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# Effects of Bank Escapes and Floods in the Kavimvira Riverside Neighborhoods

Mwenyemali Nanyamuezi Dieudonnée[1]*, Muhemura Shema Françoise[1], Kahindo Djungu[1] and Amisi Manala Christian[2]
[1]Chemistry department , Uvira Hydrobiology Research Center, CRH-Uvira, BP-73Uvira, DR Congo;
[2]Department of Fisheries Socioeconomics, Uvira Hydrobiology Research Center, CRH-Uvira, BP-73Uvira, DR Congo.

**Abstract:- The Kavimvira bridge destruction and riverine houses demolition along the two Kavimvira River banks during rain saisons 2015, 2016 and 2017 at Uvira, South Kivu Province, Democratic Republic of Congo (DRC), were investigated by direct observation and measurements of erosion areas. The study aimed erosion and inundation description, damages evaluation in order to prevent deaf for wildlife and for human beings. We found that river banks erosion and scouring inundations are the major threats of damages. We then suggest respecting ten metres from the river bank free of human activities, to reforest the Kavimvira river banks on both sides, to regularly dredge the river bed and to erect dykes for lasting environmental protection.**

***Keywords**:- Erosion, Flooded, Kavimvira River, Riverine Houses, Uvira.*

## I. INTRODUCTION

Natural disasters are diverse in nature around the world and have disastrous human consequences, resulting in numerous victims and significant destruction. These consequences are variable according to their amplitude, frequency and spatial scale (A. GAUTHIER, 1996).

In the world, between 1966 and 1992, the percentage of victims of natural disasters represented: floods 76%, storms and cyclones 18%, earthquakes 5%, and volcanoes 1% (B. LEDOUX, 1995).

A study of natural disasters in Uvira has highlighted the role of topography in these disasters linked to the rising waters of the lake, landslides and overflow of torrential streams of the Mitumba massifs. During torrential crises, these rivers often cause a lot of damage including destruction of buildings, fields, bridge, sometimes loss of human life ... (B. MWENYEMALI et al. 2014). The effects of erosion on the human environment have been investigated throughout the city of Uvira (KAHINDO et al. 2015).

The study of major erosion sites in Uvira revealed that the Kavimvira site corresponds to the channel deeply encased in the fluvio-lacustrine alluvium representing the terrace just upstream from the Kavimvira river bridge (L. ILUNGA, 2006).

The aim of this work is to describe and explain the destruction processes of the riverside houses and the Kavimvira bridge and to propose some possible solutions in order to stifle the natural risks.

## II. MATERIALS AND METHODS

- **Study environment**: the riverside districts are located at the level of the lower Kavimvira, the Mitumba massif river and a tributary of the extreme north-west of Lake Tanganyika (Fig. 1).

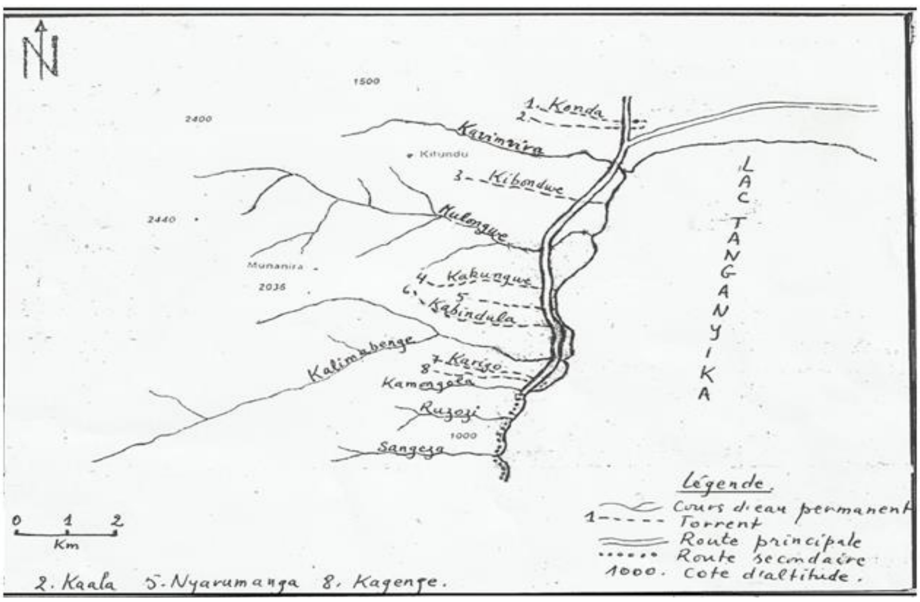

Fig 1:- The Torrential Rivers of the City of Uvira (Mwenyemali et al. 2014)

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The data was collected upstream of the RN5 up to the mouth. Indeed, in this lower course the river crosses, from west to east, two morphological sets:

- The foothills of Mitumba massifs (775 - 990m) where the river flows in a deep valley;
- The Fulvio-lacustrine plain (774 -775 m). These groups are made up of fluvio-lacustrine Quaternary detrital formations (L. Ilunga, 2006)

➢ **The following methodology** has been adopted:

- Direct observation of the facts on the ground: the slide on the steep banks, the floods in the plain, the slope, the lithological nature of the bed bottom and banks, destroyed or devastated houses, sagging bridge, the migrations of the bed and tracks used as a course by residents. These observations allowed us to:
  - ✓ Describe and explain the factors of landslides on the banks, of the mobility of the bed and the correlative destruction;
  - ✓ To classify the river according to the degree and intensity of erosion, based on the watercourse classification scale developed by the US Forest Service and then modified (SHENG T. C. 1993).
- Photographing the landscapes observed: in order to complete and correct the observation, because photography is a complement and a correction to the observation.
- Using a decameter, the migration distances of the channel and the diameter of the blocks were measured, in order to see the extent of the floods and the mobility of the bed, to explain the power of the river and recurrent destruction.
- G P S for taking geographic coordinates of the observed phenomena.
- Interview with the local population; including the question relating to the number of houses and other buildings destroyed and the cause of the settlement of the inhabitants on the banks exposed to the risks.
- Inventory of "abandoned" beds or channels in order to inquire more about the mobility of the watercourse bed.

## III. RESULTS

➢ *Sliding on the Banks in the Piedmont.*

Fig 2:- Erosion on the right bank, upstream of the bridge: (742 m; 03 ° 2116.15 Lat South and 029 ° 0912.0 Long East) this shore presents major risks: completely threatened by erosion which is invading riverside constructions: some eucalyptus trees have already been washed away. Likewise, the sanitary facilities are threatened with destruction

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Fig 3:- Erosion on the left bank, upstream of the bridge: (03 ° 2115.3 lat. SOUTH and 29 ° 0914.4 Long. East).
Shore at major risks. These houses, threatened with destruction, were established on this shore not 10 years ago. The population settled on this site for a permanent and regular supply of river water.

Fig 4:- Evolution of the erosion of Photo 1

Fig 5:- Bridge collapsed on the RN5 on the right bank: (786m; 03 ° 21 ´17,1lat. South and 029 ° 09´ 15,8 East). This bridge was definitively damaged during a flood on the night of April 03 to 04, 2015. The RN5 serves the port of Kalundu on Lake Tanganyika: the country's second economic port after that of Matadi. Upstream of the destroyed bridge, a new erect

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➢ *Flooding in the Plain.*

Fig 6:- Flooding and destruction of houses 774 m.

These two houses which resisted the destruction, obstructed the water diverted following the raising of the bed and the destruction of other houses. They then forced the river to deviate again to destroy other houses that were located where the sand and gravel sediments spread

Fig 7:- Current bed (2017) after last migration from North to South. Bank erosion

➢ *Human Influence in the Destruction.*

Fig 8:- These houses built on the right bank at the foot of an old terrace.

They are exposed to the risk of floods and landslides. These blocks, of metric dimensions, were deposited during the torrential crisis in April 2O15 and 2017. They reflect the competence of this river.

## IV. DISCUSSIONS

➢ Photos 1, 2, 3,4 and 5 show the eroded banks and the associated destruction on soft sedimentary terrain with steep slopes of around 90 °.

The steep banks are attacked both by the river's sap, and by runoff and infiltration, followed by landslides or landslides. In certain cases, certain runoff waters follow the tracks used by the inhabitants; which accelerates the erosion process of the banks.

Hence the decline of the banks towards the collapsing riverside houses (photos 1, 2,3 and 4).

Similarly, the subsidence of the bridge on the right bank can be explained by the river and runoff water (photos 5).

These flow under the RN5 roadway and infiltrate between the foundation of the bridge and the loose sandy terrain to which the latter is attached. Indeed, when a pavement is poorly supported, it is particularly vulnerable to the action of runoff, from the moment when infiltration occurs under the bitumen (J- M. AVENARD, 1995).

Another part of the runoff flows at the edges of this foundation along the tracks of local residents.

These runoff waters played a major role in this subsidence of the bridge, because having prepared this mechanism. This is why, the bridge was definitively damaged, during a flood, after its foundation had been undermined at the base and lifted off the sandy ground of the banks.

The banks of a stream can also deteriorate regardless of the speed and force of the water flowing in the bed. When the materials that make up the bank can no longer resist the forces gravitational the bank collapses and the material settles in the bed of the stream (MAPAQ, 2008).

It is on the banks that the dynamics of erosion is more important: it results in the notching and receding of the banks by the undermining at the base, by the landslide, by the landslide and by the pouring muddy (KABAZIMYA et al. 1985).

This stream exhibits the highest degree of erosion - Degree 4- according to the Classification System Scale of Various degrees of erosion manifested by the stream (developed by US Forest Service) - it that is to say very intense erosion: very active landslide and erosion in the banks, large deposits of fresh bottom charge, torrential current (TC SHENG, 1993).

In short, the banks with steep, sandy and non-woody slopes are the most vulnerable to bank slip.

➢ Photos 6 and 7 show the floods and consequent destruction, on a flat topography (774m above sea level). Some houses that have resisted destruction or partially destroyed, sometimes force the stream to deviate again.

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These floods are successively linked to the sandy-gravelly alluvial deposits and to the raising of the river bed.

Indeed, the steeply sloping stream arrives in the almost horizontal alluvial plain, it raises its bed by sedimentation, it comes out of its bed with an erosive force such that it digs another in a lower position; this bed in turn will raise, the torrent will occupy another and so on (M. ORIA, 1963; M. DERUAU, 1974; G. NEUVY, 1991). Hence the instability or mobility of the bed. It is during the torrential crisis period that the river overflows after alluvialization : the channel is moved.

The tributaries of Lake Tanganyika are real torrents (WEISS G. 1959).

Indeed, it is during the flood period that the river overflows: the channel is moved. Admittedly, the diverted waters destroy or devastate the houses.

The mobility of the bed is particularly noticeable after heavy floods. The river quickly deposits the coarse part of its charge as soon as its power decreases. This fraction stands as an obstacle that obstructs the river bed. The latter is forced to deviate (K. KABAZIMYA et al. 1984; G. NEUVY, 1991).

The flood obviously depends on the flow, but also on the obstacles to the flow. The bridges and debris that accumulate there form ice jams that have often explained why the city flood was stronger than the flow alone could have led to believe. This was the case during the Garonne flood of 1875 in Toulouse (L. Touchard 2003)

In the alluvial plains, the slight slope, crossed by a river with brutal and strong floods, the bed is not very stable and wanders periodically (G.NEUVY, 1991).

Observation on the ground of the "recent" beds of this watercourse shows that the mobility of the bed first followed the south-north direction (a migration); either 20 m and then north-south (5 migrations) or 163m from the old mouth to the current one. During our observations, it emerges from this mobility, 5 migrations corresponding to the 5 “abandoned” beds inventoried in the field. These 6 beds are indicators of channel mobility and recurrent floods as well as correlative damage to this watercourse during this period. This mobility, linked to the alluvialization - raising of the bed and favored by the flat topography, causes the floods and consequently the destruction of the buildings one after the other.

Indeed, the mobility of the bed explains the successive destruction of the houses, one after the other, during recurrent floods. Photo8, about thirty meters upstream from the mouth, shows a certain stability of the current bed in 2018 after migration to the South.

Surveys of the local population suggest the following destruction: 43 residential houses, 1 Protestant church and 1 hotel under construction.

In well-developed or heavily populated watersheds, torrential streams often cause significant damage in neighboring villages and downstream regions (T.C. SHENG, 1993).

The natural risks linked to the movements and the instability of the lithosphere, are sources of the unevenly felt constraints, of manifestations which can evolve into disasters, especially when they touch heavily populated and weakly developed regions (M. HAGNERELLE et al. 1996 ).

Ultimately, the instability of the river in this part is linked to its hydrological regime including the torrentiality and the instability of the banks.

- ➢ Human or local influence is not negligible in these destructions (photos 1, 2, 4, 6 and 9): its anarchic constructions along the banks exposed to the risk of landslides and recurrent floods. Likewise, paths or tracks used as routes and leading to the river favor the erosion process of the banks, because they are often so traveled by rainwater.

Tracks are, with each rain, taken by the runoff. (AVENARD 1995).

Indeed, the severity of disasters depends as much on human and natural factors. Disasters occur to the extent that men have occupied areas where there is a high probability of natural accidents occurring, because they also have great benefits. Among these densely populated "high risk lands", we can cite the great alluvial plains and the slopes of volcanoes where the soils provide good conditions for agriculture (M. HAGNERELLE, 1996).

## V. CONCLUSION

Ultimately, two major natural risks including the landslide on the banks and recurrent floods are the basis of the destruction of riverside houses and bridges recorded in the riverside districts of Kavimvira, during the rainy season of 2015, 2016 and 2017. Indeed, the shift of the banks is explained by the combined action of fluvial waters and those of runoff. In the plain, recurrent floods favored by are accentuated by the raising of the bed leading to the mobility of the channel.

In addition, man has an important part in this destruction by his anarchic constructions along the banks exposed to the risks.

Admittedly, these destructions had environmental and socio-economic consequences: disturbance of river ecosystems, the cost of erecting the new bridge and destruction of buildings, difficulties linked to crossing vehicles in the river during the erection of the bridge. ,… This is why, a study on these impacts is essential.

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In order to stifle these natural risks, measures must be considered, in particular the reforestation of the watershed and especially of the banks of the watercourse, by plant species resistant to erosion and floods, development of dikes along the watercourse in order to avoid the rambling of the latter, a formal ban on the population from exploiting the stones at the bank level, good channeling of runoff water and perhaps the relocation of the local population to another site presenting no risk.

**SUMMARY**

The destruction of riverside homes and the bridge over the Kavimvira River in Uvira was investigated during the 2015,2016 and 2017 rainy season by direct observation and measurements. The aim was to document erosion and flooding in order to prevent property damage, loss of wildlife and human deaths. We have shown that bank erosion and recurrent flooding are the major damage-based risks. We suggested respecting the ten meters of the bank of the Kavimvira river, reforesting the banks, regular dredging and the erection of dikes for sustainable environmental protection.

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