Policy Brief No.98

The cost of soil erosion in sub-Saharan Africa: Insights for policy

Executive Summary

- Soil erosion is an urgent environmental concern. Nearly 494 million hectares in sub-Saharan Africa (SSA) are experiencing some form of land degradation. Of these, about 227.4 million hectares (i.e., 46%) are affected by water erosion, wind erosion (186.5 million; 38%), loss of nutrients via chemical degradation (12 %), and physical deterioration (4%).
- With losses of about **50 kg** of nitrogen (N), phosphorus (P), and potassium (K) per hectare per year, and 50–66% of yield – costing SSA approximately USD 68 billion annually – soil erosion impacts the socio-economic wellbeing of millions of households across SSA.
- Regenerating degraded soils and building soil health is critical for sustainable food systems transformation. Across Africa, agriculture needs to aim for zero erosion and runoffs by embracing complementary soil management practices (e.g., combined conservation agriculture and integrated soil fertility management -ISFM), and structural measures (e.g., contour farming, terracing, and zai pits).
- Policy efforts should focus on provisioning incentives for long-term sustainable management efforts against soil erosion through complementary soil management interventions and supporting farmers and other stakeholders with enabling conditions for implementing appropriate agriculture practice bundles (see section on Policy Intervention Areas).

Introduction

Soil erosion is a pressing environmental challenge calling for urgent attention. It contributes to declining agricultural productivity, loss of biodiversity, and damage to infrastructure, among other impacts. Soil erosion has a high economic cost, extending beyond topsoil loss and reduced crop productivity, to impairing infrastructure such as dams, and compromising the wellbeing of governments and millions of households. Regenerating degraded soils is critical for effective fertilizer use and/or sustainable food systems transformation. The 2006 Abuja Declaration aimed at increasing fertilizer use in Africa to improve agricultural productivity. Since the Declaration, only five countries (Egypt, Ethiopia, Morocco, Seychelles, and Tunisia) have achieved the 2015 target of increasing fertilizer use to at least 50 kg per hectare; 13 member states recorded some progress towards meeting the target benchmark, while 33 member states are still using less than 25 kg fertilizer per hectare. Concurrently, SSA loses an equivalent of 50 kg of nutrients per hectare annually due to soil erosion and poor agricultural practices, according to the Economics of Land Degradation report (ELD, 2015) and Soil Fertility Management in SSA report by Masso et al. (2015), nulling efforts to boost fertilizer use.

The 2024 Nairobi Declaration from the Africa Fertilizer and Soil Health Summit (AFSH) affirms that using fertilizers (both mineral and organic) can boost the productivity of Africa's soils and their agricultural yields. As a result, countries have committed to triple fertilizer use, reverse land degradation, and restore soil health on at least 30% of degraded soils by 2034. The Nairobi Declaration aligns with many calls to address soil erosion. These include: (i) The African Union's (AU) Agenda 2063's (afdb.org) goals of sustainable agricultural practices and enhancing agricultural productivity; (ii) FARA's[1] agenda of using scientific innovations to address soil erosion and improve soil health; and (iii) ASARECA's[2] objectives of promoting practices that combat land degradation and enhance soil fertility. However, the AFSH Nairobi Declaration target on fertilizer and soil health may not be achieved if soil erosion is not effectively addressed. This brief highlights the costs of soil erosion and recommends implementing complementary interventions to address the problem and restore soil health.

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Magnitude of soil erosion in sub-Saharan Africa

Soil erosion threatens SSA's already-constrained cultivated land, stifling associated benefits, compromising food security and hindering achieving sustainable development. Soil degradation is widespread in SSA, with about 46% (227.4 million hectares) impacted by water erosion, 38% (186.5 million hectares) by wind erosion, 12% by chemical degradation, and 4% by physical deterioration. Around 2007, the annual cost of land degradation in SSA was USD 58 billion, equivalent to 7% of the region's gross domestic product (GDP). Zingore et al. (2015) reported the annual loss at USD 68 billion, exceeding the annual budgets allocated to addressing erosion challenges.

The cost of erosion on soil nutrients

Soil erosion depletes soils of essential plant macro-, secondary, and micro-nutrients. For example, the cultivated areas in East Africa lose an estimated 36 kg N, 5 kg P, and 25 kg K per hectare every year. Similarly, estimates from 38 countries in SSA indicated annual losses of 22 kg N, 3 kg P and 15 kg K per hectare per country (Eswaran, 2001). Projecting these losses to the 165 million hectares of the cultivated land in SSA amounts to annual losses of about 3.6, 0.4, and 2.4 million tons of N, P and K, respectively. Across Africa, approximately 5.1 million tons of N, 0.7 million tons of P, and 3.5 million tons of K are lost each year from cultivated lands. Restoring these nutrients through fertilizers potentially costs the continent over USD 4 billion in annual investment – a huge financial cost.

1 Forum for Agricultural Research in Africa
2 Association for Strengthening Agricultural Research in Eastern and Central Africa

Annual carbon emissions associated with fertiliser production, transportation and application

From global reviews, the carbon emission factors for fertiliser manufacture, transportation and storage range from 4.8–10.5 for N, 0.73–1.5 for P and 0.2–0.25 for K; all as kg CO_2-equivalent (CO_2-eq) per kg of nutrient. Data for farm operations estimate carbon emission factors from spraying/spreading fertilisers at 5-7.6 kg CO_2-eq per hectare. Using these estimates, annual emissions from fertilizers in SSA amount to 28.2–59.2 million tons of CO_2-eq (i.e., 24.3–53.6 from N, 0.51–1.05 from P, 0.7–0.88 from K, and 2.48–3.77 from the spreading/spraying of fertilizers) are associated with the loss of 9.3 million tons of NPK due to erosion on cultivated lands in SSA. Implementing effective soil conservation measures to prevent these erosion-associated losses could reduce the need for synthetic fertilizers, potentially cutting these annual emissions.

The effect of soil erosion on soil organic matter

Soil organic matter (SOM) is an important component of soils because of its ability for nutrient holding and cycling, water retention, and supporting soil biodiversity. Soil erosion significantly reduces organic matter by stripping away the topsoil, which can contain up to five times more organic matter than the subsoil that remains. In general, a loss of 1 mm of topsoil per hectare equates to a loss of about 14 tons of soil, including nutrients and organic matter (Saving Soil), and Araya et al (2011) observed an even higher annual loss of 24.2 tons of soil per hectare under conventional tillage systems. Erosion is up to four-times higher in conventional tillage systems, where residues are removed after crop harvest, than conservation tillage systems where residues are retained (Araya et al., 2011). The reduced loss under conservation agriculture practices underscores the need for integrated approaches for complementarity. SOM contains about 50% carbon. With such soil losses and assuming average SOC content of 1.84%, about 445 kg ha^{-1} of SOC may be lost annually in conventional tillage practices, compared to 95.68 kg ha^{-1} under conservation tillage. As SOM is associated with the availability of other nutrients, the magnitude of losses under conventional versus conservation tillage practices show how important conservation tillage practices may be in terms of preventing losses.

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The cost of soil erosion on crop yields, nutrition security, and soil water retention

Yields from crops grown in eroded soils are typically 9–34% lower than those from crops grown in soils with conservation structures. For instance, in Ethiopia, fields without soil and water conservation structures, such as soil and stone bunds, experienced yield reductions of up to 1.7 and 1.09 t ha^{-1} for wheat and teff respectively, compared to those with conservation structures.

Besides yield reductions, leaching via soil erosion causes nutrient imbalances that compromise crop produce's nutritional quality, potentially causing hidden hunger that affects more than 2 billion people globally. Soil erosion can also reduce water infiltration by up to 93%.

Practices that increase SOC and nutrient availability favorably influence crop nutrition, improving grain zinc and iron concentrations, among other nutrients. Soil conservation measures also improve water retention by up to 29.2–35.9% compared to systems without conservation. Although soil conservation practices demand extra costs on labor and other farmer inputs, they are associated with positive benefits. In Ethiopia, the benefit-cost ratio on yields of cereal crops grown under stone bunds and soil bunds as soil conservation measures were 1.11 and 1.51 (for teff) and 0.98 and 1.06 (for wheat), respectively, as opposed to 0.93 (for teff) and 0.73 (wheat) where there were no soil water conservation measures.

Key take away messages

Soil erosion manifests from plot/farm level to landscape level. Evidence shows that the cost of soil erosion is much higher than the investment needed to prevent it. Failure to address soil erosion can cause huge losses, significantly reducing soil and crop productivity. Assessment of erosion hotspots is needed to guide and inform appropriate intervention measures. Tailored strategies are needed to address soil erosion and soil health. Some of these strategies involve establishing terraces, practicing conservation agriculture, retaining organic residues, and using ISFM including applications of fertilizers and choice of crops. Our preferred method is to implement these practices through an integrated and systems-oriented approach because of the complementary synergies that can be realized. Moreover, people-centered restoration efforts are more likely to succeed by embracing integrated, multistakeholder co-design approaches across sectors to include farmers, researchers, and policy actors. These will more effectively address conservation- and/or restoration-related policies within local, regional, and/or national sustainable development plans that advocate for adoption of sustainable land management practices.

Policy intervention areas

Soil erosion is a problem that extends beyond the plot/farm level and should therefore be managed at the landscape level and beyond. The following are recommendations for sustainable land management to inform policy geared towards addressing the threat.

i. Focusing on integrating complimentary measures that seek to reduce or eliminate soil erosion together with those that seek to reverse the trends on already degraded lands to enhance synergies. Such approaches may entail agroforestry, input management, erosion control measures, and water and biodiversity conservation measures.

ii. Building on incentives for long-term restoration/conservation efforts: These should provide incentives such as carbon credits, payments for ecosystem services, grants, subsidies, and supportive legal/institutional frameworks, among others, geared towards strengthening restoration efforts.

iii. Embracing evidence-based restoration efforts: These may involve regular monitoring of the restoration measures employed, involving assessment of SOM, soil loss rate, biodiversity loss, nutrient loss, and soil structure and stability, among others.

iv. Building stronger partnerships, coalitions, and campaigns against soil erosion: These should foster promoting sustainable land management practices, increasing public awareness on the integrative complimentary measures to, and the need to, address soil erosion.

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