Costs of investing in ecosystem rehabilitation versus humanitarian aid: A case study of the Bale Eco-Region

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Summary

This study analysed the costs and benefits of investing in ecosystem rehabilitation, including the reduced costs of humanitarian aid, in selected sub-basins in the Bale Eco-Region (BER), Southeast Ethiopia. It also determined trends in extreme weather events between 1983 and 2013, and the impacts of catchment rehabilitation on hydrology. Results revealed a significant increase in average daily maximum and minimum temperatures. It was identified that there was a significant increase and decrease in the annual occurrence of warm extremes and cold extremes, respectively. It is estimated that well-targeted catchment rehabilitation could increase average water availability by about 17%, reduce surface runoff by about 13%, and reduce soil erosion by about 37% in the Genale-Dawa sub-basin, annually. When comparing the periods 1993-1997 and 2008-2012, the cost of humanitarian aid in drought-prone areas of the Genale-Dawa and Wabi-Shebelle sub-basins has increased 80 and 111 times, respectively; similarly, the costs of flood disaster response increased 81 and 165 times, respectively, in the two basins. Cost-benefit analysis indicates that every USD 1 spent on rehabilitation of the areas identified in the BER will yield at least USD 1.5 of on-site and off-site benefits over the next 20 years. About 61% of the benefits of rehabilitation of the catchment is estimated to accrue on-site while the remaining 39% will occur off-site. Reduced cost of humanitarian aid is estimated to constitute about 63% of the off-site benefits.

People using the Shebelle River in the arid lowlands for washing and water collection.

Background

The Bale Eco-Region (BER) hosts important biodiversity hot spots and provides ecosystem services such as the provision of food and timber, genetic resources, and provision and regulation of freshwater for millions of livelihoods in downstream areas. However, the provision of such ecosystem services has been impeded due to population pressure, unsustainable land use and climate change, among other pressures.

It is expected that Ethiopia will be severely affected by the impacts of climate change. While flooding of rivers and droughts are a natural phenomenon, this research was underpinned by the premise that, in future, there is likely to be increased frequency and intensity of flood events and periods of drought in downstream areas of the Genale-Dawa and Wabi-Shebelle basins, located in the Horn of Africa. It is not only climate change that affects hydrology. Flood events may become more frequent and more extreme, partly due to reduced water buffering capacity in the upper catchment as a result of changes in land use and land cover. The impacts of droughts may also become more severe due to the reduced resilience of communities. Drawing from evidence in Jijiga and Borena in Ethiopia, communities have become less resilient due to changing environmental and socioeconomic conditions, as well as disturbances and stresses that have reduced their adaptive capacity to deal with climate shocks (Bower et al. 2016).

Based on the hydrological characteristics of these two basins, this study provided empirical evidence of the relative costs and benefits of a variety of different resilience investment options. These options demonstrated how investment in sustainable land use and healthy ecosystems will generate more resilience impacts than short-term investments, e.g., responding to emergencies.

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Methodology

An in-depth review of published and unpublished literature was undertaken to establish a conceptual framework to obtain prior empirical evidence and to generate information/data to fill shortages encountered during data collection. Data and information were collected on the impact of extreme climate events and costs related to emergency response primarily from the National Risk and Disaster Prevention Commission (NRDPC). Some of the consulted grey literature included reports of various governmental and nongovernmental organisations working on ecosystem rehabilitation, and disaster response and prevention.

Streamflow data were collected from the Ministry of Water, Irrigation and Energy (MoWIE). Soil and farming system maps were extracted from previous studies. Information on the agroecology was obtained from databases administered by the Ministry of Agriculture.

Sources of weather data include observed data from weather stations and the climate forecast system reanalysis (CFSR) dataset provided by the National Centers for Environmental Prediction (NCEP) (Saha et al. 2010) for the period 1983-2013. The weather station data comprised daily rainfall, and maximum and minimum temperatures from seven locations across a range of elevations. Historical weather data were collected from the National Meteorology Agency', supplemented by data from global datasets.

The Soil and Water Assessment Tool (SWAT) was used to assess the spatial distribution of water resources and sediment yield from scenarios of different catchment conservation interventions. Modelled indicators included hydrological response, surface water and groundwater availability, and change in sediment yield in downstream areas.

View of the Shebelle River and water intake station in the arid lowlands.

Costs of catchment rehabilitation are considered as the total costs of construction and maintenance of conservation structures (soil bunds), and calculated based on values from Ethiopia as reported in literature, taking into consideration material and labour inputs and a 10% discount rate.

Benefits of catchment rehabilitation are on-site: reducing soil erosion, improving soil properties and crop yields, reducing runoff, carbon sequestration, and mitigating the impacts of drought and flood events. On-site benefits of catchment rehabilitation were calculated based on crop yield increment, increased availability of grass for livestock and sustainable harvest from woody biomass. Off-site benefits include reducing soil erosion and related sedimentation, as well as regulating runoff and reducing related costs to respond to flooding and drought events. These off-site benefits were calculated based on values found in literature.

Findings from the study

The findings from the study show changes in the indices of extreme temperature and precipitation that capture the essence of changes in duration, intensity and frequency of climate extremes at seven weather stations across the BER over the period 1983-2013. The results of the temperature-based indices analysis revealed that most stations show a significant increase in both the daily maximum and minimum temperatures.

Another important indication of a change in climate extremes is the evidence of increases in heavy precipitation events that lead to flooding, as recorded at most stations in the study area. A statistically significant increasing trend in the annual contribution of very wet days to the total annual precipitation was observed in the area. This indicates a relatively greater change in extreme precipitation events than in the total amount of rainfall. Changes in heavy rainfall events (R95p) indicate that extreme precipitation has increased significantly at rates of 17.0, 1.8 and 8.0 mm year^{-1} at Delo Mena, Dolo Odo and Filtu stations, respectively.

Results of the SWAT scenario analyses show that implementation of sustainable catchment rehabilitation measures could result in an average annual increase in water yield by about 17%, and a reduction in surface runoff and erosion by about 13 % and 37%, respectively, in the Genale-Dawa sub-basin. Results of the cost-benefit analysis show that, for every USD 1 spent in rehabilitation of the identified areas of the BER, there will be a financial gain of at least USD 1.5 in on-site

and off-site benefits. About 61% of the benefits of rehabilitation of the catchment accrue on-site (including increase in crop yield, increased availability of grass for livestock and sustainable harvest from woody biomass). The remaining 39% consists of off-site benefits in the form of reducing soil erosion and related sedimentation, as well as regulating runoff and reducing related costs to respond to flooding and drought events. Reduced costs of humanitarian aid constitute about 63% of the off-site benefits. Increased water availability and reduced livestock deaths are some of these off-site benefits. When we look at costs, of the investment in catchment rehabilitation, about 47% of the estimated costs consist of labour and material inputs, while the remaining 53% is maintenance cost, which consists mainly of labour costs. The off-site benefits of rehabilitation of the BER reaches part of Somalia and northern Kenya, although this study was not able to estimate and account for those benefits in its cost-benefit analysis due to data limitations.

Key findings

- Increasing and decreasing trends in the annual occurrence of warm extremes and cold extremes, respectively, during the period 1983-2013.
- Catchment rehabilitation measures could, on average, increase water availability by about 17% and reduce surface runoff and erosion by about 13% and 37%, respectively, in the Genale-Dawa sub-basin.
- For every USD 1 spent on rehabilitation of the identified areas of the Bale Eco-Region, there will be a financial gain of about UDS 1.5 in on-site and off-site benefits.
- Despite limitations, the findings are considered to be useful in providing important insights into the ways in which ecosystem rehabilitation has significant downstream benefits.

The study shows an increasing trend in the cost of humanitarian aid in the area between 1993 and 2012. During the 1990s, these costs were around a few million US dollars per year, while costs increased to more than USD 10 million during the period 2000-2005, followed by costs between USD 120 and 200 million up to 2012. While being outside the scope of this study, it is suggested that the rise in the cost of humanitarian aid could be largely due to population growth in the area (fertility rates around 5%), possible increases in the frequency and intensity of climate-related disasters, and growing per-unit cost of humanitarian aid delivery (from USD 39 in 2003 to USD 168 in 2008, and USD 183 per beneficiary in 2011 [Venton et al. 2012]). It was identified that drought-related climate extreme indices are associated positively and statistically significantly with the number of people affected in the drought-prone area of both Genale-Dawa and Wabi-Shebelle basins. Particularly, mean daily maximum temperature (R=0.67), warm spell duration indicator index (R=0.62), and the occurrence of warm days (R0.60) appear to be moderately and positively associated with the number of people affected by drought, while a strong negative association is observed between the number of people affected by drought and the occurrence of cold nights (R=0.74).

The study also found that maximum and minimum temperatures, and the annual occurrence of warm extremes are expected to increase by 2030. Catchment rehabilitation should be part of disaster management and adaptation strategies to reduce the vulnerability of communities to extreme weather events, particularly those living in the drought- and flood-prone areas of the Bale Eco-Region and further downstream. In this regard, sustainable land management activities such as forest landscape restoration, integrated land use, ecosystem adaptation and conservation agriculture could help address challenges posed by both land degradation and climate change.

Limitations of the study

This study was limited by the availability of data, particularly on the costs and benefits of rehabilitation of the Bale Eco-Region. For instance, the study was not able to include the monetary value of the on-site and off-site soil fertility improvement benefits from land rehabilitation. Other benefits such as on-site and off-site carbon sequestration, and biodiversity conservation could not be estimated due to data limitations. In the cost-benefit analysis, the impact of catchment rehabilitation in Somalia and northern Kenya could not be estimated. Conservative assumptions were made for estimating the off-site benefits of catchment rehabilitation, including their impact on reducing the cost of humanitarian aid downstream. This may have led to an underestimation of the total benefits of rehabilitation of the Bale Eco-Region. The cost of humanitarian aid is also based on ex-ante estimates of the number of beneficiaries for humanitarian requirement, and on data obtained from previous studies. The actual beneficiaries may exceed or be less than the estimated beneficiaries. Additionally, the analyses of climate extremes and SWAT modelling were based on CFSR weather data, which was used in the absence of high-quality observed weather data. Better results might be obtained using continuous measured data. Despite the limitations outlined here, the study is still considered relevant.

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About the SHARE Bale Eco-Region (BER) project

Conservation of Biodiversity and Ecosystem Functions and Improved Well-being of Highland and Lowland Communities within the Bale Eco-Region (BER) is one of the European Union (EU)-funded projects that stands for Supporting Horn of Africa Resilience (SHARE) initiative. In Ethiopia, the project covers 16 districts (*woredas*) in West Arsi and Bale zones of Oromia Regional State, around 22,000 km^2, with a population of about 3.3 million. The life span of the project is 42 months starting in July 2014 and ending in November 2017. Five partners are implementers of the project: Farm Africa; SOS Sahel Ethiopia; Frankfurt Zoological Society (FZS); International Water Management Institute (IWMI); and Population, Health and Environment (PHE) Ethiopia Consortium.

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