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Qualitative assessment of the impact of soil erosion on the water resources in Uganda

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Abstract

The present water resources situation in Uganda with respect to sediment loads and siltation and in relation to land use practices, is virtually unknown due to lack of quantitative data. Information on the detrimental impact of soil erosion on water bodies is qualitative. Our experience during a study tour of a number of districts in the southern part of the country suggested that this information often was an overstatement of the extent of soil erosion as well as its impact, representing people's perceptions of these problems. The study area was divided into regions of very high to low erosion potential based on the scoring of physical characteristics and land management practices. This can only serve as precursor to generating quantitative data through appropriate assessment methods in order to determine the extent and causes of soil erosion and its impact on the water resources.

Key words: Erosion potential, soil fertility, sedimentation

Introduction

The water available in various water bodies (streams/ rivers, ground water reservoirs, lakes, swamps, etc) originates largely from rainfall via the soil surface on which a particular land use is practised. A given land use system will determine amount, quality, time and velocity of the runoff that enters a water body. Thus, water management is necessary linked to land management. In Uganda where smallhold farming is dominant, poor agricultural practices, such as cultivation on steep slopes and overgrazing, may lead to increased surface runoff and consequently, soil erosion.

The resultant negative effects on the water resources would include: a) transportation of soil/sediment to water bodies, resulting in technical problems in water processing and electricity generating plants, as well as irrigation schemes; b) transfer of nutrients and chemicals, leading to pollution and eutrophication; c) poor soil structure and decreased infiltration rates, resulting in reduced ground water re-change and lowered flow during dry seasons; and d) increasing peak flow during wet seasons.

The effects of soil erosion in Uganda have been widely reported, primarily in relation to the negative effects on soil fertility (Hamilton 1984; Fendru, 1986; Tumuhairwe, 1986; Zake 1992; Bagoora, 1988; Tukahirwa 1992). This study was conducted in five districts to assess the existence and extent of transportation of soil and sediment on the water resources, and as influenced by different land-use practices.

Methodology

Five districts previously reported to experience severe erosion, namely Kabale, Kasese, Mbarara, Mbale and Kapchorwa, constituted the study sites. Additional observations were recorded along the routes leading to the study districts including Tororo, Iganga, Mukono, Mpigi, Masaka, Ntungamo and Bushenyi. The study was conducted in the rainy season, during March, 1994 and the routes followed are outlined in Figure 1.

During the study, discussions were held with district officials responsible for water, agriculture, forestry, health and veterinary services. These officials served as resource persons, guiding us to areas of potential and actual erosion impacts in the field. In addition, they acted as interpreters during discussions with the local people.

The discussions were aimed at obtaining some insight on the people's perceptions on the problems of water resource use and their working relationships with the relevant officials.

The assessment of soil impact on water resources was based on physical characteristics, namely topography, landuse (subdivided into proportion of area cultivated, livestock density and vegetation cover), observed erosion indicators (gulleys, rills, siltation) and population density. These were given weightings of 4,3,2 and 1 respectively, being the order of severity of impact. In addition, each characteristic was given a scale of 4 through 1, where 4 represented the most severe status. The overall ranking of the region was based on the sum of the product of the indices. Severity of erosion and its impact on water resources was classified as very high when the score was between 36-40, high between 30-35, medium between 25-29, low between 20-24 and very low when less than 20.

Results

Using information gained during the study, the areas visited were scored and ranked as given in Table 1. The areas were classified into regions that appeared homogenous in susceptibility to soil erosion and consequent impact on the water resources (Figure 1), and are described below.

South-western mountainous region. This region covers Kabale, Kisoro and part of Rukungiri districts. The districts are similar in terms of physical features and land use practices such that the data obtained from Kabale district is applicable to the whole region.

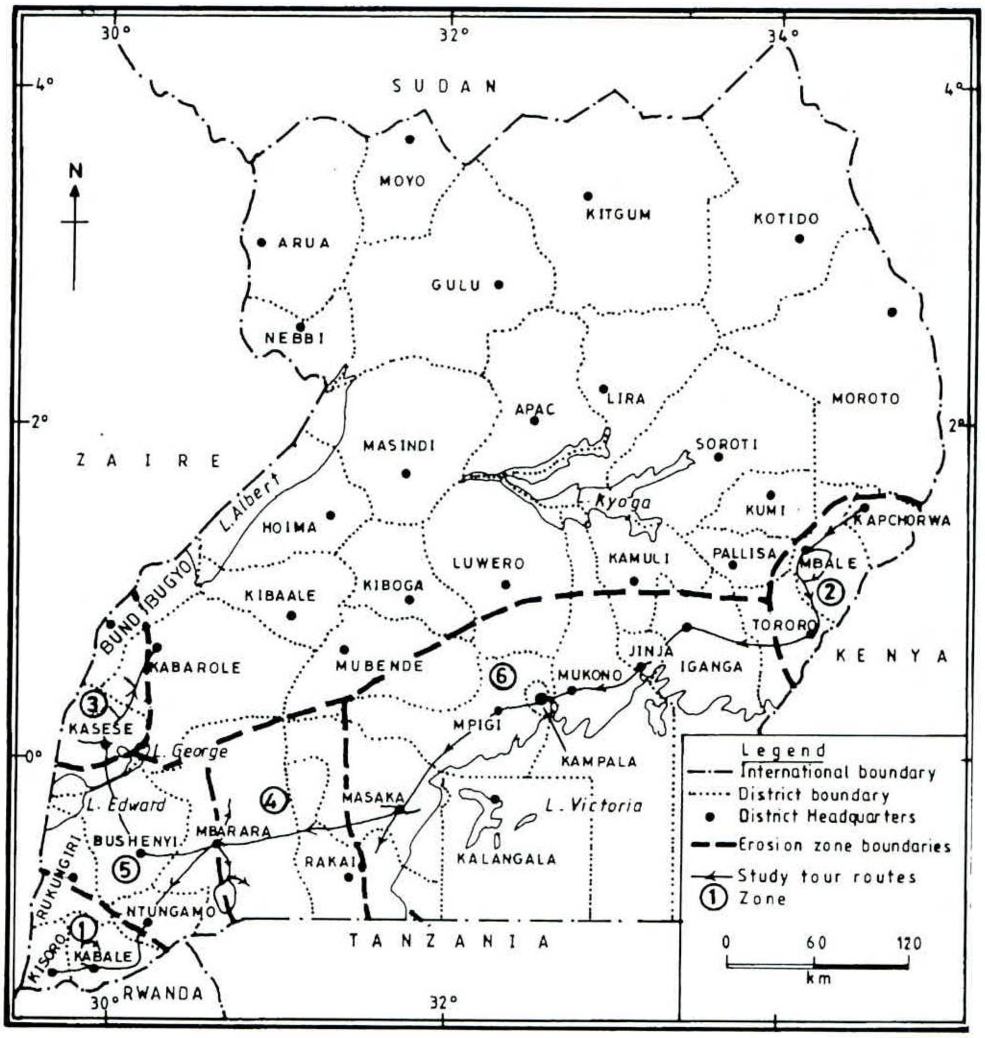

Figure 1. Map of Uganda showing the routes followed and districts visited during the study

Table 1. Scores and ranking of the study areas during the assessment of soil erosion impact on water resources

Study area	Topo-graphy	Land use	Erosion indicator	Popu-lation	Score	Impact
Kabale	4*4	3*4	2*4	1*4	40	V.high
Mbale/ Kapchorwa	4*4	3*3	2*2	1*4	33	high
Kasese/ Kabarole	4*4	3*2	2*3	1*3	31	high
Mbarara	4*2.5	3*4	2*2	1*2	28	medium
Bushenyi/ Ntungamo	4*2	3*2	2*2	1*3	21	low
L.Victoria Crescent	4*2	3*2	2*2	1*4	22	low

The terrain is dominated by flat topped ridges with slopes as steep as 10-40% in the upper parts and declining to 5-10% in the lower parts. About 50% of the area is too steep to be cultivated without risking serious accelerated erosion. However due to the high population pressure (250-300 persons km^{-2} up to 800 persons km^{-2} in some acres), virtually all available land is cultivated. Cultivation of annual crops is dominant and is continuous throughout the year leaving the soil bare at the onset of the rainy seasons.

Terracing which was established in 1945, has been neglected. The existing structures are left without vegetation and are, therefore, unstable and ineffective. Some are being removed in order to expand the arable acreage. Livestock movements in search of grass and crop residues, as well as burning of crop residues further aggravate the problem.

In consonance with the above, sheet erosion was observed almost all over the areas visited, and rill erosion was prevalent on the steep slope around Lake Bunyonyi and in Rwamucucu, Kitumba, Muko and Maziba sub-counties. Gulleys existed in valleys between the spurs, caused by the accumulation of huge amounts of water, and water moving though them during heavy storms. The impact of these on water resources was largely siltation and increased turbidity of water bodies. In Rwamucucu, the impact were full of deposited silt, gravel and stones.

Silting of the water tanks at the gravity scheme at Kiyoora and at the hydro-power station at Maziba was apparent. As a result, turbines at Maziba are cleaned after every third month to minimize wear. The gravity scheme is shut off during storms to reduce pollution of the town's water supply.

Despite the severe erosion, most of the rural spring water supply was not affected. The springs said to be affected by erosion had been constructed in technically unsuitable areas. However, continuous erosion may, in the long run, affect spring water resources through reduced infiltrability due to deterioration soil structures.

Mountain Elgon region. This region too, has a high population density (280 persons km^{-2} in Mbale), leading to the cultivation of nearly all the area despite the steep slopes. Unlike in Kabale, the predominant perennial crops offer a good ground cover. The soils have relatively high water infiltration capacity and, therefore, low erodibility (run-off coefficients vary between 24 and 43%). Livestock are zero-grazed.

Rivers originating from Mt Elgon carry high sediment loads, especially during the rainy season, causing severe technical problems down stream. At the water purification stations on River Manafwa (serving Mbale town) and river Malaba (serving Tororo town), silt of up to 1 m^3 is removed daily from the intake structures. At the Doho Rice Scheme, the main canal and the intake structures are desilted every third week. Silting was mainly due to the collapse of the upstream river banks and soil wash resulting from cultivation on the river banks. However, lack of soil and water conservation measures and the continued cultivation on the steep slopes is likely to lead to accelerated erosion. Spring water sources in the mountains were not visibly affected by erosion.

The Rwenzori region. Though there is cultivation on very steep slopes of Kasese district, it is not as extensive as in Kabale and Mbale, owing to lower population density. Like in the Mt Elgon area, few soil and water conservation measures (terraces, tie-ridges) have been erected. Furthermore, bushfires and burning of crop residues (even within banana plantations) are practised prior to the onset of the rains, thereby leaving the soils bare.

Sheet and rill erosion were the most common, with gullies forming where huge amounts of water collect. During the heavy rains in April and May, the gravity scheme serving Kasese and Kilembe is heavily silted; many parts of Kasese and Kilembe are flooded, leaving huge amounts of silt when the water subsides. Silting was evident in the valleys along the Kasese to Fort Portal road. The district officials reported that the erosion hazard is relatively more serious on the slopes draining into Semiliki river (Bundibugyo District) where the population density is higher and cultivation is more intense.

The South-western pastoral region. This region receives low rainfall but it is overstocked and overgrazed leading to poor vegetation cover especially towards the end of the dry season. In the same period, there is bush burning, leaving the ground exposed to surface runoff. Thus, sheet erosion is common although some gullies were observed in the V-shaped geologic-erosional valleys that run down between spurs of side ridges. Valley dams and tanks are the water sources in the dry, but topographically gently undulating areas. The poor condition of these structures was due to their poor maintenance. In one case, the construction of the valley tank was technically inappropriate with no observed inflow. The region has very few springs, and the surface water is the source for bulk domestic consumption. There, erosion impact on the quality of water should be of serious concern.

The south-western highlands. This region is undulating to hilly, and is covered mainly with perennial crops, especially bananas. High rain permits good plant cover all year round. Relatively high numbers of livestock are grazed in the lowland. Thus, soil erosion is less severe but, due to differences in topography, soil loss might be considerable on some of the localised steep slopes.

The Lake Victoria crescent. This region is densely populated and most of the area is cultivated. However, the area is dominated by perennial crops with good ground cover, which protects the soil from rain drop impact as well as enhancing infiltration. Thus, erosion is also moderate. A considerable portion of the area is covered by swamps which act as filters and reduce sediment pollution of the water bodies.

Discussion

In the present study, we have qualitatively presented an assessment of the extent of soil erosion in the southern part of Uganda based on observed physical characteristics of the land and their interaction with the land management practices. The actual impact of soil erosion on the water resources can only be estimated when quantitative data on soil erosion are available. Research to obtain such data has been initiated mainly in academic institutions using soil erosion plots. These are suitable for local relative comparisons of various conservation measures and their effectiveness in controlling erosion. Preliminary data (Nakileza, 1992; C.Arnold, pers. commun.) suggest that erosion in the mountainous areas may not be as severe as suggested by qualitative reports. The threshold for erosion in the Mt Elgon region was as high as 20 mm of rainfall, because it was very gentle and falling on the granular structured soils. Our rating of the study area, therefore, can only serve as a basis for identifying likely research stations from where generated data would have an impact on farmer and official decision making in effectively conserving soil and water in specific regions.

It was apparent from the discussions with the district officials and the farmers that, in addition to physical data, the socio-economic aspects are also important in any soil and water resources management strategies. A comprehensive analysis of these is given by Tukahirwa (1992). Smallholder farmers can take up integrated soil and water management if they can benefit, for example, through improved crop yields or, in case of steep slopes, alternative settlement are available. Farmers were aware of these. Terrace structures were being cultivated because they were fertile and produced better yields. Encroachment on steep slopes was due to lack of alternative cultivation areas. Financial and logical support will be needed to implement appropriate soil and water management programmes.

The integration of the physical and socio-economic data is a multi-disciplinary effort. We noted poor cross-sectoral collaboration and lack of awareness among the officers of different disciplines of soil conservation measures and the negative effects of soil erosion on water resources. The messages passed on to the farmers were sometimes contradictory as a result of skewed training in relation to the subject. Proper management of water resources needs to be coordinated with land management planning, perhaps through committees of technical staff from the relevant disciplines.

Soil erosion features were observed during this study but with limited attempts at controlling the erosion. The implication is that there are consequent negative impacts on the water resources, the most notable being siltation. To estimate the magnitude of the impact requires that quantitative data be generated. Until then, however, a multi-discipline effort should be initiated to implement soil and water conservation strategies based on the available information.

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