the region. Restoration solutions that are cheap, simple, effective, and easily implemented by pastoralists are urgently needed.

We are testing the cost-effectiveness of several simple erosion barriers. Our goal is to demonstrate how cheap, locally available materials can be used to reduce erosion and promote grass establishment in degraded rangelands that have large amounts of bare ground.

Figure 1. Research assistants measure vegetation around a plastic mesh sack barrier 4 months after installation. (Photo by David Kimiti)

Methods

We experimentally tested six different types of erosion barriers on the Mpala Ranch in Laikipia, Kenya. The Mpala Ranch is adjacent to a number of community-owned ranches and large parts of it are similarly degraded. Each of the 67 barriers was located in areas where the soil surface was completely bare and extremely hard. From a previous pilot experiment, we knew that commercially available *silt fence* (made from woven polypropylene geotextile) was highly effective at trapping soil and water and promoting plant establishment, but was expensive and susceptible to damage by elephants. We thus modified the silt-fence barrier design, using locally available plastic mesh sacking and nested pieces of sacking within bundles of branches covered with loose thorn brush in an effort to construct a cheaper and more durable barrier. We also tested barriers made from branches and burlap sacks, branches and balls of elephant dung, branches only, and shallow trenches. We measured the cover and species diversity of grasses and other plants that established uphill from the barriers; the sediment that accumulated uphill; and the durability of the barriers.

"After only two months, plastic mesh sack barriers and small trenches had captured a large amount of sediment and numerous new plants had established themselves uphill from the barriers."

Preliminary Findings

After two months (about 200 mm of rainfall), plastic mesh sack barriers and small trenches had captured a large amount of sediment and numerous new plants had established themselves uphill from the barriers (Figures 1-2). After five months (500 mm of rainfall), vegetation was abundant and diverse at many of the barriers (Figures 1-2). Newly established plants included a variety of annual and perennial grasses and herbs. Overall, trenches were most effective for getting new plants to establish (on average, 22% cover in the first meter uphill from the barrier). However, the mesh sack barriers were most effective at trapping a large amount of sediment in a patch extending 2 to 3m uphill from the barrier. This sediment will be important for allowing the new vegetation to spread into areas that used to be hard ground. In half of the barriers we also planted grass seed (Cenchrus ciliaries), but found that naturally occurring perennial grasses established successfully in barriers that were not seeded. This indicates that planting seed is not necessary in landscapes that have at least some source of perennial grass seed.

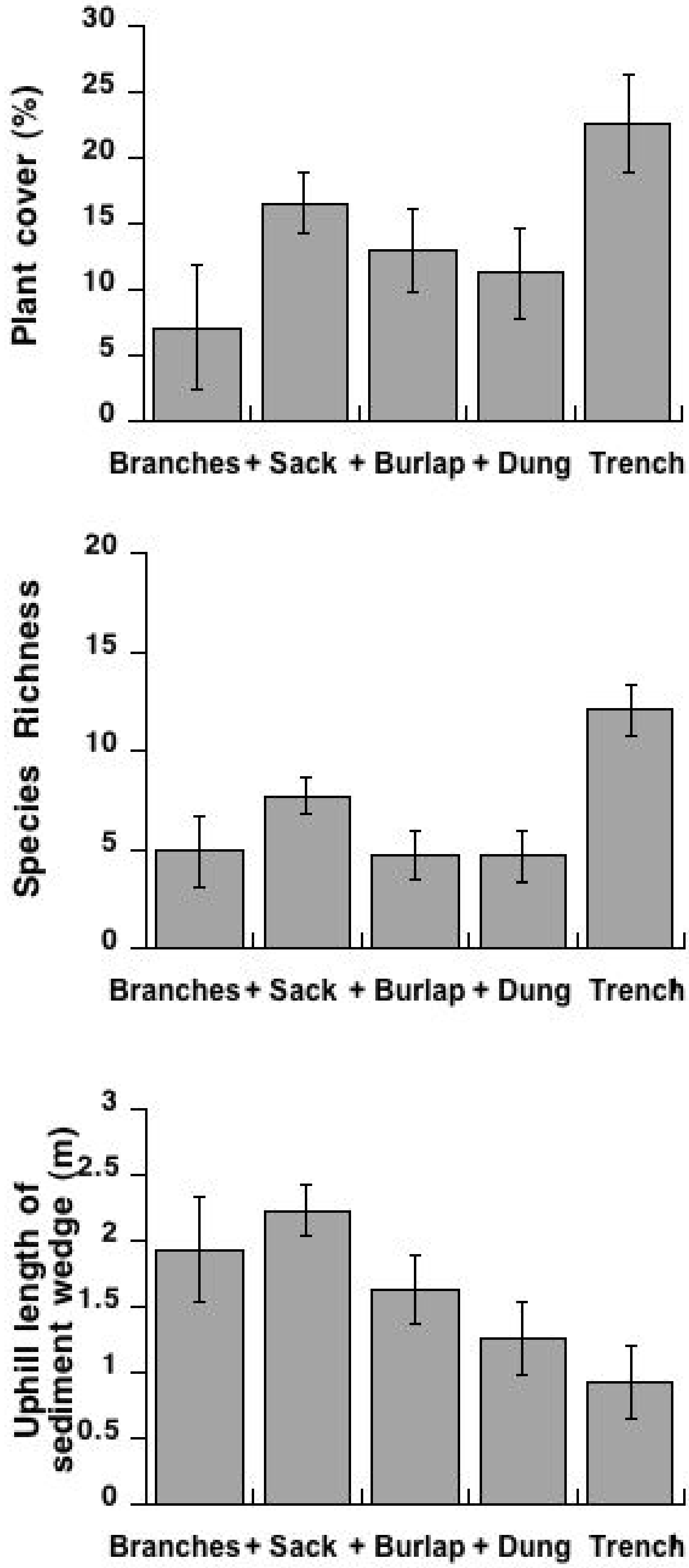

Figure 2: Plant cover, grass species richness and sediment location using various barrier methods.

Practical Implications

Our work illustrates that erosion and bare ground – so prevalent in rangelands in eastern Africa and around the globe – can be arrested and reversed using cheap, locally available materials and a small amount of labor. Barriers such as the ones we are testing can be extremely effective if positioned between existing patches of grass. We have seen that barriers can connect two patches of grass to create one larger patch. Larger patches of grass will be more persistent, more resilient to disturbances, and will provide ecosystem services, such as forage for livestock, more reliably than smaller patches.

These barriers took two people only 20 to 30 minutes each to install. They required no special tools or materials – only a *panga* (machete), digging tool, and, in the case of the plastic mesh sack barriers, some used sacks (Ksh 25, or approximately $0.33 per barrier). This ease of set-up suggests that these techniques could be used over a large scale by local communities. With only a small amount of effort employed incrementally and consistently, large amounts of currently barren land could be restored to grass.

We recently established a demonstration site to illustrate how our results could be scaled up in the landscape. A crew of 10 workers from a nearby community set up 2 to 3 kilometers of total barrier length in an area of approximately 10 hectares. We established trenches in flatter areas and mesh sack barriers in more steeply sloped areas.

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Increased grass cover is essential for food security, as the forage base for cattle and other livestock is currently missing in many community lands. Perhaps even more importantly, erosion urgently needs to be arrested in order to prevent further decreases in soil fertility and forage available to livestock. As barriers reduce erosion and promote grass establishment, the livestock food base will increase over time. Livestock health and milk production will improve, resulting in an increase in human well-being.

We are very excited by these results, as they demonstrate an extremely practical solution to a widespread problem.

Scaling up -- installing barriers over a large area (about 10 hectares) – a mix of plastic mesh sack barriers and trenches. (Photo by Corinna Riginos)

Further Reading

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A Cost-Effectiveness Framework for Landscape Rehabilitation and Carbon Sequestration in North Kenya (CARBON)

Co-Principal Investigators: Daniel Rubenstein and Corinna Riginos Princeton University

The CARBON project was initiated to: (1) Develop protocol for assessing current land health and site potential, (2) Determine risks of carbon loss and potential for recovery, (3) Quantify the potential of "bomas" for carbon sequestration and landscape rehabilitation, and (4) Test cost-effectiveness of rehabilitation at different sites.

Carbon sequestration through improved management of African rangelands has significant potential to contribute to climate change mitigation while simultaneously improving livelihoods among the rural poor. However, since most of Africa's rangelands are substantially degraded, increasing carbon sequestration will require urgent action to arrest and reverse this degradation. As yet there is little knowledge about where the costs of not arresting degradation, or where the opportunities for rehabilitating landscapes for greater carbon sequestration, forage production, and ecosystem functioning, are greatest. We have developed a process-based framework for deciding where to focus management and rehabilitation efforts in northern Kenya. We have acheived this by (1) developing participatory tools for assessing land health and potential for degradation; (2) using these tools to predict where rehabilitation interventions are most needed or most likely to succeed in increasing carbon sequestration, ecosystem functioning, and forage production; and (3) testing these predictions and the cost-effectiveness of the associated interventions. This work was carried out in northern Kenya building upon existing partnerships among the Mpala Research Centre, local NGOs, local pastoralist communities, USAID Kenya, and the University of Nairobi. With this project we have (1) strengthened local capacity and support it with scientific tools necessary to scale up rehabilitation efforts over a large region; and (2) provided training opportunities for young Kenyan rangeland scientists. Together, these activities will further the long-term goals of improving land management, increasing carbon sequestration, and improving pastoralist livelihoods in the Horn of Africa region.

The Adapting Livestock Systems to Climate Change Collaborative Research Support Program is dedicated to catalyzing and coordinating research that improves the livelihoods of livestock producers affected by climate change by reducing vulnerability and increasing adaptive capacity.

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