



Reflection on Sediment Retention and the Valuation Process

Lesson Learned from the Godino Watershed, Awash River Basin

*A policy brief adapted from MSc research project conducted by Ashenafi Dabesa
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Sediment Challenges and Impacts

While the upstream Ethiopian highlands are well known as water sources benefiting many East African countries, the impacts of flooding, excessive sediment transportation, and siltation originating from them are creating catastrophic problems, both in Ethiopia and many neighboring states—particularly Sudan—as the loss of organic matter and nutrients adversely affects crop yields.

Ethiopia loses an estimated 7.8 billion tons of soil per year to erosion caused by poor land management and flooding problems (Hawando 1997, 162–63). According to Ahmed and Ismael (2008), the Roseires Dam in Sudan generates only a fraction of its hydropower potential during the rainy season because of low head and frequent blockage of the turbine intakes caused by Nile sediment debris.

Ethiopia and many of the basin countries do

not have a clear national policy promoting sediment retention and valuation of the services of the watersheds.

Watershed is an area of land where all ecosystems are inextricably linked together, and an area from which water, sediment, and dissolved materials drain to their common water course. It is also a natural boundary useful for modeling and regulatory purposes. Effective ways of watershed management include conservation of soil and water to protect the ecosystems from degradation. Ecosystem services can be defined as the conditions, processes, and components of the natural environment that provide both tangible and intangible benefits for sustaining and fulfilling human life (Daily 1997).

The main purpose of the research described here to value the sediment retention services of the Godino watershed area was to assess the benefit of ecosystem services requiring non-technical contribution from a number of stakeholders. Although this policy brief was

envisioned primarily as an aid to students developing policy and research application skills, it and other non-technical briefs may also be useful to key stakeholders and policy advocates and for distribution to other partner institutions. Its key target audience comprises Ethiopia's surface water, wetlands, and forest management policymakers (specifically Ministry of Water Irrigation and Energy, and other local and international development institutions).

The research summarized here involved a three-step process:

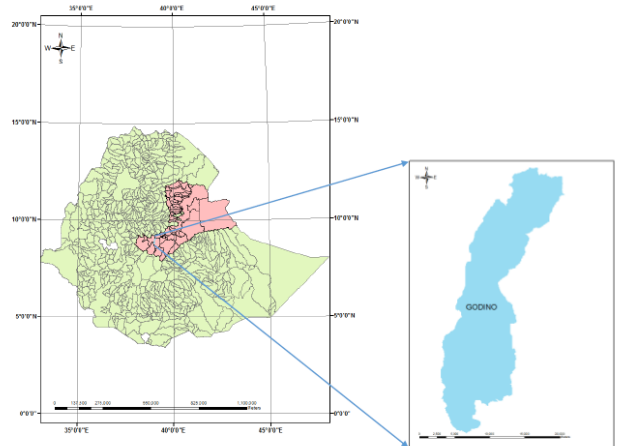
- Estimating and mapping the sediment retention capacity of each sub-watershed in the study area
- Estimating the avoided reservoir loss resulting from sedimentation
- Developing and applying an appropriate valuation technique to calculate the sediment retention value of the watershed

The lesson learned from this research can play a paramount role in alleviating sedimentation problems in many river basins of the country, in particular the Nile river basin, where sedimentation and siltation are the main problems.

The Case Study Area

The Godino watershed, located in the upper Awash River basin identified for the pilot study, has two cascade dams called

Wadecha and Belbela. The Cuban civil mission, in collaboration with the Water Resources Development Authority (WRDA) of Ethiopia, constructed these storage dams in 1980. Their main purpose was to irrigate about 1,600 hectares of land area, to be used by state farms (Oromia Irrigation Development Authority Central Branch, Adama, 1998).



Study area: Godino watershed and Awash River basin

The demand for water in the watershed is increasing at an alarming rate due to exponential growth in population and the number of private business farms, with the following results:

- The distribution and availability of water for food production, domestic purposes, and livestock consumption have become a great problem in this area.
- Deforestation and the cutting of bush trees have become common practice in the region, with protected grazing lands, forests, and bush lands being converted to agricultural lands (Wakena 2006).
- Poor management and competition over water distribution and utilization for

irrigation during dry and wet seasons have led to the escalation of conflicts between upstream and downstream communities.

Altogether, improper utilization and management of the Godino watershed have increased sedimentation problems and reduced the storage capacity of the Wadecha and Belbela reservoirs, to the detriment of the people in the region. Unless decision makers and concerned stakeholders take immediate remedial action, the livelihood of communities and irrigation workers whose lives entirely depend upon the reservoirs will suffer catastrophic impacts.

Why Value Ecosystems?

According to the Millennium Ecosystem Assessment (MEA), an integrated ecosystem assessment established with the involvement of governments, the private sector, nongovernmental organizations, and scientists, “Over the past 50 years, humans have changed . . . ecosystems more rapidly and extensively than in any comparable period of time in human history” (MEA 2005, 1). The MEA research shows that 60 percent of the world ecosystem services are in decline (WRI 2001; MEA 2005), and the greatest disturbance or imbalance in their structure and functions has been the result of human–environment interaction.

Through a comprehensive consideration of the integration of various factors, the

MEA presented a valuable framework for defining and analyzing the linkages and interdependencies between natural and human systems and understanding the connections between ecosystem services and human well-being (MEA 2003). The framework distinguishes four categories of ecosystem services: supporting services, provisioning services, regulating services, and cultural services (MEA 2003). Analysis of the social-ecological system it represents requires information drawn from a broad range of natural and social sciences (Carpenter et al. 2009).

The provision of ecosystem services depends on biophysical conditions and is affected by changes over space and time, including anthropogenic changes in land cover, land use, and climate. The spatial pattern of land cover change can be directly linked with a large region’s human activity (Riitters et al. 2000). Decision makers—for example, land managers—can use the mapping of ecosystem services provided by a watershed as a powerful tool to support landscape sustainability assessments. Unfortunately, the available information applicable to local-level decision-making purposes is inadequate (Turner and Daily 1997).

The explicit quantification and mapping of ecosystem services, then, is considered a main requirement for incorporating the ecosystem services concept into the decision making of environmental institutions (Daily 1997; Matson 2008).

Why Sediment Retention and Valuation?

Over half of the world ecosystem services, particularly of wetland ecosystems, whose valuable functions include controlling flooding, trapping nutrient-rich sediments, and providing habitat for rare species and aquatic vegetation, are degrading and on the verge of disappearance. Apparently, the main driver of this decline is anthropogenic activities causing severe land and water resource degradation. Regrettably, measures taken to combat the problems have been limited.

Considerable effort in this study has gone toward estimating the sediment retention potential of the Godino watershed using spatially explicit modeling software and valuating its benefit with appropriate economic measures. It estimates the single sub-watershed loss in the Godino watershed at 427,076 tons of soil per hectare of land per year. The total amount of sediment retained each year is about 1,386,287 tons. Adapting the current market value of irrigation water produces, an estimate of 52,463 Birr (2,623 USD) per year of the value of sediment retention services of the watershed.

This finding supports a focus by decision makers and different stakeholders on watershed sediment protection, erosion control, and the creation of better economic opportunities in watershed management.

What are the benefits?

The results of this study are a good source of decision-making information for stakeholders

taking action to reduce erosion and sedimentation problems. The study approached the problems according to four principles centering on sediment retention location, management practices, stakeholder participation, and the financial situation of the watershed, as follows:

- *Location:* Much emphasis on the protection of areas that retain the most sediment and pollute the least
- *Management:* Identification and design of adaptive management practices that maximize retention capacity
- *Stakeholders:* Engagement of stakeholders residing in places where day-to-day socioeconomic activities conflict with existing erosion control practices
- *Finance:* Development of a cost reduction strategic conservation plan to reduce the damages and costs associated with sedimentation, land, water and reservoir management
- A policy approach focusing on the reduction of sediment problems will provide great benefits by increasing agricultural productivity, lowering the risk of structural failure, improving water quality, reducing maintenance costs, and creating socioeconomic opportunity for the community.

Critique of Policy Options

The national water resources management policy (1999) and environmental policy (1997) highlighted the development and improvement of the environment, watershed management, and water resources protection and the conservation of natural resources. Neither policy, however, clearly addressed the major cross-cutting issues related to sediment retention and valuation processes.

In formulating policy, decision makers have not adequately addressed questions of shared responsibilities, collaborative approaches, involvement of local communities in integrated watershed management activities, surface water management, wetland protection, forest management, ecosystem valuation, or matters related to water and ecosystem security.

Policy on soil retention will provide greater benefits if all decision makers and stakeholders start to promote appropriate and cooperative management practices related to reducing surface runoff and increasing soil retention efficiency by constructing terraces on the steeper cultivated parts of the watershed,, engaging in contour farming in other cultivated areas, selecting cropping systems that result in maximum soil retention, adopting the minimum tillage possible, and so on. Particularly important is paying all due attention to appropriate watershed development and soil and water conservation practices for the steeper parts of the watershed, where the sediment yield is higher.

This emerging research area represents a step forward in assessing the value and developing the regulation of ecosystem services. Most important, the research has identified areas that contribute to high erosion, providing concerned stakeholders with a sense of where more effort is needed.

What are the Emerging Policy Issues?

Land degradation is a major problem in Ethiopia. Poor land use practices, deforestation, and improper management of natural resources play a significant role in causing high erosion rates, sediment transportation, and loss of agricultural nutrients. Awareness of shared responsibility in and capacity for establishing coordinated links among water, wetlands, ecosystems, and afforestation is inadequate.

To address the non-technical issue of sediment retention and the valuation process in Ethiopia, due attention must be paid to studying and responding to the key drivers of ecosystem protection, sediment retention, and the sustainable development of water resources. Some of these include the need for an efficient system of wetland protection, for watershed management, for forest management, for surface water management, and for water security.

The following four key policy issues related to improving sediment retention and valuation processes emerge from this study:

Policy Issue 1: Wetland Protection and Watershed Management

Wetlands play a critical role in improving sediment retention efficiency, mainly by regulating water quality and quantity. Wetlands contribute naturally to pollution and flood control, trapping sediment, and stabilizing shorelines. As many wetlands are converted to agricultural lands in Ethiopia, wetland management and protection are urgently

needed. Presently, this area receives inadequate attention from the government, nongovernmental organizations, the private sector, investors, and the beneficiary communities working at multiple levels.

Vibrant wetland and watershed management policy that will contribute to the sustainable development of natural resources and improve the socioeconomic growth of the society is vital.

Policy Issue 2: Afforestation and Forest Management

Vegetation does not only keep sediment from eroding where it grows; it also traps sediment that has eroded upstream.

The national water and environmental policies and the 2007 Forest Development and Conservation Proclamation inadequately address the issue of sediment retention and valuation and the importance of collaborative and integrated approaches.

To enhance the process of retaining sediment through the use of vegetation, a better national afforestation and forest management policy that takes a coordinated approach and recognizes the shared responsibilities of each stakeholder is vital.

Policy Issue 3: Surface Water Management

Establishing systems that reduce surface water runoff helps control the movement

of sediment and nutrients and the transportation of pollutants in the watershed.

Surface water management and development policy issues are not sufficiently addressed in the existing national water resources management policy.

Policy Issue 4: Water and Ecosystem Security

Efficient water security policies, plans, and practices will preserve ecosystem protection, provide sustainable solutions to security problems, establish better decision support systems (DSSs), and improve the national capacity of water and ecosystem governance.

To reduce the damages and costs associated with sedimentation, land, water, and reservoir, managers require DSS information regarding the extent to which different parts of a landscape contribute to sediment retention and how land use changes may affect this retention. Environmental protection, productive ecosystems, attainment of water information, and capacity building will be successfully achieved through efficient water institutions and a water policy that addresses sustainable water and ecosystem security issues.

Water and ecosystem security currently receive little or no attention from the government or concerned stakeholders. No agency in the country deals with water security issues.

Formation of a water and ecosystem security policy, establishment of institutions capable of managing a dynamic databases containing

water, land, natural resources, and DSSs information, and the establishment of an information monitoring system to keep the system up to date, transparent, and fully functional are vital.

The above four policy issues require immediate attention to bring about sustainable development of water resources, reduce the challenges facing our ecosystems in general, and, in particular, improve the sediment retention and valuation capacity of Ethiopia.

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