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# Erosion and sedimentation: The case of Mwembeshi stream in Chilanga District, Zambia.

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***Abstract***
*This study aimed to provide knowledge on the causes of erosion and its effect along the Mwembeshi stream a major tributary to Kafue River in Zambia. The study utilized the case study research design in order to understand the phenomena at a smaller scale. Purposive sampling was utilized in selecting the local area leadership while the convenience sampling technique was used in selecting residents in the area. The data collected were analyzed using thematic analysis. The study revealed that* ***the*** *causes of erosion and sedimentation in Mwembeshi were influenced mainly by human activities such as deforestation, gardening, and livestock farming. The observed onsite effects of erosion in the Mwembeshi stream catchment comprise the loss of soil, the damage of soil's structures, the decline in organic matters, and the loss of soil moisture which leads to more drought-prone conditions and the reduction in soil fertility. The off-site effects rose from the sedimentation downstream.*

*In conclusion, it was observed that sediment inflow from gully erosion into the stream impacts negatively the water quality. The implications on the health of humans and livestock of the Mwembeshi area that use the water should be a source of concern to the Government and Non- governmental organizations. Henceforth, the study recommends that community leaders sensitize community members to diversify their income activities apart from charcoal production, clay bricklaying, and huge livestock farming to activities such as agroforestry and aquaculture.*

***Keywords****: Sedimentation, Mwembeshi stream, Chilanga, erosion.*

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## I. INTRODUCTION

Erosion is a three-phase process consisting of the detachment of individual soil particles from the soil mass and their transportation by erosion agents with subsequent deposition of the related sediments into land depressions, as influenced by natural geologic or human activities (Hundson, 1981). Soil erosion is a major environmental threat to the sustainability and productive capacity of Agriculture. During the last 40years, nearly one-third of the Worlds arable land has been lost to erosion and continues to be lost at a rate of more than 10million ha/year. With the addition of a quarter of a million people each day, the world is increasing at a time when per capita food production is beginning to decline. (Penitel et al., 1975).

Erosion poses a major ecological problem in various parts of the World such as disruptions of drains, and roads (Eze-Uzoamaka, 1991). Furthermore, it can be noted that loss of Agricultural productivity, siltation, and washing away of pollutants into river courses are some of the major effects of erosion with serious effects on the environment and productivity.

However, despite the purported problems facing the agriculture sector as a result of erosion and sedimentation very few studies have been undertaken for Chilanga district to be specific the Mwembeshi stream a tributary to KafueRiver which is one of the major drivers contributing to the generation of hydro-electricity generation in the country as well as contributing a lot to the agricultural activities in this catchment area.

Therefore, the study was carried out in Chilanga district of Lusaka in the Mwembeshi stream catchment area with the aim of determining the effects of erosion and sedimentation on the local people who are dominantly involved in both arable and livestock farming. The objectives of the study were three-fold namely; identify areas affected by erosion and sediments in Chilanga District**;** Find out the effects of erosion and sediments on local people in Chilanga District and determine strategies to reduce the effects of erosion and sedimentation by local people in Chilanga District.

## II. Literature Review

### 2.1 Definition of soil erosion

Soil erosion is the result of the detachment, transport, and deposition process (Panizza, 1996). It is a hazard traditionally associated with agriculture and it influences the productivity and the sustainability of agriculture in the long term (Morgan, 2005). The term 'erosion' initially came from the Latin word 'to erodere' which means to eat away and to excavate. Later, the term erosion is used to describe all forms of destruction of the earth's surface due to water (Zachar, 1982).

### 2.2 Kinds of soil erosion

Zachar (1982) differentiated the kind of erosion into two groups, natural process, and anthropogenic process. In natural conditions where there are not any anthropogenic activities, the soil productivity remains constant and the erosion is in equilibrium with deposition. If anthropogenic activities interfere with the practice of agriculture but if it is done by applying conservation techniques, the effect on soil erosion can still be zero. However, the equilibrium can be altered if exceptional natural events occur, such as heavy rainfall, long period of drought, earthquakes, landslides, e.t.c, abnormal erosion can be triggered. (Panizza, 1996).

### 2.3 Erosion Process

Morgan (2005) stated that the process of erosion completes two phases. The detachment of soil particles from soil mass and the transporting of soil particles by erosive agents. During a rainstorm, either because there is no vegetation or because it passes through gaps in the plat canopy, part of the waterfalls directly on the land. Part of the rain is intercepted by the canopy, and returns to the atmosphere by evaporation or finds its way to the ground by dripping from the leaves, or by running down the plant stems as stemflow. The action of direct through-fall and leaf drainage produces rain-splash erosion. The rain that reaches the ground may be stored in small depressions or hollows on the surface or it may infiltrate the soil, contributing to soil moisture storage. When the soil is unable to take in more water, the excess contributes to the runoff on the surface, resulting in erosion by overland flow or by rills and gullies (Morgan, 2005).

Land-use change has been acknowledged as one of the prominent triggers of the world's environmental shift (Schosser et al, 2010; Han et al., 2007). Regardless of the socioeconomic advantage, land-use change possesses unintended consequences on the natural environment (Leh, 2013). On a regional scale, the effect of land-use change can lead to biodiversity loss and decreasing in land fertility and it is also known to affect climate and water quality. In terms of soil erosion, the role of land use or cover was highlighted by Morgan (2005) that vegetation cover is able to neutralize the effects of precipitation on soil erosion

### 2.4 Sediments and their effects

Sediments are naturally occurring materials that are broken down by the processes of weathering and erosion. Sediments enter a river either as fragments eroded from rocky channels or in dissolved form. McDowell (1989). The deposition of sediment into a waterway can significantly diminish the water quality and aquatic habitat. Sediment deposition in a waterway makes the water more turbid and does not allow as much light to penetrate the water. This causes problems for aquatic plants that need sunlight in order to perform photosynthesis. Furthermore, suspended sediments in the water have the potential of clogging the gills of aquatic organisms and covering the stream bottom. Deposition of sediment on the stream bottom can lead to the suffocation of fish eggs and benthic macroinvertebrates and can cause the destruction of the natural spawning substrate. Also, with an increased amount of particles in the water, dissolved oxygen levels are reduced because of higher water temperatures. (MCWG, 2012).

The most troublesome nutrient element is phosphorous. Freshwater ecosystems developed under very low phosphorous can stimulate the production of algae blooms. The organisms in the aquatic system decompose the algae to use as a food source. In the process, they also use significant amounts of oxygen. Pesticides, some metals, and other toxins may sometimes cling to suspended sediments in water and increase the concentration of toxins in water with high amounts of suspended sediments. Similarly, phosphate can enter a waterway by attaching to eroded particles.

Pesticides, some metals, and other toxins may sometimes cling to suspended sediments in water and increase the concentration of toxins in water with high amounts of suspended sediments. Similarly, phosphate can also enter a waterway by attaching to eroded particles. When at high levels, phosphate in the water can lead to algal blooms and lower the amount of dissolved oxygen in a waterway.

Furthermore, sediments that come about as a result of erosion may have led to serious changes to any fluvial system. Wohl , (2015)adds that fluvial systems are highly responsive to water-sediment erosion, transportation, and depositions of debris from their watersheds. These processes may lead to changes in the shape or form of a fluvial system because there is a link between upstream erosion and sediment deliveries in any river channel that can be devastating overtime especially when there are high magnitudes of upstream

erosion which ultimately result in downstream river adjustments which may be observed through alterations in channel morphology

## III. Methodology

The study was conducted in the Chilanga district of Zambia lying on latitude 15 degrees South and Longitude 16 degrees east and shares its boundaries with Kafue Town on the South-east, Mumbwa town on the west, Lusaka town on the North, and Chibombo Town on the North-Western side. The total population is estimated at 107, 051 of which 53,863 are males and 53, 188 females with 21,853 households. Chilanga rests on the side of a large hill, which is a major decline in altitude between the plateau of Lusaka Province, and the Kafue River flats. The district has a mixture of open Savanna and Miombo trees which have been massively cut down either for wood fuel or paving way for the booming housing industry and farming which has rocked the district. Chilanga district is predominantly a farming area and most of the people living in the area are either commercial or subsistence farmers (GRZ, 2013)

Data was collected using both primary and secondary sources. Secondary data sources included peer-reviewed journals, textbooks, conference papers, and international organization reports. Primary data was collected through field observation and interviews (Kothari, 2004). There was no complete sampling frame for the population as a result; it was not possible to undertake a probability sampling technique. Therefore, a purposive and convenience sampling method was used in this study. The convenience sampling method is appropriate in situations where a sampling frame is unavailable (Lee, 2003). A total of 100 people were interviewed on-site and the response was 100% while ensuring gender equality of 50 males and 50 females. Data were analyzed using thematic analysis.

This study utilized qualitative research strategies. Haradhan (2018) describes qualitative research as a form of social action that stresses the way people interpret and make sense of their experiences to understand the social reality. In qualitative research, researchers are interested in people's beliefs, experiences, and meanings from the perspective of the people. According to Shakouri (2014), qualitative research is a means to empower individuals to share their stories and hear their voices in a study the researcher is interested in. In this instance, qualitative research was appropriate in enabling the researcher to interact with community members living along the Mwembeshi stream. In addition, the study used a case study design where the researcher explored community members on the causes and effects of erosion and sedimentation. According to Zainal (2007), the case study method selects a small geographical area or a very limited number of individuals as the subjects of study to describe the natural phenomena which occur within the data in question.

## IV. Discussion of findings

### 4.1 Causes of soil erosion

The observed causes of erosion and sedimentation in Mwembeshi were influenced mainly by human activities, especially along the stream. This was in line with the findings of Chomba and Sichingabula (2016) who reported the main anthropogenic activities increasing sediment supply to water bodies in Lusaka Province include; changes in land use in catchment areas; increased areas of sedentary agriculture and deforestation leading to greater areas of bare soils susceptible to erosion (Chomba, 2016). Sichingabula (1997) as cited by Chomba (2016) also indicated that the seriousness of soil erosion and sedimentation in small dams in Southern Province and some parts of Lusaka Province of Zambia was due to increased human, and cattle population and the existence of large cultivated areas in catchment areas.

***Figure 1: Anthropogenic causes of erosion and sedimentation along Mwembeshi stream***

### 4.2 Effects of erosion and sedimentation

The observed effects of erosion in the Mwembeshi river catchment can be grouped into two kinds: on-site effects and off-site effects. The onsite effects comprise the loss of soil, the damage to soil's structures, the decline in organic matters, the loss of soil moisture which leads to more drought-prone conditions, the reduction

in soil fertility which impact the reduction of cultivable land, and the restriction of the plantation that can be grown and result in the increase of expenditure of fertilizer as this was also reported by Morgan (2005). The off-site effects rose from the sedimentation downstream and downwind which reduced the capacity of rivers and ditches, leading to an increase in flood risk (Morgan, 2005).

***Figure 2: Images of a dry dam on the left and deposited sediments in the Mwembeshi stream***

In addition, the findings revealed that 60% of respondents indicated that erosion and sedimentation affected the quality of water due to high levels of turbidity, especially along the Mwembeshi stream where small pools of stagnant water were observed. Furthermore, 100% of the respondents reported a reduction in the usefulness of wetlands around the area, especially during the dry season resulting from a lack of water in these points. This finding was in agreement with Chomba (2016); Sichingabula; (1997) and Morgan (2005) who also reported the reduction in usage of small dams due to reduced water storage in the Chongwe area.

Furthermore, the findings showed the reduction in water flowing in the Mwembeshi stream and the storage capacity of the dams in the area is negatively affecting irrigation watering and livestock as can be seen in figure 1 where animals were searching for water in an empty dam. In addition, respondents postulated that the storage capacity of the local water bodies quickly fills up with water at the onset of the rain season and the storage capacity has been lost due to sedimentation limiting livestock farming and irrigation throughout the year.

***Figure 3. Effects of erosion and sedimentation in Membership***

**4.3 Erosion and Sediments mitigation strategies**

One sediment control measure that came out strongly is natural vegetation. From the field observations and interviews, the natural vegetation is the main soil erosion/sediment control measure that can be used in the catchment but it's not done effectively because of livestock farming which requires vegetation to feed on especially during the dry season. On contrary, the vegetation in the catchment was observed to have been over-exploited due to overgrazing and charcoal burning especially during the dry season. However, it was revealed that most of the vegetative cover that was once well established in the catchments of the studied dams has been cleared for agriculture, settlements, and charcoal burning.

**Figure 4: Images of Livestock farming and Overexploited Maize field**

## V. Conclusion

From the results, it is observed that sediment inflow from gully erosion into the river imparts negatively on the river quality. The implications on the health of humans and livestock of the Mwembeshi area that use the water should be a source of concern to the Government and Non- governmental organizations.

Since virtually all gullies in discharged into watercourses, the pollution effect is bound to increase with the increasing menace of gully erosion in the Mwembeshi stream and surrounding water bodies. It is, therefore, necessary that a proactive and multidisciplinary approach should be adopted in solving the problems of erosion and sedimentation. Beyond the primary effects such as loss of land and property, the secondary effects like sediments inflow into the Mwembeshi stream and the resultant effect on surface and livelihoods should not be neglected.

## VI. Recommendations

(i) There is an important need for soil conservation by farmers in the Mwembeshi area due to the high erosion rates.

(ii) Training of the local population in anti-erosion management and also in river sediment transport is required.

(iii) In response to the high rate of population growth and the associated pressure on vegetation cover, erosion is increasing at a faster rate. It is necessary to reduce this trend using both biological methods (e.g. reforestation) and mechanical methods (eg. construction of debris dams).

(iv) The participation of the local population in anti-erosion management is an important requirement and equilibrium should be established between the upstream and downstream areas of a drainage basin. It is recommended that the population should be made more aware of the negative consequences of erosion and sedimentation problems.

(v) After the establishment of anti-erosion management programs in the local area, cost-benefit studies aimed at assessing the real efficiency of the program and at developing the best methods and conservation systems for future programs should be undertaken.

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