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Floods recurrence and effects on socio-economic livelihoods of communities in Dar Es Salaam region, Tanzania

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Abstract

This paper assesses flood recurrence and effects on the socio-economic livelihoods of communities in Dar es Salaam Region, Tanzania. Limited studies conducted focused on the effects of the recurrence of floods but none on the socio-economic livelihoods of communities in Dar es Salaam Region. Specifically, this article examines the reasons for the recurrence of floods, determines the effects of floods on communities' socio-economic livelihoods, and evaluates measures to mitigate the recurrence. The study conducted in Ubungo and Kinondoni Districts, employed mixed research methods to triangulate the information collected, whereby in-depth interviews, field observations, and household surveys were used for data collection. The study found that the recurrence of floods is a result of heavy rainfall, building in the drainage systems, impervious surfaces, disposing of waste in the drainages, and poor drainage systems. Effects of the floods include death, injuries, damage to properties, and diseases. Remedial measures for the recurrence of floods include enlargement of the drainages, frequent cleaning of the drainage systems, avoiding disposal of waste in the drainages and demolishing all buildings which obstruct the flow of water. The study recommends reinforcement of emergencies, preparedness, resettling people living in flood-prone areas, and acting on forecasts provided by the Meteorological Authority in the study area.

Keywords: Communities, flood, livelihood, recurrence, socio-economic effects

Introduction

Floods are more recurrent and usual events in several countries (White, 2013; Ramiaramanana and Teller, 2021). Arguably, it is the weather-related hazard that is most widespread around the global

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(White, 2013), and the lowland and riverine areas are naturally prone to flooding (Tockner and Stanford, 2002). Flooding have different effects on society and the environment (WHO, 2020). Flooding is a result of heavy rainfall, melting of ice and snow, dams breaking and ocean waves coming onshore (White, 2013; Ramiaramanana and Teller, 2021). However, the causes of floods vary from one part of the earth to the other (Ramiaramanana and Teller, 2021).

Flood is one of the most significant disasters in the world (Tingsanchali, 2011; WHO, 2020) and the most destructive natural hazard ever (Dewan, 2013; McGlade *et al.*, 2019). Many cities and urban areas are situated in flood plains because low land areas are fertile and flat, suitable for agriculture and urban development (Tingsanchali, 2011; Tariq, 2021). Cities have a large part of impervious areas that prevent the infiltration of water into the soil (Chithra *et al.,* 2015). Impervious surfaces are defined as surfaces that reduce the speed or prohibit the infiltration of water from the land surface into the underlying soil (Chithra *et al.,* 2015). Impervious surfaces increase the frequency and intensity of downstream runoff and decreases water quality since it collects whatever is met on the course of movement (Chithra *et al.,* 2015).

Many authors have raised concern that, impervious surface reduces base flow (Chithra *et al.,* 2015; Feng *et al.,* 2021; Shahzad *et al.,* 2021). It is a concern because impervious surfaces prevent infiltration thereby reducing groundwater recharge and base flow (Schueler *et al.,* 2009; Shuler *et al.,* 2021). Impervious surfaces prevent infiltration, thereby leading to large runoff and high flood levels (Ferreira *et al.,* 2021). Most urban floods are due to locally heavy rainfall, river overbank flow, and high tides or storm surges. Floods due to locally heavy rainfall are caused by small or poor drainages,

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which cannot take all water. Construction of cities in flood plains reduces storage and blocks waterways in the flood plains worsening flood damage. Cities in coastal areas are normally located in low-lying areas where drainage is difficult without pumping. Climate change has led to heavy rainfall, and severe and frequent floods in several countries (Wainwright *et al.*, 2021) such as Thailand, Bangladesh, Nigeria, Mozambique, Kenya, Uganda and Tanzania.

The study done in Nigeria revealed that, floods have an impact on the socio-economy of the Riverine Communities of River Benue in Adamawa (Abubakar *et al.*, 2020). Thousands of hectares of farmlands and other properties have been destroyed by flood over the years in Adamawa State in Nigeria (Abubakar *et al.*, 2020). Kenya experienced hazards and impacts of floods during the year 1997/1998 El Nin˜o episodes (Opere, 2013). These floods led to a severe loss of life (human and livestock) and properties, destruction of infrastructure, disruption of the communication networks, and large losses to the economy (Opere, 2013). Floods in Kenya were also associated with land degradation, soil erosion, silting of hydropower dams, and destruction of power lines (Opere, 2013).

Tanzania is not exempted as it is one of the flood-affected countries in East Africa. Flooding caused a significant impact on people as it led to death, injuries, diseases, and damage to properties. Dar es Salaam Region among other regions in Tanzania is frequently affected by severe floods causing destruction and impeding the daily life of its 4.5 million inhabitants (Erman *et al.*, 2019). In April 2018, Dar es Salaam Region was hit by the worst flooding in its history, with 81.8mm of rain falling on 14-15 April and 99.6 mm in the 24 hours that followed (World Bank, 2019). The Inter-Tropical Convergence Belt in 2019 reported rainfall in Dar es Salaam which started on 8 May

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2019, and peaked on 13 May 2019 resulting in widespread flooding (Brown, 2020). This paper is designed to determine the causes and effects of the recurrence of floods on communities' socio-economic livelihood in Dar es Salaam Region. The objectives are to examine the reasons for flood recurrence in Dar es Salaam Region, determine the effects of floods on the socio-economic livelihood of communities, and to evaluate measures to mitigate the recurrence of floods in Dar es Salaam Region.

Materials and Methods

Study area

This study was conducted in Dar es Salaam Region located in the Eastern part of Tanzania. The region lies on the latitude 6.45°S and 7.25°S and longitude 39°E and 39.55°E. Administratively, the region is made of five districts; Kinondoni, Ilala, Temeke, Ubungo and Kigamboni. Dar es Salaam Region is the largest city in Tanzania in terms of population; it has 5.5 million people and high urbanization rate with a growth rate of 4.3% per year (URT, 2002; NBS, 2020). It is also a region experiencing a high number of floods compared to other regions in the country. In this study two districts were selected, Ubungo and Kinondoni. The data was collected from four wards; Manzese and Sinza in Ubungo District, and Magomeni and Mwananyamala in Kinondoni District. These wards were selected due to frequency of occurrence and effects of floods. This paper adopted a descriptive research design because issues on the recurrence of floods are explained in detail.

Data collection and statistical analysis

The data was collected using a household questionnaire survey, in-depth interviews, and field observations. The study employed mixed research methods to triangulate the information (Creswell, 2014; Almalki, 2016). The survey involved a total sample of 101 heads of households (≥18 years old)

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selected through simple random sampling. In each ward, a list of heads of households was obtained from the ward executive officer. In selecting respondents for in-depth interviews, purposive sampling technique was applied. In depth interview involved a total of 21 key informants yielding a total sample of 122 respondents. In in-depth interview only respondents with knowledge, experience and have lived in the study areas for 20 and above years were selected (≥20 years have lived in the study area). Field observation was also employed to collect nonverbal information like the drainage systems, flood plain areas, and structure of buildings, damaged crops, destroyed roads and destroyed bridges. For the analysis of qualitative data, content analysis technique was used. Qualitative data from interviews (key informants) were organised into themes and presented in narrations. Quantitative data were analysed using Statistical Packages for Social Sciences (SPSS) version 20.0 where the results were presented in tables, figures, frequencies, and percentages.

Results and Discussion

The concept of flood

Respondents show a strong understanding of the concept, causes, and effects of flooding. Respondents were asked to define the word floods in their own words. This question aimed to probe the understanding of the respondents about the word floods. The majority of the respondents (96%) were able to tell the meaning of the word "flood", only 4% did not know the meaning of the concept (Table 1). According to the respondents, a flood is the overflow of water beyond its normal limit while others defined a flood as an excessive or overflowing of water on the land (Table 1). Flooding is an event where water rises higher than normal levels and causes damage to land, and infrastructure. These definitions auger the definition by McGlade *et al.* (2019) who stated that, floods denotes water overflowing onto land that is usually

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dry. Floods are natural incidents where a dry area or land is soaked with water.

Table 1: The meaning of the word flood

S/n	Definition of floods	Responses	Percentages
1.	A flood is the overflow of water beyond its normal limit.	32	31.7
2.	A flood is an overflowing of a large amount of water beyond the normal amount of it.	11	10.9
3.	Flooding is an excessive or overflowing of water on land which is normally dry.	16	15.8
4.	Flood is an enormous flow of water	16	15.8
5.	Flood denotes the water overflow beyond the level of its embankment.	12	11.9
6.	Flood is an overflow of excess water that submerges land and inflow of tide onto land	2	2.0
7.	Flood is too much water flowing or overflowing of water on land which may (in most cases) result into a threat to human life and properties	8	7.9
8.	Don't know	4	4.0
	Total	101	100

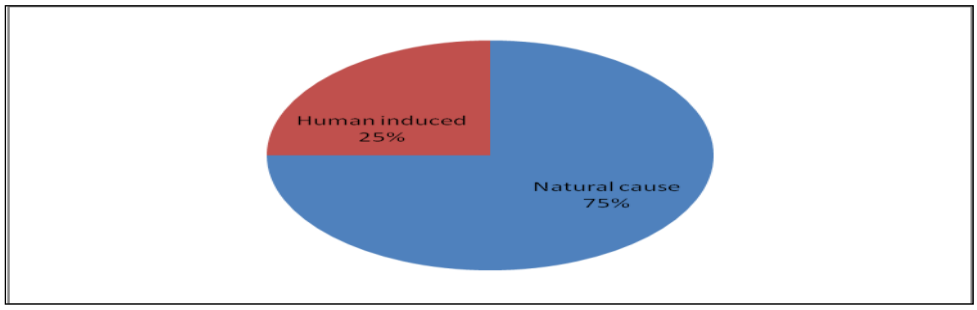

Figure 1: Responder's view on the causes of floods in Dar Es Salaam, Tanzania

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Causes of floods

This paper collected reasons for the occurrence of floods in Dar es Salaam Region. This question was designed to seek views from the respondents regarding the causes of floods in the region. Flood is natural event or human induced event. In some places floods happened once while in other areas is repetitive. It is once if the reasons for its cause are addressed or corrected. A head of household met at Sinza A Ward in Ubungo District had this to say, "*In this place (Sinza A ward) we experienced flood in 2018 because my neighbor built a fence which obstructs the drainage system, obstruct the smooth flow of water downstream, as an outcome floods occur. Sinza A Ward office tasked the owner of the fence to demolish the fence, he did so, since then we have not experienced floods*".

The causes of flood vary from one place to the other. It was revealed that causes of floods can be grouped as natural cause and human-induced (Figure 1). About 75% of the respondents said that, a flood is a natural event while 25% stated "*human is the cause of floods*" (Figure 1). Naturally, causes of floods among others include heavy rainfall, long periods of rain, ocean waves coming onshore such as storm surges, melting of snow and ice, and breaking of dams or levees. Not all floods are caused by nature, some are man-made. Humans induce floods by building on the drainage systems, disposing of waste in the drainages, poor design, and lack of maintenance of the drainage systems. Other human activities which exacerbate floods include deforestation, impermeable surfaces, and climate change.

Responder's views on flooding are varied. For instance, one of the responders claimed that "*Not all floods are caused by nature, others are man-made. Dar es Salaam usually gets floods because of poor design of the drainage systems, when construction of drainage systems does not consider quantity or volume of water*". Another

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respondent explained that, "*Flood is natural because, as I know, Dar es Salaam Region usual gets floods during rain time, no rain no floods*". He further said that, "*No dam or water reserve in Dar es Salaam which can cause floods, that's why I said that, floods in Dar es Salaam is natural and not man-induced*".

Three main natural factors are identified for causing floods in Dar es Salaam, namely heavy rainfall (79% of respondents), long period of rainfall (14%), and ocean waves (4%) (Figure 2). A respondent, an old man from Manzese Uzuri emphasized that "*Rain which takes more than a day, amounts to floods because the land becomes saturated and then the water overflow on the land leading to floods*".

Human-induced flooding is noted as another cause of flooding in the study area. A man interviewed at Mwananyamala Ward claimed that "*Flood is carelessly caused, for example, people build on the water stream, what do you expect when the rain comes?*" In Magomeni Ward, the old women interrogated said, "*People know that, Jangwani or Msimbazi Valley is one of the areas susceptible to floods, but people build houses there, if water engulfed the area, is that a flood or what. It is not a flood because people have followed the way of water*".

Another factor mentioned for causing floods is people building on waterways, which was supported by 35.6% of the respondents (Table 2). Humans are causing floods due to blocking water streams/ systems by building houses on them. Floods experienced in Manzese and Mwananyamala are mainly due to blockage of the water system. Reducing the size of water streams or drainage is another cause of floods. Since the drainage system cannot hold all water, water overflows its banks leading to floods. Roofs of buildings collect water massively when on its movements to the ocean, overflows leading to floods.

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Disposing of solid waste in the drainage systems is not a new thing in Dar es Salaam Region. One of the areas used for disposing of waste is in the drainage system. This is a big problem because throwing waste into the drainage system is done at night when most people are in their homes. It is a problem during the rainy season as waste or garbage block the smooth movement of water downstream leading to floods. Poor waste disposal as a cause of floods is supported by 50.5% of the respondents (Table 2).

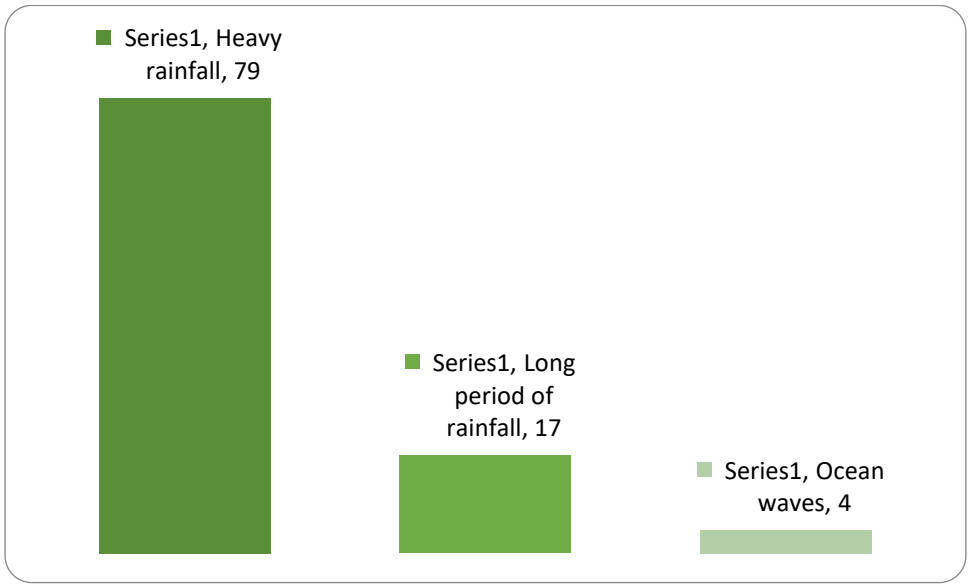

Figure 2: Natural causes of floods

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Table 2: Reasons for persistent floods in Dar es Salaam Region (n = 101)

Factors leading to floods	Frequencies	Percentages
Dispose waste in the drainage systems	51	50.5
Building in/ on the water way	36	35.6
Heavy rainfall	49	48.5
Reduced the size of water way	32	31.7
Poor urban planning	31	30.7
Long time of rainfall	28	27.7
Poor design of the drainages	26	25.7
Establishing settlements on the drainage systems	15	14.9
Dar es Salaam is in a low land area	9	8.9

Another human cause of floods is associated with designing of drainages. Drainage systems are poorly designed in the sense that, some drainages are small in size while others are very shallow. Existing drainages failed to accommodate the runoff during heavy rainfall. Poor design of the drainages as a reason for floods is supported by 25.7% of the 101 respondents (Table 2).

Building of residential settlements in the drainage systems is another reason for floods in Dar es Salaam Region as revealed by 14.9% of the respondents (Table 2). People build houses in the waterways or near the waterway the situation which reduce the size of drainages leading to floods. Respondents claimed that before Mto Ng'ombe, a river crossing between Sinza and Manzese was upgraded, the area used to be flooded every year. It is observed that houses are built close to the river, which makes the river channel small and unable to contain all water. The findings

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further revealed that floods in Dar es Salaam Region are mainly caused by Dar es Salaam being a low land area. Geographically, the region collects water in a short period of time leading to floods. About 8.9% of 101people interviewed mentioned Dar es Salaam Region being in a low land area which is the reason for floods (Table 2).

Effects of floods on the livelihoods of Dar es Salaam residents

The second objective of this article was to identify effects of floods on the lives of people in Dar es Salaam Region particular to those residing in flood prone areas. The question asked was; "what were the effects of floods on the lives of the residents residing in Dar es Salaam Region?" In response to this question, different effects of floods were identified (Table 3). The social and economic status of the people in the study area was not spared by floods. Many persons were left homeless as their houses and even farm crops and stocked food were washed away by the floods (Mbura, 2014). About 70.3% of the respondents have experienced their house and valuable properties damaged (Table 3). Due to floods, infrastructure-like roads and railway were badly damaged while others washed away by floods. Table 3 showed that, 66.3% of the respondents showed that, infrastructures like roads, schools and health centers were affected by occurrence of floods.

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Table 3: Effects of flood related disaster on socio-economy of victims

Effects of floods	Responses	Percentages
Many houses swept away with a lot of properties damaged	71	70.3
Infrastructure damaged	67	66.3
Many business have been destroyed	51	50.5
Many people lost job due to floods	39	38.6
Number of dependent has increased due to floods	21	20.9

Due to floods many businesses were destroyed and others closed. About 50.5% of the people interviewed (50.5%) revealed that businesses have been destroyed by floods. Floods engulfed their businesses, destroyed their business items which gave them a big loss. Some were forced to close their business while others moved their business to other location. A business man interviewed in Mwananyamala Kisiwani had this to say, "*Floods has been a blow to me, I lost my shop which I opened after getting a loan from one of the bank in Tanzania. I don't know how I will service the loan without a business*".

Losing job and redundancy was another outcome of the floods. The results showed that, some people lost their job because floods forced people to close businesses while some activities like building construction stopped, thus people have to live without pay. This effect of losing job was supported by 38.6% of the respondents (Table 3). As explained above that, some businesses were closed workers in these businesses have to stop working. Activities like welding, garages, music studios and others situated in the flood prone area were closed.

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Number of dependant has increased due to floods. About 20.6% of the respondents mentioned increased of dependant as the result of floods (Table 3). Socially, the impact of floods increased number of orphans, family separations, diseases, crimes and general immorality. The flooding caused displacement of people which disturb social ties. Affected people were temporarily hosted by friends as well as in temporary public buildings, schools, mosques, and churches.

There was widespread destruction of physical infrastructure, particularly roads and bridges, some of which were completely damaged/ broken. The damaged infrastructure interfered with communication between neighboring places within and outside the municipality. Flood caused significant damage to houses and swept away personal household items and belongings as well as other properties, including poultry; death and damage of properties. Death was another effect of flood. For example a number of people lost their lives following the outbreak of dreadful epidemics which were a result of the post –floods disasters that were caused by the el-nino of 1997/1998. For example years, 1998 and 2010 had a record of 1,871 deaths each. The other years had a record of smaller numbers of deaths. Regarding deaths caused by floods; year 1990-183 deaths were recorded; in 1997-304 and in year 2011-102 deaths (Mbura, 2014).

Floods are usually associated with negative societal impacts in different countries (Bubeck, 2017). Socially, the impact of flood leads to increased number of orphans, leads to separations, cause diseases and crimes. Majority of the respondents (75%) declared that, floods had an effect in the social lives of the people living in the areas which were attacked by floods. And the literatures also revealed the effects that have been experienced for a span of time (Mbura, 2014; Bubeck, 2017). According

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to available documentations, every flood which occurred in Dar es Salaam and last for 4 hours or more down-pour of rains killed people. The rains also caused a great destruction of personal properties, public infrastructures as well as leaving hundreds of people homeless. The findings revealed further that, most of the deaths were caused by drowning and trauma. All of which were a result of the victims failure to escape whenever floods occurred. From the literature it is revealed that flood disaster have hit countries like Bangladesh, other countries and has left the countries seriously affected socially (Mallick *et al.*, 2015). The reasons presented in Table 3 clearly answer the question which probes the effects of floods on social and economic lives of the people in Dar es Salaam.

Mitigation measures and management of floods

It was found that flood is a result of natural and man-made event. Different regions have experienced floods including Bangkok in Thailand, Maputo in Mozambique, Mombasa in Kenya, Bangladesh and Dar es Salaam in Tanzania (Mallick *et al.*, 2015). Since flood is inflicting different cities and Dar es Salaam in particular, there is a need of addressing its causes.

The first measure to avoid effects of floods to people is government and municipality to ensure that, land planning policies are reinforced. Land use planning will enable people to use the land for the purposes planned for, which will prevent people from building near and in valleys or in the area susceptible to floods. Municipalities have master plan which shows what is to be done where. Adherence to master plans; would prevent floods from happening and if it happen will not affect people and their properties. 32.7% of the respondents suggested master plan to be a guide for land use in urban areas (Table 4).

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Table 4: Mitigation measures to floods

Measures	**Frequencies**	**Percentages**
Reinforce land-use planning or master plan	33	32.7
Upgrade and enlarge drainage systems	27	26.7
Keeping drainage systems clean	26	25.7
Avoid disposal of waste in the drainages	19	18.8

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Another solution to floods is to upgrade and enlarge drainage systems in order to accommodate all rain water. Mto-Ng'ombe River crossing between Sinza and Manzese wards, its banks has been constructed, the work which have controlled floods which was a problem to some parts of these wards. Some people have constructed residential houses close to or in the drainage system and reduce the size of the drainage. Solution to this was relocating people to other areas which paved ways for demolishing of settlements built in the drainage and pave the way for water. This activity lessens the problem of floods inflicting different areas in Dar es Salaam in every rain season.

Cleaning campaign is another solution to floods in the study wards. In Rwanda, it is a law that everyone on the last Saturday of every month between 08.00 and 11.00, at least one person between the ages of 18 and 65 in every Rwandan household must get outside and clean, fix or do maintenance work. This habit make the city clean and reduce the possibility of getting floods due to garbage or waste to obstruct water movement. The same style can apply in the study wards. Frequent cleaning of drainage water systems can facilitate smooth flow of water and control floods. Keeping drainage system clear as a solution to floods was supported by 25.7% of the respondents (Table 4).

A proper handling of waste or garbage is a step towards floods control. Avoiding disposal of waste in the drainages is a measure against floods as said by 18.8% of the respondents (Table 4). A place where most people dispose waste for free is in the drainage system. People are not paying the cost of waste or garbage collections. People prefer drainages as a place to dump their waste because it is done for free, no payment

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is charged. Fines should be enforced and wards must set or identify a point for garbage collection. This will control the problem of people thrown waste in the drainage systems which then leads to floods.

Discussions

Floods are common events around the world. Floods have severe impacts on peoples' livelihoods in term of food, water and socio-economy. In recent decades, sub-Saharan Africa has been affected by catastrophic floods (Tiepolo and Galligari, 2021). Floods are caused by different factors which are natural and human induced factors (Dodman *et al.,* 2017; Satterthwaite, 2017).

Floods are short-lived events that can happen suddenly, sometimes with little or no warning (Opere, 2013). Floods are caused by intense storms that produce more run-off than an area can infiltrate and store or a stream can carry within its normal channel. The floods caused a significant impact to the affected people. Floods led to severe loss of life (human and livestock) and damage of properties, destruction of infrastructure, disruption of the communication networks and large losses to the economy. Floods put the affected population at risk of diseases. Floods have socio-economic impacts on the livelihoods of people. Floods in some countries like Bangladeshi and Bangkok lead to displacement and relocation of people. Affected people were temporarily hosted by friends as well as in temporary public buildings, schools, mosques and churches. There was a widespread destruction of physical infrastructure, particularly roads and bridges, some of which were completely damaged/ broken. The flooding caused significant damage to houses and swept away personal household items and belongings as well as other properties, including poultry. The ENSO floods in 1998 in East Africa resulted in human suffering and deaths, as well as extensive damage to infrastructure

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and crops in Kenya (Opere, 2013; Mbura, 2014). In Kenya, the hazards and impacts of floods were demonstrated by the 1997/1998 El Nin˜o episodes (Opere, 2013; Mbura, 2014).

Floods is always an abrupt event, thus preparedness is a very important aspect of dealing with the prospective disaster management approach. The management of floods is not uniform to all countries as floods vary from one area or country to the other. Flood loss prevention and mitigation includes flood control measures such as construction of dams or river dikes and non-structural measures such as flood forecasting and warning (Tingsanchali, 2012). Urban authority should re-enforce land-use planning and master plan and ensure that each land use activity is executed where they are supposed to be executed and not otherwise. According to Tingsanchali (2012), many cities and urban areas are located in flood plains because land is fertile and flat which is suitable for agriculture and urban development. For this reason, people living in flood plain areas must be on alert, prepared and be ready at any time to leave. Some drainages are shallow and small, thus to upgrade and enlarge them is recommended as it will accommodate all storm water, Keeping drainage systems clean and avoid disposal of waste in the drainages is good as it will allow smooth flow of water to the downstream. Precautionary approaches such as those introduced in Bangladesh develop adaptive strategies to improve coping capacities against flood risks (Mbura, 2014).

Conclusions and Recommendations

Flood risk is rapidly increasing due to climate change and human activities. Flood is both natural and human caused. It was discovered that, most residents in the study districts in Dar es Salaam Region are unprepared for

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floods. Thus, if there is proper floods management mechanism in Dar es Salaam and Tanzania as a whole, the effects of floods will not be there or will be minimized. Existing drainages and sewers have a limited carrying capacity and excess water from extreme rainfall cannot be absorbed by impervious surfaces, thereby increasing the rate of storm water runoff (Rincón *et al.,* 2018). Most of the Dar es Salaam area consists of plains and impervious surfaces which accelerate floods experienced by Ubungo and Kinondoni Thus, several floods which happened in Dar es Salaam have devastating impacts such as death, damage to infrastructure, disease outbreaks and flooding in ground-related homes.

This study finds that there are several solutions for the management of floods. Enlarge drainages to increase its water holding or carrying capacity, this reason will control floods. The Government of Tanzania has taken several initiatives to create awareness to its people on the danger of settling near and along the valleys; still people are residing in the areas susceptible to floods which blocks the draining systems leading to floods. Government have tried to remove people residing on floods prone areas like Jangwani Valley and Bonde la Mpunga in Dar es Salaam Region to list some, this exercise has rescued life of many people. The experience showed that slowly people returned to the areas they have been removed. It is high time for the government to do monitoring to those areas so that people cannot clandestinely return to the areas they have been removed. The Government should remove its people from the flood prone areas and convert those areas to other uses and direct people to areas which are safe from floods.

Permanent resettlement and construction of flood resilient homes will be part of the long

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term recovery process. The families from the worst affected areas should be provided with land for resettlement to start a new life. Serious training should be given to people over the risk of building in unwanted or flooded areas. In general education, awareness and warning appear to be a key in preventing effects of floods. For example, people should be told to avoid entering flood waters, either by vehicle or on foot. In the future, urban planners and politicians could look into implementing reservoir flood storage systems in urban areas. Government policies that restrict the urban transformation of green spaces to impervious surfaces could prove useful. Finally, it is recommended that urban planners and politicians develop an index that calculates the impacts that impervious surfaces have on floods. With this in mind, future developments can be planned appropriately.

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Conflict of interest

The author declares no conflict of interest in this paper.

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