

Comparative Analysis of Non-Infrastructural Impacts of Floods Case Study: 2011 And 2014 Floods in Dar Es Salaam

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Abstract

This study compared and analysed the non -infrastructural impacts of 2011 and 2014 floods disaster in Dar es Salaam. This study area particularly involved the 15 wards in Dar es Salaam. Both qualitative and quantitative data were collected using different data collection methods. The variety of data collection methods were used in this study in which qualitative data were collected through physical investigation/observation including visual inspections of damaged. Questionnaire was conducted to the affected households. Interview was conducted to the ward executive officers (WEOs) and district disaster focal point officer. Consultation was conducted to the disaster management stakeholder. The findings of this study based on non-infrastructural impacts that occurred in 2011 and 2014 floods include death, damage to property mostly houses. Social impacts include disruption of social service such as school, water system and hospital. Environmental impacts include water and air pollution, destruction of ecosystem. Economic impacts such as the cost for rebuilding, medical treatment, food and shelter. Health impacts include eruption of diseases such as malaria, respiratory disease, and cholera. The non-infrastructural impacts that are related to floods include death, property damage, economic, social, health, environment and safety and security. The 2014 flood was more severe as it caused great impacts on infrastructures, economy, social services and environment. Due to lack of awareness, training and preparedness, the 2011 floods also caused great impacts in life and properties. Also, the response authorities did not respond accordingly. The study recommends that areas prone to flood should be mapped and the awareness of people on disaster risks should be created so as to reduce the occurrence of the impacts.

Keywords: Non-infrastructural impacts; Flooding and Floods risks; Disaster; Coping strategies

1. Background Information

Floods are one of the natural disasters which affect the East African coast in particular Tanzania. Construction of unregulated shelters by poor people in slum areas has reduced infiltration of rainfall, increasing runoff to 6 times that which would occur in natural terrain. Some of the increase is probably due to climate change, but some is also the direct result of land cover change as experienced in Kampala, Uganda. Many communities in Dar es Salaam are at varying degrees of flood risk which if overlooked may bring beyond repair losses (Thomas *et al*, 2012). Flood risk is exacerbated by the increasing population and hence the ever-increasing intrusion of urban development into traditional flood-plain areas. Dar es Salaam, the largest commercial city in Tanzania, is estimated to have a population of four million (UN-Habitat, 2010). Nearly 80% (3.2 million) of the population live in about 43 informal settlements of different sizes which have limited access to basic infrastructure services such as water supply, sewerage and storm water drainage systems. Some of the settlements are regularly affected by devastating flooding whenever it rains. Inhabitants have continued to reside in these settlements despite flooding effects such as loss of human life, destruction of properties, environmental degradation, environmental pollution and disease outbreaks (Lerise and Malele 2005). The city of Dar es Salaam has not been spared from flood catastrophes over the past decades. Some notable examples of major floods in Dar es Salaam are the one that were experienced in 1997/1998, an El- Nino associated floods (Guleid, 2005); the 2011 floods that wrecked the coastal city of Dar es Salaam (Mbalamwezi, 2011) and the 2014 flood which occurred in March which caused much destruction of the communication network. With reference to 2011 and 2014 flood events in Dar es Salaam city-Tanzania, urban areas continue to be at risk to both infrastructural and non-infrastructural impacts. In December 2011, Dar es Salaam city experienced heavy rains that resulted in unprecedented flash floods that devastated many areas of the city. At least 23 people were killed in the disaster and 4,909 people were displaced. Businesses were forced to close and thousands were left homeless as the city became inundated with floods. The impact of the floods is still in the memories of most residents of Dar es Salaam hence the need to initiate mitigation measures to reduce or prevent occurrence of floods in the future as well as adaptation measures to speed up saving of people's lives if floods occur.

This paper presents results of a study whose main objective was to compare and analyse the non-

infrastructural impacts of 2011 and 2014 floods in Dar es Salaam. In this study, the areas affected by floods, the severity of flooding in the affected area, factors that influence the occurrence of non-infrastructural impacts of floods and the response agencies and authorities were also studied in order to accomplish the study.

2. Methods and description of case study

A case study approach was used in carrying out this research primarily because a deeper understanding of the non-infrastructural impacts of floods. The choice of a case study settlement started with an inventory of all wards affected by flooding in Dar es Salaam. A total of 15 wards were identified.

Both primary and secondary data sources were deployed in this research. Literature review Published materials and reports were used to get information on floods, types of non-infrastructural impacts, measure for mitigation and prevention of flood impacts, and the roles and responsibility of the relevant agencies and authorities who respond in disasters in general was undertaken. Consultation In this study, different expertise and knowledgeable people on flood were consulted so as to get their opinion and views about the study. Photography used when conducting observations, pictures were captured for further understanding of the types and the factors that lead to the occurrence of non -infrastructural impacts that occur in the community. Questionnaires were mainly provided to the ward executive officers, environmental health officers and affected household. A total of 384 questionnaires were administered. Interview this was done to the ward leaders, disasters focal point in each municipalities and also interviews with the key disaster stakeholder. Physical investigation/observation this was done in identifying the extent of flooding in affected areas.

The key instruments for this study were questionnaires which were administered to the identified affected household at the case study. Another instrument that were used include camera, checklist

Case Study description

The Dar es Salaam City region is composed of three municipalities: Kinondoni, Ilala and Temeke. Each municipality is autonomous, but administratively the three are coordinated by the Dar es Salaam City Council. The study area of Kinondoni, Ilala and Temeke, in each municipal five wards were selected. According to the 2012 census the Kinondoni has total population of 200,995 for the five wards Magomeni, Hananasif, Msasani, Kigogo and Mikocheni. Ilala has 291,259 populations for the Mchikichini, Buguruni, Vingunguti, Upanga west and Tabata. For the Temeke have 359,976 population for the selected ward Kiburugwa, Kijichi, Charambe, Keko and Mbagala kuu.

3.0 Results and discussion

This part provides the finding of the study based on the objectives which are the non- infrastructural impacts and the factors influencing the occurrence of the impacts for the 2011 and 2014 floods events in Dar es Salaam. The non-infrastructural impacts include loss of life, property damage, health impacts, environmental impacts, social impacts, economical impacts and security and safety. The main factors that contributed to the occurrence of floods and the non -infrastructural impacts for the 2011 and 2014 floods in Dar es Salaam were illegal dumping of the solid waste along the river, rapid urbanization (high development of house in unplanned manner), blockage of natural water flow, and poor storm water drainage systems.

3.1 The Non-infrastructural Impacts of 2011 and 2014 floods in Dar es Salaam

The main non-infrastructural impacts of floods the area affected by 2011 and 2014 floods in Dar es Salaam are loss of life, property damage (house), environmental impacts, social impacts, health impacts, economic impacts, and safety and security

3.1.1 Loss of Life of 2011 and 2014

The results show that in 2011 floods event 40 people died whereas in 2014, 25 people died in all three Municipals (Kinondoni, Ilala and Temeke). As shown in Table 1, the death of people was due to the collapse of structure, drowning, washed away by storm water and presence of victims in unsafe areas.

Comparative analysis of Loss of Life for the 2011 and 2014 floods

This implies that the death rate in 2011 was more severe compared to that of 2014 because the level of water in the flooded houses were higher than that of 2014. Also, the number of death in 2014 was lower due to the fact that after 2011 floods event, the awareness was raised to people to make them attentive on how to go about such catastrophic events. However, such awareness raised did not help them to overcome the problem but rather helped to minimize the death rate as compared to 2011.

Table 1: Number of Death in 2011 and 2014 Flood Events in Dar es Salaam

Year	Number of Death (people)
2011	40
2014	25

3.1.2 Impacts of Floods on Properties for 2011 and 2014

Flooding had destroyed human properties especially house assets such as furniture, home equipment and

livestock. The results in Figure 1 show that in 2011 and 2014 floods event, more houses were totally destroyed with floods compare to those filled with water. But for those surrounded with water the value was high in 2014. Figure 2 show the house destructed by water due to soil erosion.

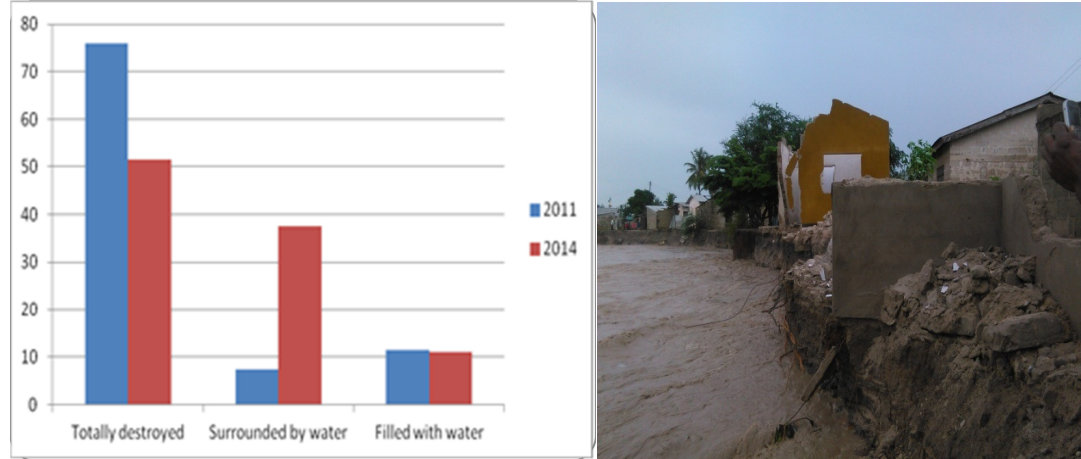


Figure 1 and 2: Impacts of Floods on Properties (house) damage in 2011 and 2014 at Dar es Salaam Comparative Analysis of the Damage to Houses between 2011 and 2014 Floods

According to the data presented on the impacts of floods in properties, the 2011 floods had destroyed 201 houses while the 2014 had destroyed 103 houses. In regard to the houses which were surrounded by water, the 2011 floods event had left 75 houses surrounded by water while in 2014, 75 houses were surrounded by water. This implies that the 2011 floods event had caused more negative effects on houses than that of 2014. This was because of fluctuation of the overall amount of rainfall to each particular year in which the 2011 rainfall was higher than that of 2014. It was the first floods experience since the happening of EL' NINO in 1998 and people were not aware of it.

3.1.3 Impacts of Floods on Health for 2011 and 2014 floods

In 2011 and 2014, the floods had caused wide spread of diseases to the surrounding community in Dar es Salaam city. The data shows that the 2011 floods event led to the occurrence of different health diseases such as Cholera, Malaria, Fungus, Skin diseases, Dysentery and Pneumonic plague. Also, in 2014 floods, the Urinary Tract Infection and acute Respiratory Infection diseases were common and cholera did not occur during this time. As shown in Table 2 the floods had posed wide spread of health risks for poor residents by causing pit latrines to overflow due to the high water table and, sewers and drains to overflow due to improper waste disposal practices.

Table 2: Types of Diseases Occurred in 2011 and 2014 Floods

Diseases	2011	2014
Cholera	✓	-
Malaria	✓	✓
Fungus	✓	✓
Skin disease	✓	✓
Dysentery	✓	✓
Pneumonic plague	✓	✓
Urinary Tract Infection	-	✓
Acute Respiratory Infection	-	✓

Comparative Analysis of Health Impacts between 2011 and 2014 Floods

According to the data presented, both 2011 and 2014 floods events had resulted into high rate of infections from various diseases associated with heavy flooding. Flooding often damages public infrastructures such as bridges, roads, schools and water supply system. Since sanitation provision in Dar es Salaam is glossy deficient, most people living in unplanned settlements do not have access to hygienic toilets, thus large amount of faecal waste are discharged to the environment without adequate treatment (Lupala, 2002).

3.1.4 Impact of Flood on Environment for 2011 and 2014

The impacts associated with floods in environment for the 2011 and 2014 flood as presented in figure. The results show floods had more effect in water and ecosystem for both events while for sanitation system show it had more impact in 2011.

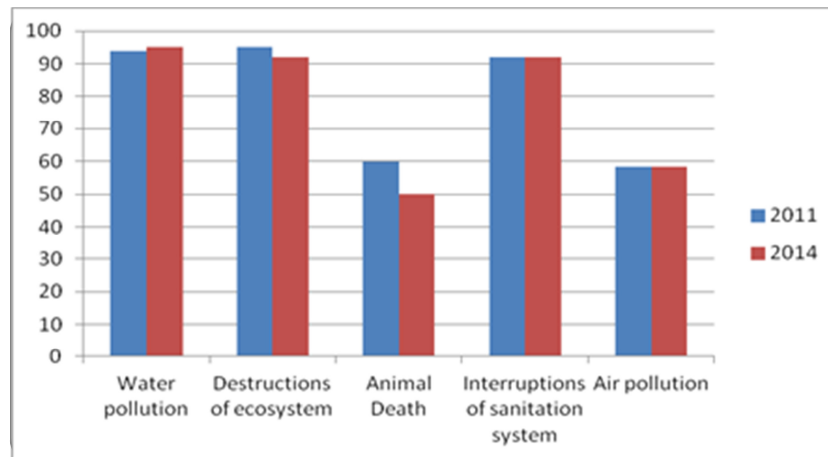


Figure 3: Environmental impacts of 2011 floods

Comparative analysis of the environmental impacts between 2011 and 2014 floods

According to the data, the 2011 flood has more impacts on environment than 2014. This implies that 2011 flood was severe compared to 2014.

Water pollution, air pollution and ecosystem destruction seems to be severe in both events. The reason is that pollution and destruction of ecosystem are not easily avoided in flood events. They can only be avoided when floods are prevented from occurring. Both groundwater and surface water pollution were found to be significant in Keko Machungwa. The shallow wells were easily polluted by flooded pit latrines and crude disposal of liquid waste from toilets. Crude dumping of solid waste and poor management also contributed to ground and surface water pollution (Sakijege *et al.*, 2012). Air pollution was manifested in an unpleasant smell as a result of rotting waste in the streams and in settlements. This unpleasant condition was affecting almost all households in the study area. The sanitation systems were highly destroyed in 2011 than 2014. The reason could be that in 2011 floods, the authorities and residents decided to rebuild better systems than the destroyed ones. This is contrary to 2014 floods where systems were better and stronger and so they were not destroyed as previous.

3.1.5 Impact of Flood on Economy for the 2011 and 2014

The economic impacts associated with floods in the affected areas in Dar es Salaam for the 2011 and 2014 event are as in Figure 4. The results shows that the floods has more impacts on microfinance organization followed by cost for treatment, food and loss of income but it has less impact in loss of wages in both year.

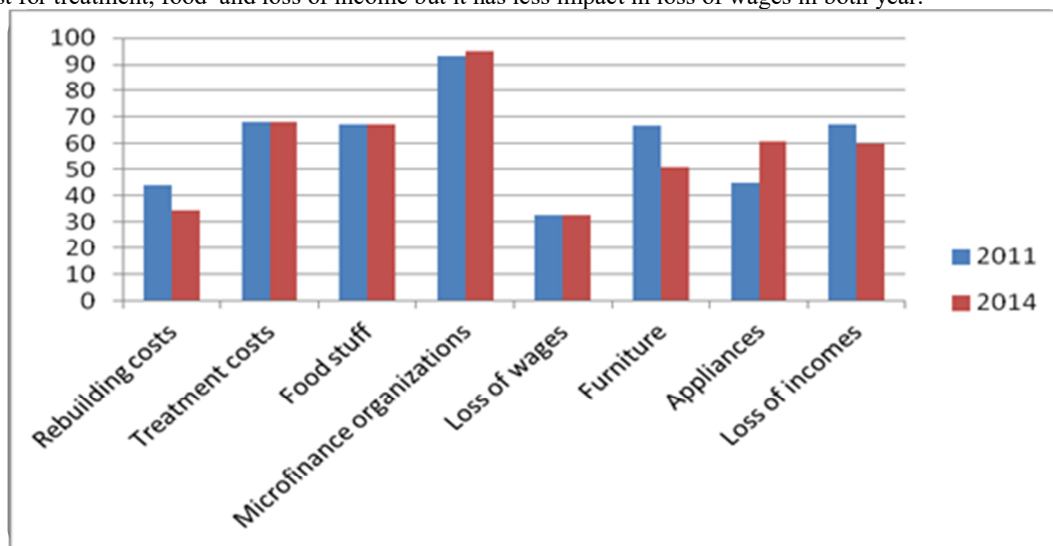


Figure 4: Economic impacts of 2011 and 2014 floods

Comparative analysis on economic impacts between 2011 and 2014 floods

According to the data presented, the 2011 flood has more impacts on economy compared to 2014 flood. This implies that, 2011 flood was more severe in economy than the 2014. This is due to fact that most of people

require money or capital to rebuild their houses by removing all mud and waste/debris which entered during floods, and money paid to workers who help them with the activities.

3.1.6 Social Impacts of floods for the 2011 and 2014

Flooding affect a lot of social services like schools, health centre, electric power supply. Based on the data presented in Figure 5 the results show that it had more impact on electricity power supply, water system and family separation but it had less impact on playing grounds and health centre

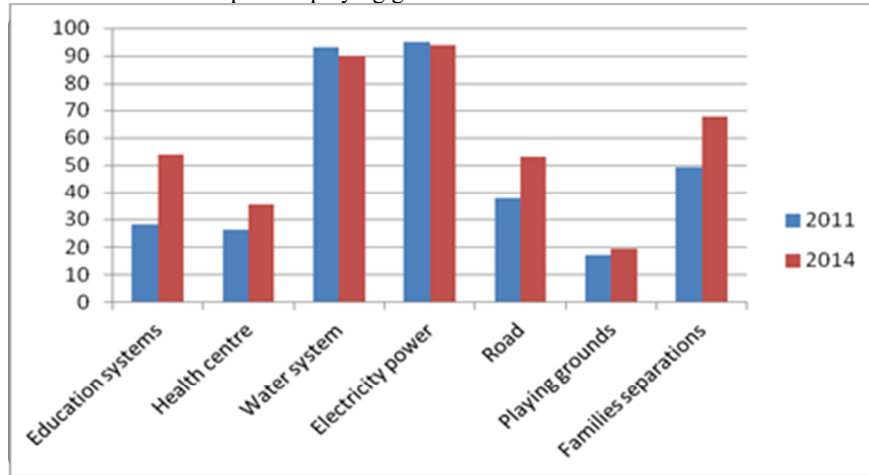


Figure 5: Social impacts of 2011 floods

Comparative analysis on social impacts between 2011 and 2014 floods

According to the data presented, the 2011 flood had more likely the same social impacts compared to 2014; flood because for the 2014 most of the community were somehow aware about the floods events. When it occurs they were try to be at the same place with their family.

3.1.7 Impacts of floods on Safety and Security

The results show that for both events the safety and security of the people i the affected areas were low compared to the period when there is no floods. As it presented in figure 6

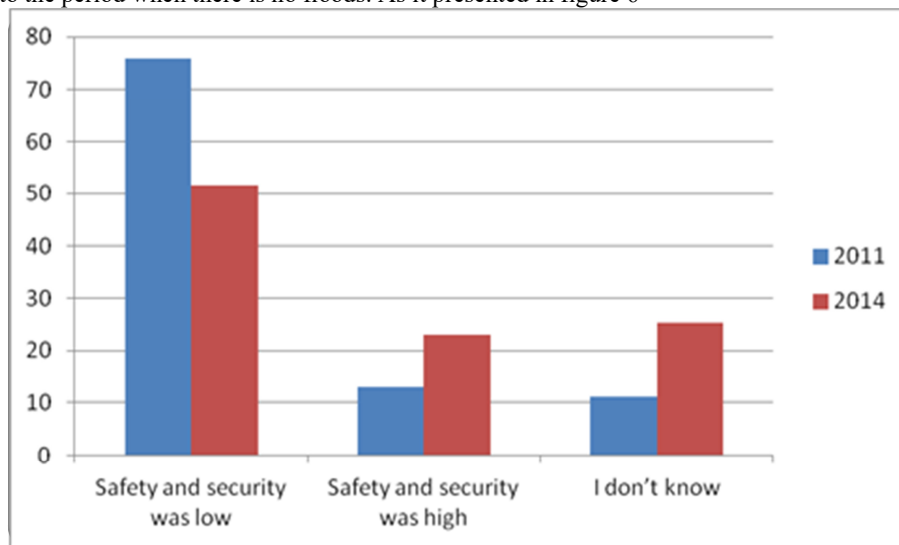


Figure 6: Security and safety impacts of 2011 floods

Comparative analysis on safety and security impacts between 2011 and 2014 floods

According to the data presented, the 2011 flood has more security and safety impacts than 2014 floods. This is due to the fact that in 2011 flood events, most of the houses were totally destroyed while others were filled with water. So, people could not rescue their properties as they were confused with the situation.

3.2 Factors that Influenced the Occurrences and Non-infrastructural Impacts of 2011 and 2014 Floods in Dar es Salaam

Based on the data from the households questionnaire shows that main factors that contributed to the occurrence

of floods and the non -infrastructural impacts for the 2011 and 2014 floods in Dar es Salaam said 42% is due to illegal dumping of the solid waste along the river, 65% rapid urbanization (high development of house in unplanned manner), 75% blockage of natural water flow, and 85% of the respondent said due to poor storm water drainage systems.

Blockage of natural water flow

Haphazard (illegal) construction of industries and housing has influenced the occurrence of flooding in Dar es Salaam city. Most of the people in the case study areas were complaining that people who own some industries (large scale developer) around their settlement areas have built walls which block water flow. As a result, during rainfall, large amount of surface runoff get blocked by the walls and diverted to residential premises.



Figure 7: Blockage of natural water flow

Poor storm water drainage systems.

Dar es Salaam city has few comprehensive storm water drainage system and the existing ones are not in good condition. Some have been constructed individually and in uncoordinated manner. Whilst this area receives storm water from different settlement, its drainage channels are too narrow and shallow to accommodate water from upstream catchment areas. Apart from that, the settlement has a high water table that exacerbates flooding during the rainy season.



Figure 8: Condition of storm water drainage system

Illegal dumping of solid waste

During site visiting and observation, it was discovered that most of household at the affected areas dump their solid waste along the river valley. Lack of proper solid waste management has resulted into dispose of waste into the drains and natural streams, contributing further to the increase in flooding when it rains heavily.



Figure 9: Haphazard dumping of solid waste

Rapid urbanization/ housing development

During site visits and observations, it was discovered that population growth was among the factors that accelerated occurrences of floods in Dar es Salaam. A lot of people tend to move from rural areas to urban areas. Majority of them occupy and establish their settlements in flood prone areas. Illegal construction of houses in these areas leads to blockage of natural water flows, and sabotage water filtration due to the fact that large areas are occupied by houses instead of water.

4.0 Conclusion and recommendations

4.1 Conclusion

Dar es Salaam has been experiencing the frequent intervals of floods almost every year during rainy season especially in the months of April and May.

- Many areas in Dar es Salaam city are located in the flood plains, along the rivers, in unplanned settlements and low lying areas. Based on the study, it shows that 56% of the wards were affected by floods in 2014 compared to that of 2011 which comprised of 49% of the affected wards.
- The severity of flooding in the areas which were affected by 2011 and 2014 floods was measured by assessing the rainfall amount, flood water level and spatial and temporal distribution of floods. Based on the results, it was observed that the 2014 flood event was high in terms of rainfall amount and spatial and temporal distribution of flood in the affected areas compared to that of 2011. For the 2011 flood, it shows that only flood water level was high compared to that of 2014 since in 2011 event people's awareness on floods was low and the water channels and natural water flow were blocked by solid waste and urbanization problem.
- Flood events are always associated with both physical and human impacts. The non-infrastructure impact that is related to floods includes death, property damage like house, economic, social include death of people, separation of family and disruption of social services like school, hospital and water system. Health impacts includes eruption of diseases such as malaria, respiratory disease, environment impacts include air and water pollution, destruction of ecosystem and safety and security. However, the 2014 flood was more severe as it caused great impacts on infrastructures, economy, social services and environment. But due to lack of awareness, training and preparedness, the 2011 floods caused great impacts in life and properties. Also, the response authorities did not respond accordingly.
- Dar es Salaam city gets flood even when the rain is not heavy. As discussed, there are many factors which lead to the occurrence of impacts. These factors include blockage of natural water flow, poor storm water drainage system, rapid urbanization and illegal dumping of solid wastes.
- The response authorities and agencies did not respond as required in 2011 flood due to lack of experience because it was the first incident to occur in Dar es Salaam in recent years. They also lacked reasonable equipment, personnel and training to respond accordingly. Destruction of infrastructures made it difficult to reach the affected areas in time.

4.2 Recommendations

Recommendations to household, community, municipal and the city are as follows:

- Mapping of all flood-prone areas in the city should be carried out and continuously updated. These maps should contain detailed information on flooding areas since many people tend to occupy areas

which are prone to floods. And these maps should be disseminated to the municipalities so as to increase people's awareness about floods.

- Community level initiatives to control house and warehouse construction in the settlement and across the natural drains should be augmented. Besides, storm water drainage channels should be built and regularly maintained. Initiatives to manage solid waste should also be promoted.
- The response agencies and authorities such as fire and rescue department, Tanzania Red Cross, as well as the police should be well prepared, trained, and equipped so as to be able to respond accordingly during flood disaster or other disasters that might happen. Also, the Joint Operations Centre should be established in order to coordinate various disaster management actors.

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