



## EFFECTS OF RAINFALL PATTERNS AND GASENYI RIVER'S DAMAGE, BUJUMBURA BURUNDI

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**ABSTRACT:** *During the rainy period some of rivers can cause some damages in the neighborhoods near them and we know that rivers are receiving storm water runoff from different areas and it can be the source of the disaster which causes damage following unsuitable human activities. Many Countries in Sub-Saharan Africa (SSA) are already knowing the water stress as a result of insufficient and unreliable rainfall, changing rainfall patterns or flooding. The effects of Gasenyi River which disturb people a lot are the destruction of houses and the flooding. The results of this work show that the disadvantages of the Gasenyi River during the rainy season are often the destruction of houses, flooding and some impassable roads. Among these damages, the one that weakens people is the destruction of houses and the main cause is the extraction of materials. Even if extracting materials causes a problem, few people claim that it is beneficial to them.*

**KEYWORDS:** Houses' Destruction, Flooding, Material Extraction.

### INTRODUCTION

Heavy rains are the most important severe weather phenomena in Burundi. Bujumbura city, the economic capital of Burundi, is crossed by a lot of rivers. During the rainy period some of those rivers can cause some damages in the neighborhoods near them and we know that rivers are receiving storm water runoff from different areas and it can be the source of the disaster which causes damage following unsuitable human activities (Buhungu, 2017). Water is one of the essential elements for life and water ecosystems are essential for various activities (Buhungu, 2018). The potential of climate change increases the risk of soil erosion, surface runoff, and related environmental consequences. Earth's climate is changing in considerably way; both global warming and rising sea levels are a reality (Manjit S. Kang & Surinder S. Banga, 2013).

Many countries in Sub-Saharan Africa (SSA) are already knowing the water stress as a result of insufficient and unreliable rainfall, changing rainfall patterns or flooding (Kubwarugira, G., Mayoussi, M., & El Khalki, Y. ,2019). Similarly, the impacts of climate change including predicted increases in extremes are likely to add to this stress, leading to additional pressure on water availability, accessibility, supply and demand. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change predicts decreasing rainfall in northern and

southern Africa, increasing rainfall over the East African and a considerable increase in frequency of floods and drought (Kiprutto, N., Rotich, L. K., & Riungu, G. K,2015).

Burundi, an East African country, is situated between 2.3°S to 4.5°S of latitude and 28.8°E to 31°E of longitude. It is bordered by Rwanda in the north, Tanzania in the east and south, Democratic republic of Congo (DRC) in the west. The total area of the country is 27,834 sq. Km (Butterfield, R, 2009). Burundi has a tropical highland climate. Burundi's temperature varies from one region to another. Bujumbura's average annual temperature is 23°C. Rain is irregular, falling most heavily in the northwest. Most of Burundi receives 1,300 and 1,600mm of rainfall a year.



**Figure 1: Mutimbuzi commune in Bujumbura province**

**Bujumbura Province**

The main physical features of the country include a variety of ecological regions. In this region, there are many rivers and Gasenyi is one of them that crosses Gahahe Hill in Mutimbuzi Commune. Now days, in rainfall season, some of these rivers may behave in unusual ways. Following the damage caused by Gasenyi River in January 2020, a study for avoiding water damage in the future is essential. In this Work we are showing the effects of rainfall patterns and Gasenyi River's damage.

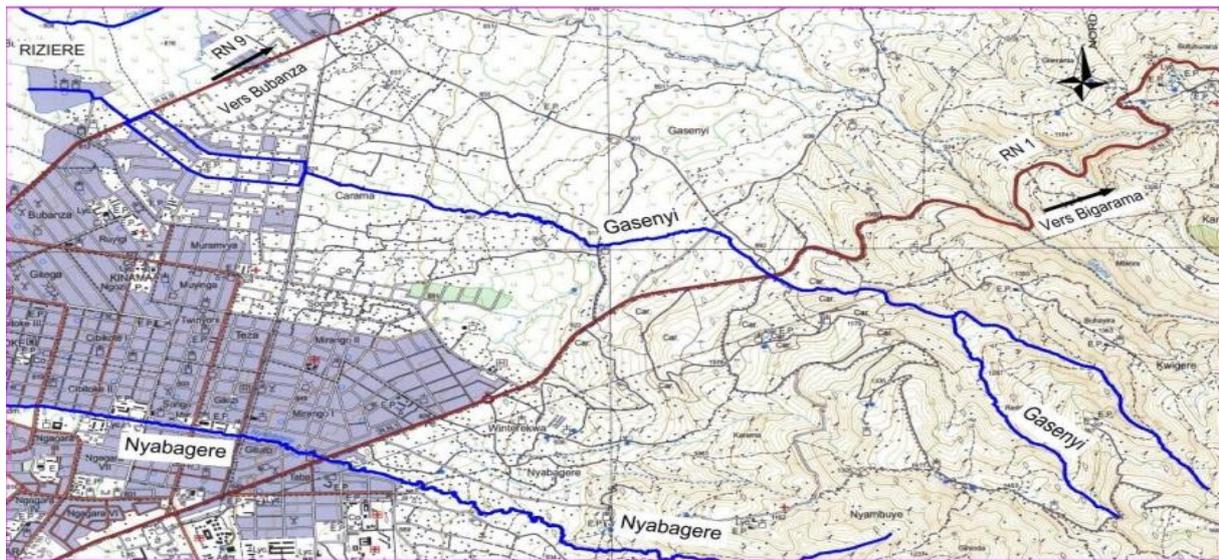
## MATERIALS AND METHODS

### Study Area

Mutimbuzi commune is one of the 9 communes of Bujumbura Rural Province (Isare, Kabezi, Kanyosha, Mubimbi, Mugongomanga, Mukike, Mutambu, Mutimbuzi, Nyabiraba). In 2008, the population density was 314 inhab /Km<sup>2</sup>. In some areas there are high concentrations of people and a developed commercial activity especially for food items. The majority of the

population meets their needs with food crops (rice, maize, etc.) as well as livestock. The said town is crossed by a lot of rivers, including Rusizi, Muzazi, Gikoma, Gasenyi (Ba, N. A, 2016).

In these rivers, construction materials such as stones and pebbles are exploited... The Gasenyi River downstream from the bridge on the RN1 passes through two different zones, namely an agricultural zone dominated by rice cultivation and an urban zone.



**Figure 2: Gasenyi River**

Gahahe hill is a part of this urban area and which was affected by the damage caused by the rain very close to the Gasenyi River.

### **Sampling Method**

It is not often to collect data from every person in a set of persons, when you're conducting a research about the set. As an alternative, you have to select a sample and that sample is a set of persons who will actually participate in the research. You have also to decide carefully the sample that is representative of the whole group, in order to find good and valid conclusions from your results, (Tryfos, P. 1996).

Our study is based on accidental sampling method. This technique is often used by journalists to paint a picture of the variety of opinions that people may have on a hot topic Viateur, H. ., Jean De Dieu, N. ., & Anaclet, C. 2020). In this work, the target population is the set of some individuals who are living in Gahahe quarter, Mutimbuzi Commune. The sample size is  $n=38$ . Before we tested our questionnaire and we made a final survey. Data analysis was done using statistical software called SPSS.



## Multivariate Analysis

### MCA (Multiple correspondence analysis)

Multiple Correspondence analysis is a descriptive method for examining relationships among categorical variables. It is a close analogue of principal component analysis for quantitative variables (Le Roux, B., & Rouanet, H. 2010). In multiple correspondence analysis, the object is to display geometrically the rows and columns of the data table where rows represent individuals and columns the categories of the variable. SPSS makes it possible to obtain not only the basic results but also those for supplementary elements (Landau, S. 2019)

### Logistic regression

Logistic regression is one of the analytical methods that allow modeling the relationships between variables (NYANDWI, S., & NDAYIRAGIJE, F. 2017). Its use, made easy by the use of statistical software, allows the control of confusion bias (Aminot, I., & Damon, M. 2002). It measures the odds-ratio, a quantification of the association probability between a given occurrence, represented by a dichotomic variable, and factors susceptible to influence it, represented by explicative variables (Aminot, I., & Damon, M. 2002).

## RESULTS

### Houses' destruction and Materials extraction

**Table 1: Composites Tests of coefficients of model**

	Chi-square	Dof	Sig.
Step	4,750	1	.029
Bloc	4,750	1	.029
Model	4,750	1	.029

**Table 2: Models summary**

Log likelihood -2	R-square of Cox and Snell	R-square of Nagelkerke
4.499a	.118	.544

According to the results in **Table 1**, p-value of Chi-square test is less than 5 % (p-value = 0.029). This shows that houses' destruction is very depending on materials extraction done in Gasenyi River. Considering the tests of Snell and Nagelkerke, the house's destruction is caused by materials extraction at the rate of 11.8 to 54.4%. On the following graphic, 89.47 % confirm the results obtained above.

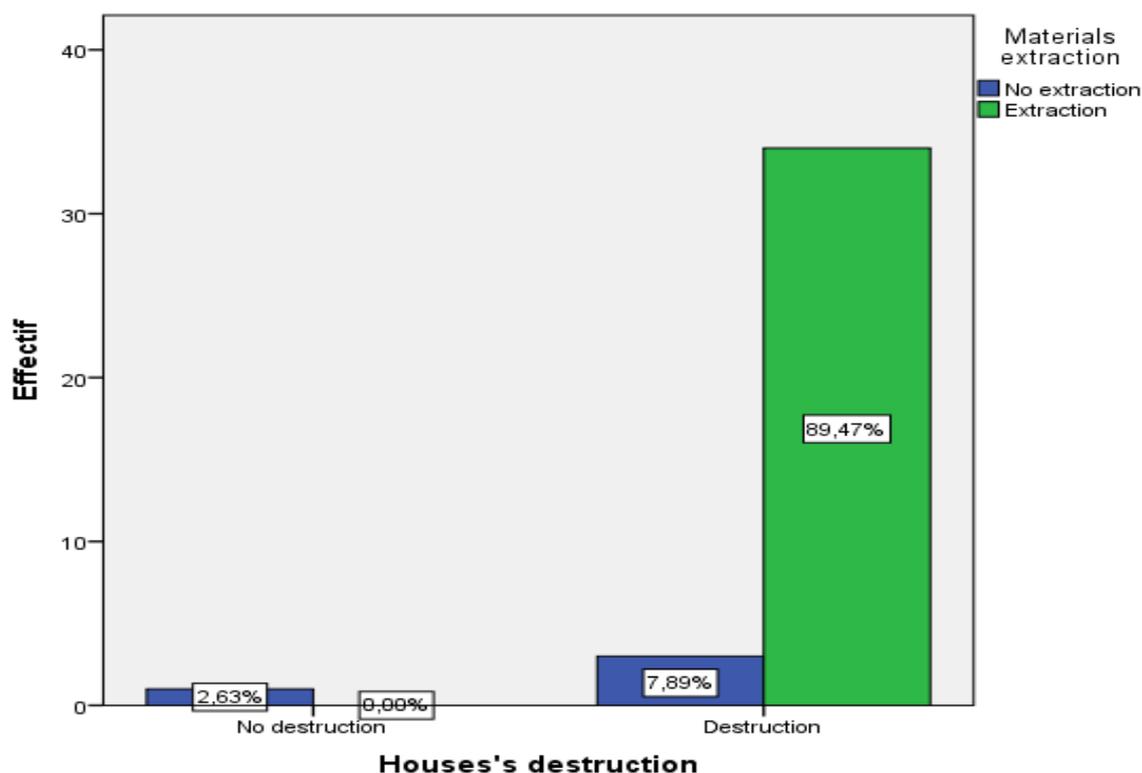


Figure 3: Houses' destruction and Materials extraction.

**Flood and houses' destruction**

**Table 3: Composites Tests of coefficients of model**

	Chi-square	DoF	Sig.
Step	3.507	1	.061
Bloc	3.507	1	.061
Model	4.750	1	.061

**Table 4: Models summary**

Log likelihood	R-square of Cox and Snell	R-square of Nagelkerke
-2	.088	.408

Taking into account the results of **Table 3** and **Table 4**, p-value of Chi-square test is greater than 5% (p-value = 0.061) and the tests of Snell and Nagelkerke show the contribution flood from 8.8 to 40.8% on houses' destruction. This shows that the flood contributes weakly to the destruction of houses. These confirmations is observed on the graphic below.

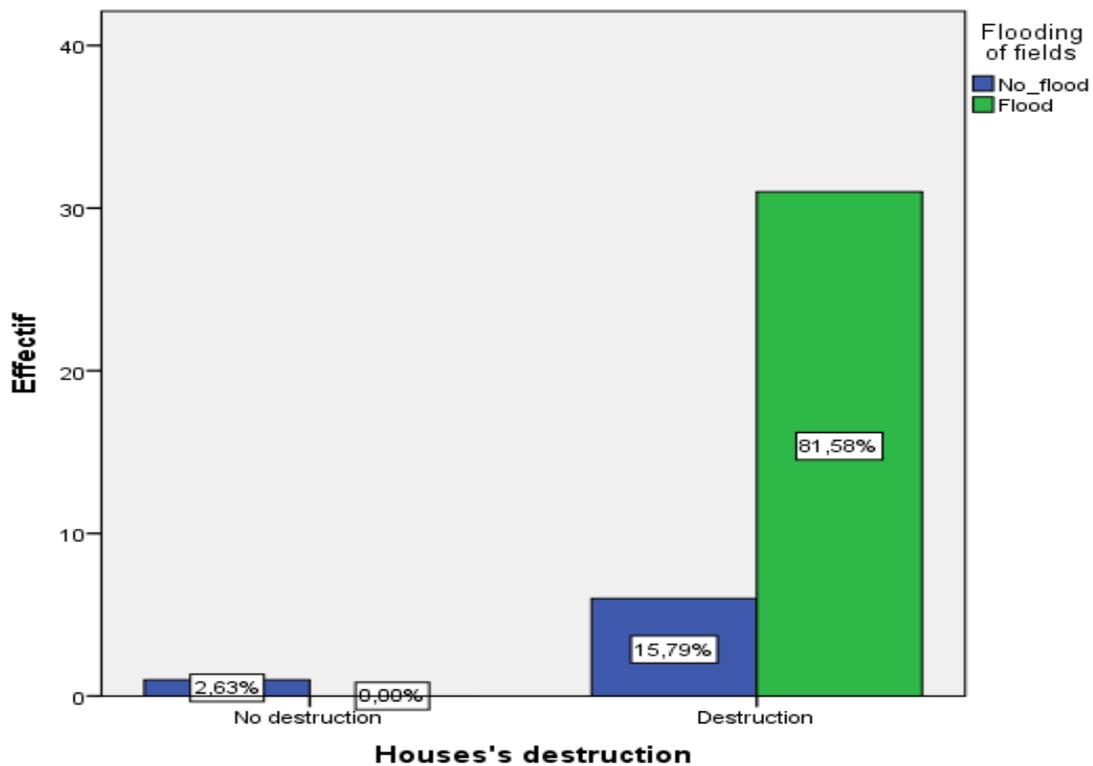


Figure 4: Flood and houses' destruction.

Irrigation and houses' destruction

Table 5: Composites Tests of coefficients of model

	Chi-square	DoF	Sig.
Step	2.747	1	.097
Bloc	2.747	1	.097
Model	2.747	1	.097

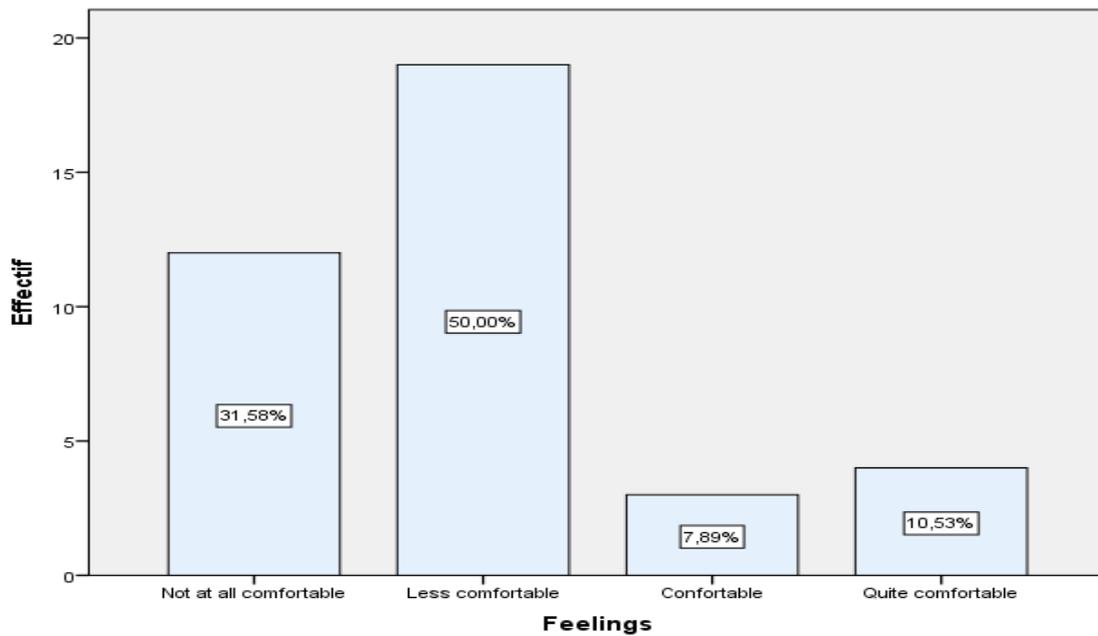
Table 6: Models summary

Log likelihood -2	R-square of Cox and Snell	R-square of Nagelkerke
6.502a	.070	.323

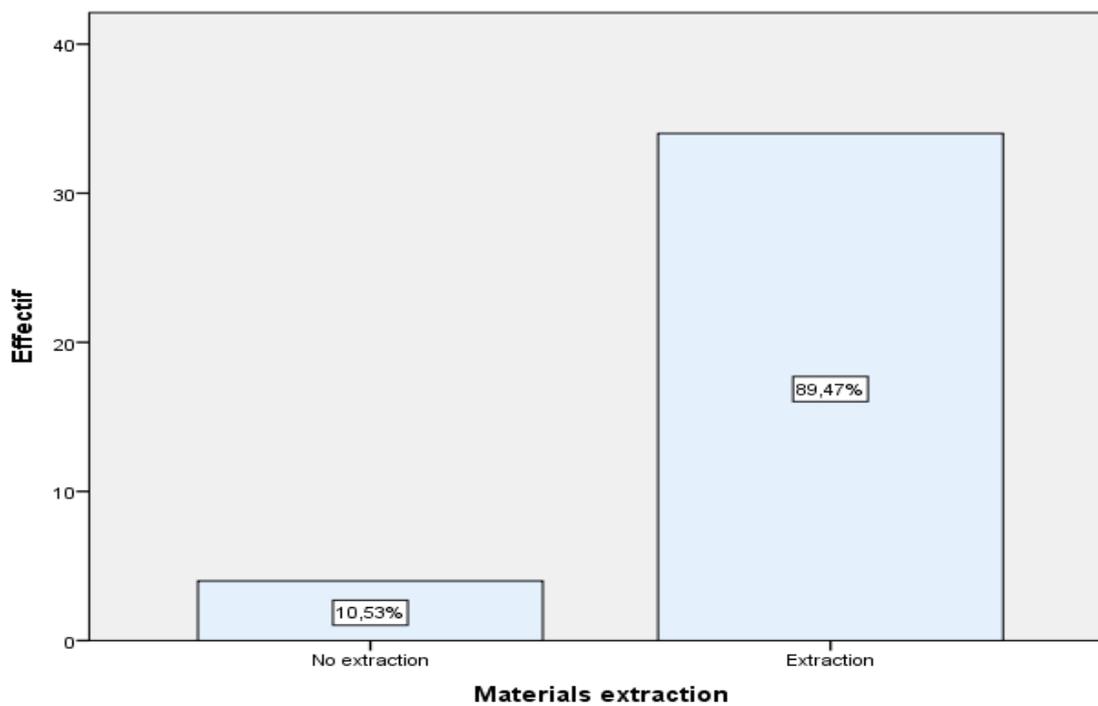
Tables 5 and 6 show that irrigation fields do not influence the damage caused by the destruction of houses. This because p-value of Chi-square test is near to 10% (p-value = 0.097) and Snell and Nagelkerke give us 7 to 32.3%.

### Material Extraction

The previous results show that the extraction of the materials causes a lot of problems, but 18.42% (**Figure5**) of the people living near to the Gasenyi River are comfortable. Yes, 89.47% accept that there is an extraction of materials (**Figure6**). Then those who remove the Materials are among the well-to-do around the river.



**Figure 5: Locals Feelings about Gasenyi**



**Figure 6: Material Extraction.**



## DISCUSSION

The results of this work show that the disadvantages of the Gasenyi River during the rainy season are often the destruction of houses, flooding and some impassable roads. Among these dangers, the destruction of houses scares many people who live near the said river. There are some disadvantages and advantages that contribute to the destruction of these houses. The main causes are the extraction of materials (p-value = 0.029) and the flooding (p-value = 0.061). Even if there is destruction of houses, 18.42 % are comfortable (Figure 5). This is explained by the fact that those people who remove the building materials gain money. Meanwhile, there are other advantages such as irrigation. Irrigating fields is an advantage that does not cause a problem. Irrigation doesn't influence the flooding and the destruction of houses (p-value = 0.097). This is because they do not often irrigate during the rainy season but accidentally.

While the extraction of construction materials is a serious problem, fewer (18.42 %) say it is a benefit to them because they sell the materials and may have food. This shows that the extraction of these materials is not well organized. Then, how to organize this well in order to minimize the problems caused by the extraction of these materials.

## CONCLUSION

The effects of the river which disturb people a lot are the destruction of houses and the flooding. The main cause is the extraction of construction materials and the flooding influence at low rate. Even if it's like that, few people confirm that the extraction of construction material is useful for them. Then it is better to reorganize the way of extracting the construction material in the right conditions that do not cause the destruction of the houses. For this, others best practices are needed for protecting people. Plant trees, especially bamboo, to stabilize the banks of the river; Rearrange the upstream part; Backfill the gully and masonry the gutters for drainage of runoff on either side of the RN1; Channel the Gasenyi River towards the Gikoma River in order to protect the people of the Carama and Gatunguru quarters. Irrigation is an advantage of the Gasenyi River and does not cause any problem, therefore irrigation is to be encouraged.

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