Tanzanian Journal of Population Studies and Development, Vol. 24 Nos. 1&2, 2017: 67-93

Community Disaster Risk Assessment in Arusha City, Tanzania

Herbert Hambati[*]

Abstract

Urban population growth has demonstrated synergetic relationship with the growth of informal settlements and disasters, especially in developing countries. The increase in the density of people in informal settlements in Tanzania has accelerated their vulnerability to disaster risks. This study employs Community Participatory Disaster Risk and Vulnerability Assessment (PDRVA) to analyse vulnerability to disasters in informal settlements in Arusha city, Tanzania. The results show that a plethora of factors—human, physical, social, and economic—interact in a complex non-linear way to shape vulnerability to disasters in informal settlements in the city. Indigenous and western knowledge in the settlements used to cope with environmental hazards hold a great potential in shifting community responses to long-term considerations. The study recommends that measures and strategies aimed at reducing disaster risks should address the whole set of issues leading to poverty and disparities within the community.

Keywords: *risk, vulnerability, disaster, informal settlements, Arusha, Tanzania*.

1. General Introduction

The population of Tanzania is growing very rapidly: a trend particularly pronounced in urban areas that are growing at a rate twice that of their counterpart rural areas. The UN projects that the urban population in Tanzania will grow from 9.4m in 2005 to 29m by 2030 (UN, 2011). Rapid urbanization has increased the stress on institutions already struggling to cope with the delivery of basic services such as roads, drainage, sewerage, solid waste management, clean water supply and basic health care; while investment in urban infrastructure in the country has also not kept pace with population growth. This has resulted in poor or declining access to urban infrastructure and services in several sectors**.** The rapid spatial expansion of cities due to increased population growth has resulted in the mushrooming of settlements in unplanned areas (Hambati, 2013). Incidentally, they are the fragile urban ecosystems that attract the majority of urban dwellers due to their social and economic conditions. As noted by the UN-Habitat Agenda in 2004, rapid urbanization, the concentration of urban population in large cities, the sprawl of cities into wider geographical areas and the rapid growth of mega-cities are among the most significant transformations of human settlements in the 21st century that need to be addressed in developing sustainable cities (UN-Habitat, 2004).

[*] Senior Lecturer, Department of Geography, University of Dar es Salaam: hhambati@udsm.ac.tz

The country's human settlement policy (URT 2000: 25) observes that fragile ecosystems in urban areas in Tanzania are occupied and developed without permission from the respective city councils. It is stated that building in unplanned and un-serviced areas accounts for most of the new constructions in many urban centres. Moreover, these areas accommodate many flowering informal sector activities, and provide employment opportunities on which the majority of urban residents depend for their livelihood (Healy, 1997; Pelling, 2003). According to the Tanzania national census report, 28% of the total population is living in urban areas (UNCHS, 1996; URT, 2012). The projection also indicated that by the year 2025 the urban population in Tanzania will grow to 46% of the total population. The environmental and social consequences, risks and demands of this shift are a challenge to many urban authorities in developing sustainable cities with sustainable ecosystems.

Observations have revealed that rapid urbanization has produced externalities that have impacted on health, safety, and quality of life: all of which are directly linked to climate vulnerability, greenhouse gas emissions, and lagging infrastructure delivery. For example, over 70% of Dar es Salaam's residents reside in unplanned settlements (World Bank, 2002). Typically, these areas have inadequate basic services—such as water supply, waste disposal, electricity, public amenities and road networks—and are particularly vulnerable to flooding and soil erosion as many are located in low-lying marginal areas and hill-sides with poor drainage. From an emission standpoint, most urban households in the country rely on charcoal for cooking (approximately 71% in Dar es Salaam, and 53% in other urban areas), generating emissions and environmental degradation tied to deforestation in peri-urban areas and rural hinterlands, as well as household and citywide air pollution (World Bank, 2009). The culmination of these factors has led to an increased risk of flooding, which can be severely damaging to informal and fragile environments. An example is the flooding that happened in Dar es Salaam between December 2011 – January 2012 that displaced 10,000 people and caused 40 deaths (IFRR, 2012).

In general, cities are particularly vulnerable to the impacts of natural hazards due to their population density and concentration of infrastructure and economic assets. As many Tanzanian urban areas are located near the coast or along rivers, drainage lines and extreme climatic events such as windstorms and heavy rainfall can cause tidal surges, floods and soil erosion that have substantial impacts on life and property. Within cities, the impacts of climatic hazards are distributed unevenly among urban populations. Generally speaking, lower-income communities tend to live in marginalized lands that face greater risks. Their capacity to respond to impacts is also lower: poorer residents tend to have less access to information, scant resources to withstand adverse impacts, and fewer safety-nets. With little assurance that their homes and belongings will be safe in the case of evacuation, they can also be reluctant to leave and thus take risks with their properties, health and safety.

The theory underpinning the analysis of hazards and disaster risks in cities is based on the progression of vulnerability of humankind in urban setting, developed by Wisner et al. (2005); and seeks to unveil causes of disasters and also to reverse the processes. The 'crunch' model by Wisner et al. (2005) explains what disaster is and why it happens, while the pressure and release model addresses the opposite. The explanation of vulnerability has three levels, which connect a disaster to processes that are sometimes quite remote and lie in the economic and political spheres. These levels include: root causes, dynamic pressures and unsafe conditions.

Root causes (underlying causes) refer to all distant causes of vulnerability. The most important root causes that give rise to vulnerability (and that produce vulnerability over time) are economic, demographic, and political processes. These affect the allocation and distribution of resources between different groups of people. Root causes are normally a function of economic structure, legal definition of rights, gender relations, and other elements of ideological order. They are connected with the functioning of the state, and are ultimately controlled by policy and declarations (Hambati, 2011).

Dynamic pressures are processes and activities that 'translate' the effects of root causes into the vulnerability of unsafe conditions. Dynamic pressures channel root causes into particular forms of insecurity that have to be considered in relation to the types of hazards facing people. These include the lack of local institutions, training, and local markets: all of which reduce access to resources as a result of the way regional or global pressures—such as rapid population growth, epidemic diseases, deforestation and rapid urbanization—work through to localities.

Unsafe conditions are specific forms in which the vulnerability of a population is expressed in time and space in conjunction with a hazard. Examples include people having to live in dangerous locations, being unable to afford safe buildings, lacking effective protection by the state (for instance, in terms of effective buildings codes), having to engage in dangerous livelihoods, or having entitlements that are prone to rapid disruption.

The chain of explanation linking unsafe conditions to dynamic pressures and root causes in the cities can be illustrated by examining events of unsafe locations. The presence of people in hazardous areas is often the result of broader political, economic and social pressures, which tend to displace weaker groups from safe to unsafe ecosystems.

The general objective of this study is to assess community resilience to disasters in Arusha city. It also examines community perceptions of hazards and disasters so as get people's knowledge on what are the likely causes, impacts and adaptation measures and strategies to disasters in cities. The major research questions are: What are the hazards and disasters found in Arusha city? What are the causes and impact of these hazards and disasters? What are the existing adaptation measures and strategies used to cope with hazards and disasters in the city?

2. Methodology

The study employed participatory disaster risk assessment (PDRA) methods to get the information on disaster risk(s) in the study areas (Table 1). The PDRA was supported by field observations, interviews and household surveys to verify and cross-check information.

Table 1: Community Participatory Disaster Risk Assessment Design

Steps	Objectives	Output
One	Describe hazards in the community	List and nature of hazards.
Two	Conduct community hazards mapping	Hazards and disaster risks mapped.
Three	Describe Exposure and vulnerability of the community.	Exposure and Vulnerability Analysis (EVA)
Four	Determine Elements at risks per each hazard (people and their properties)	Comprehensive list of disaster risk facing the community in the city
Five	Rank disaster risks	Prioritized list of disaster risks
Six	Decide on acceptable level of hazard/risk	Community perception on hazards/risks Agreed level of risk for family and community security.
Seven	Decide whether to prevent, reduce, transfer, or live with the disaster risk(s)	Agreed community adaptation measures and strategies

Source: Modified from Hambati (2013)

Before PDRA is conducted, we identified the top two ranked wards that are highly at risk from natural disasters in Arusha city in collaboration with the regional disaster management committee based on the output of landscape-distance-population (LDP) criteria. The committee is composed of heads of departments and chaired by a disaster focal-point person. The selected wards were Ngarenaro and Daraja Mbili (located in Arusha district) (Fig. 1). The aim of selecting the two wards was to make a comparison between community perceptions on hazards and disasters even though the two are located within Arusha city.

The study employed geographical information system (GIS) techniques to identify the physical vulnerability within the city. Through the use of the GIS techniques three main factors were considered—landscape, distance and population—when assessing the vulnerability of a community to natural hazards and disasters (e.g., flooding). Through GIS, digital elevation model was used to determine the elevation of the area under study, distance of houses from flood-prone areas, and the number of human populations exposed to flood disaster risks (Fig. 1). For example, people have settled and made developments in a number of stream channels in Arusha city. These areas are at greatest risk to flooding during extreme rainfalls. The hazard and vulnerability assessment model in this study take into considerations the distance from stream channels to households. Existing stream channel data was found to be extremely

inaccurate and unsuitable for this investigation. Streams were manually digitized, using the 1 Meter IKONOS imagery at a scale of 1:6000, which resulted in acceptable accuracy of the stream channels (Fig. 2).

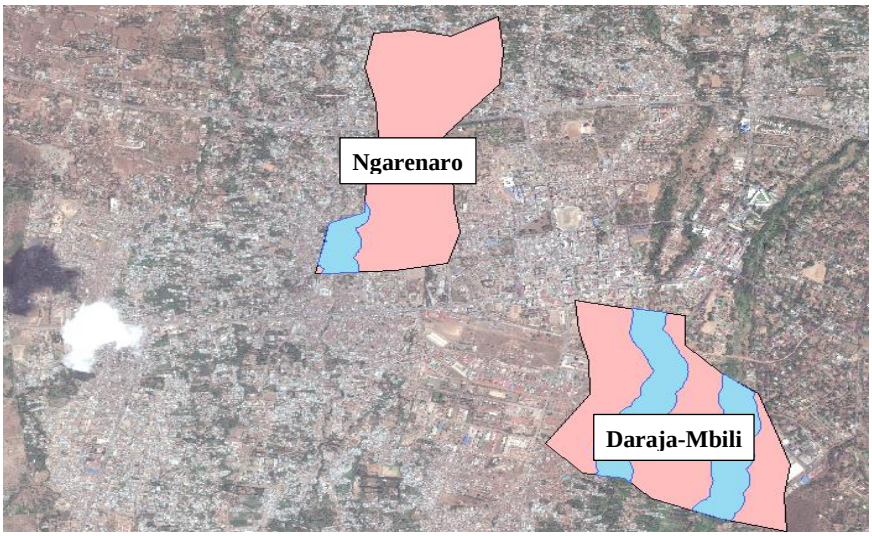


Figure 1: *Sample Wards in Arusha City*
Source: Landsat Imagery, (2016)

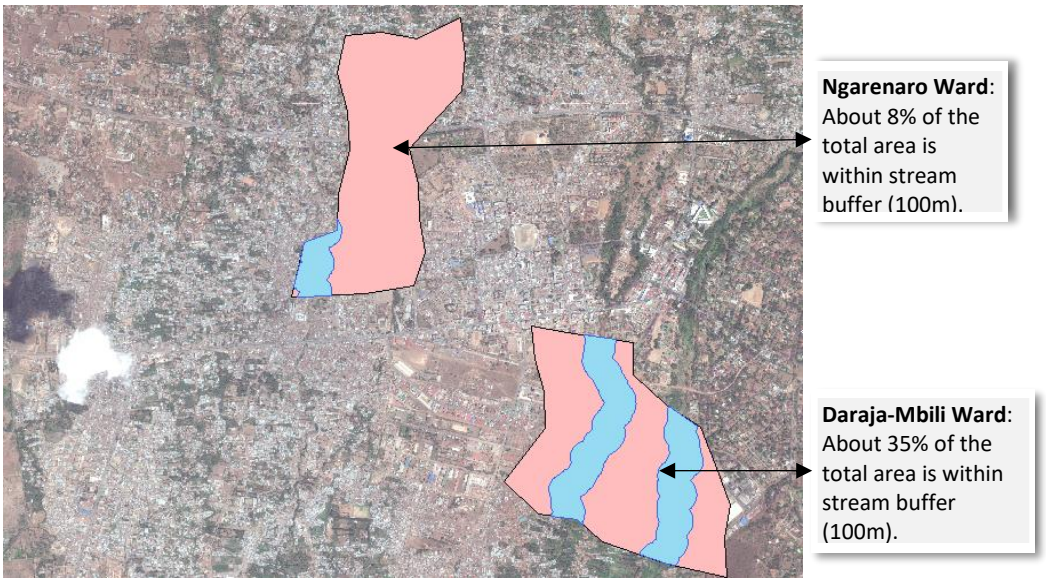


Figure 2: *Area within the Flood Prone Areas in the Study Wards in Arusha City*
Source: Landsat Imagery, (2016)

Streams were identified along visible channel features: when a channel was obscured by vegetation/construction or clouds the channel position was estimated closely following additional visual clues, especially riparian vegetation. Streams were digitized as continuous poly-lines. No indication of culverts or other potential channel barriers were recorded for the streams. The streams were buffered at 100m (Fig. 2). The model is additive with higher values, indicating progressively higher threats for flooding. The highest risks for flooding are in areas within 100m of a mapped stream. This is because as the distance from stream channel and elevation increases, the flood risk decreases as well. The number of house units and community properties that fall within the lines of 100m buffer from stream channels (inlands) are also assumed to be at higher risk to flooding in the study areas.

3. Results

3.1 Socio-Demographic Profile

The socio-economic parameters inevitably play a key role in a community's vulnerability and resilience to hazards and disasters. These parameters include age and gender characteristics, education level, marital and employment status.

3.1.1 Age and Gender

The gender and the age of respondents are important in determining a community's perception on hazards and disasters in their area. Most of the respondents (62%) were aged between 18–35 years, followed by 35% who were between 36–59 years old. Only a few people (3%) aged above 60 years were interviewed: this was due to the fact that the labour force in any community is in the age between 18–59 years, and thus it is the right age-group to explain community disaster risks, livelihoods and wellbeing. Out of the 192 respondents interviewed, 54% were female and 46% were male. This shows that most of the women were at home compared to men who are bread-earners in most African families and as such go out in search of, or to work. This implies that during the onset of a rapid hazard/disaster such as floods or flash-flooding in the day time, women and dependent populations are more at risk compared to men. Indirectly, these result shows that women and children are more at risk and vulnerable to hazards compared to men because they spend most of their time in hazardous areas compared to men.

3.1.2 Education

Education in the study areas was categorized into three major groups: formal, informal and non-formal education. According to the households interviewed, education level determines the occupation of household members. Those with formal education were employed in decent and well-paid jobs, and have access to land in planned areas. On the other hand, those with informal and non-formal education were self-employed in the informal sector, with low returns, and were

located on marginal areas. Sometimes marginal areas (valley bottoms) are unfit for human settlements because of the lack of social services, security and insurance. Household interviews revealed that 46% of the respondents have attained primary school education, while 40% had secondary school education. Only a few (6%) had attained certificates after their secondary education. Similarly, only 4% were diploma and degree holders (Fig. 3).

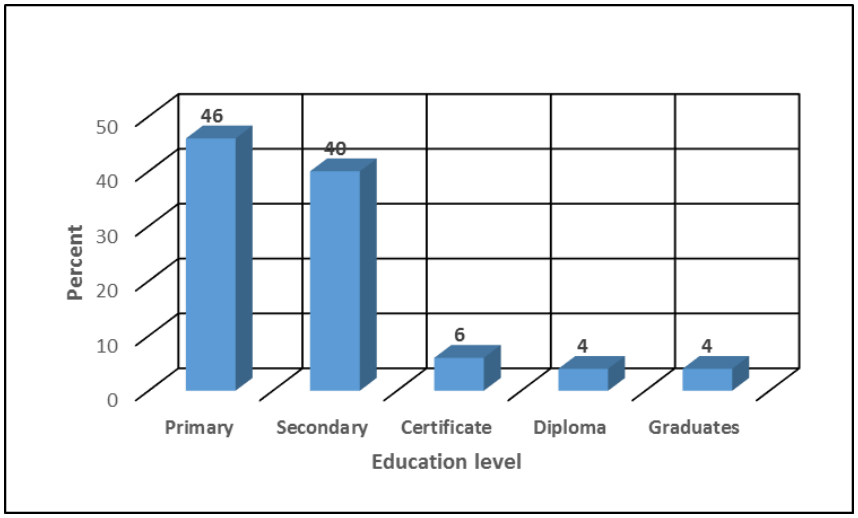


Figure 3: ***Education level of the respondents***
Source: Field data (2017).

According to the households interviewed, those who had secondary education and above were employed in the formal sector. On the other hand, those with informal and primary education had no chance to have formal employment: they had more chances of being employed in the informal sector where an educational level is not a prerequisite. The majority of the households (46%) with primary school education were women. During the survey, women with primary education mentioned that they had never been employed in the formal sector, probably due to their education level. Most of the women are employed in the informal sector, which is economically and politically a marginalized sector, thus making them more susceptible to natural, human-made and human-induced hazards. It was also noted that the majority of the households interviewed (86%) were employed in the informal sector. Most of the informal sector activities were located on hazard-prone areas. In fact, apart from being susceptible to natural, human-made and human-induced hazards, the informal sector has low returns (income). As might be expected, households heavily dependent on this employment base suffer greater impacts from natural hazards, and face slower recovery from disasters.

The education status and skills of an individual is an important dimension of vulnerability assessment. Apart from determining occupational status, education also has a key role to play in understanding and interpreting preparedness measures (i.e., vulnerability assessment, plan of action, institutional arrangements, resource mobilizations, public education and training, alert systems, information-sharing, response mechanisms and rehearsal) on the expected hazards and disasters in an area. The more the knowledge on hazards impacts and preparedness measures in place, the less the loss and the sooner the recovery, while the opposite case is also true.

3.1.3 Marital Status

A family bond (father and mother) is an important socio-economic characteristic in explaining a household's vulnerability and resilience to hazards and disasters because a household's income depends on its head (father or mother, or both). According to discussions with the households, the more a household is united and shares resources equally, the greater is its resilience to hazards and disasters. Families that are single or unmarried, and those that are married and married with children perceived hazards and disasters differently. In the studied sample, 39% of the respondents were married and had children. About 36% were single or unmarried, while 25% were married and widowed (Fig. 4).

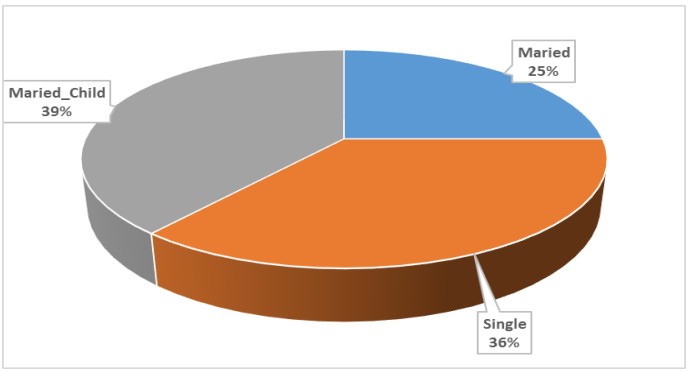


Figure 4: ***Marital Status of the Respondents***
Source: Field data (2017).

Most of the widows, widowers and divorced household members interviewed (78%) had been living in the sites free from hazard events before getting divorced or widowed, while 22% were living in hazardous location. One of the respondents (widow) affirmed this by saying:

> *"My husband and I lived in a planned area near the city centre. By then my husband was an employee of a textile industry, while I was a housewife. After his death two year ago, I and my three children were not able to pay house rent in that area. We decided to move into this area because the rent was cheap, though it is prone to floods."*

The above statement implies that the people at risk were aware of the hazardous nature of the sites they are living in. However, they have been forced to settle on hazardous areas because of social, economic and ecological constrains. From the profile of the household interviewed, widowhood in the study areas was concentrated in the age group of 50 years and above, while divorcees were sporadically scattered in the different cohorts of above 30 years of age. This could be attributed to the fact that while widowhood is likely to increase in older age cohorts, divorcees are an outcome of socio-economic attributes such as confrontations, conflicts and economic hardship as indicated by 56% of the households interviewed. This lack of social unit exposed households to hazards and disaster risks, especially in their old ages.

3.1.4 Employment

Employment is a source of income in a household. The heads of households who are employed—either by the government or private companies—have different perceptions on how to deal with hazards and disasters over time and space. The ones seeking for employment have also their own views and priorities on disaster mitigation and preparedness. The results on the surveyed households revealed that about 72% of the respondents were self-employed in the informal sector within the city. About 18% were looking for employment, while 10% were employed as civil servants (Fig. 5).

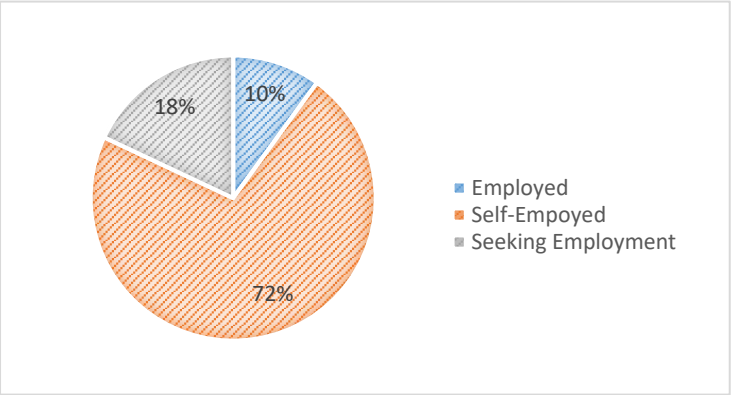


Figure 5: ***Employment Status of the Respondents***
Source: Field data (2017).

The results revealed that the surveyed communities were subjected to hazards and disasters as they lack strong economic base to put in place mitigation measures. As mentioned earlier, the occupation of an individual has a role to play in determining his/her income, which determines access to resources, and one's social, economic and political standing in a society. Also, we have seen that occupations—which are the sources of incomes—are categorized into formal for those who are working in the formal sector (sector registered and known to government), and informal for those who are working in the informal sector (sector not registered and not recognised by the government). Formal sector occupations have security in terms of wage payment, land tenure and insurance (loss-sharing), while informal sector occupations have no security in terms of wage payment, land tenure and loss-sharing (insurance). Thus, people whose employment depend on the informal sector are vulnerable to loss of income and susceptible to natural, human-made and human-induced hazards and disasters.

3.1.5 Migration and Settlement on Hazardous Areas

The influx of rural-urban migrants into Arusha city has been an influencing factor in the invasion of hazardous areas. The household survey showed that only 10% of the interviewed households were indigenous inhabitants of the city. Of these, 6% were residing in valley bottoms, while 4% were residing on mixed planned settlements. Most of the household interviewed (90%) were migrants from other regions of Tanzania. The study findings reveal that the influx of migrants into the hazard-prone areas started in 1975, and the situation become intense in the 1990s.

The influx of rural-urban migrants is attributed to the changes in agricultural policies and reform programs that were introduced in Tanzania beginning 1975 to early 1990s. The country adopted structural adjustment programs (SAPs) in the mid-1980s as a way of improving its economy. However, the agricultural sector was negatively affected by SAPs. One of the preconditions of the SAPs was to remove subsidies on agricultural inputs, which left a great burden on farmers. Before the SAPs farmers received subsidies in the form of seeds, fertilizers and farm implements. With the removal of subsidies, agriculture became more of a burden to farmers. Returns from agriculture decreased due to low production since most farmers could not afford the high cost of farm inputs and implements. An interview with one of the city council members (a male aged 54 years) revealed that, for the younger generation, agriculture has no better future: "*The younger people are looking for better opportunities in the cities, hoping to find something better than agriculture.*" Moreover, the price and demand of some agricultural exports have gone down in the world market due to the discovery of low-cost substitutes or alternative products, such as synthetic fibres in place of products like sisal and cotton, which were among the country's highest income-earning products.

Another factor that can explain the rural-urban movement, as narrated during an interview with one government official in Arusha regional office, was the 'urban bias' in development. Most rural areas have been neglected by the government in terms of service provision (hospitals, schools, water, etc.), infrastructures (roads, electricity, transport, etc.), and worst of all, they also lack employment opportunities. Industries and other income generating activities are concentrated in urban centres. Hence, this situation in rural areas has becomes a push factor for emigration. A great number of respondents (90%) confirmed that urbanization had been the main attraction for rural-urban migration in Tanzania.

3.2 Community Risk Mapping in Informal Settlements

Disaster risk is a function of hazards and vulnerabilities in a given area. It encompasses the determination of the probability and the sum of harmful consequences or expected losses resulting from interactions between natural, human-made and human-induced hazards, and vulnerable conditions of elements at risk.

3.2.1 Identification and Mapping of Community Hazards

Communities in the study areas identified fifteen types of hazards, which were classified into three main categories: natural, human-made and human-induced hazards (Table 2). The community has also indicated the location of each particular type of hazard along the landscape, and the probability of its occurrence. Ranking of each category of hazard was also done in respect to the expected consequences of the derived risk; that is, the likely loss created by each event over time and space. According to the community's physical environment assessment, flood, flash-flood, landslide and storm hazards are location-specific. These hazards vary in probability of occurrence across the landscape. The variation was mainly attributed to the slope, aspect and the configuration of a land surface.

In contrast, the probability of occurrence of other hazards (epidemics, human-made and human-induced) does not vary spatially across the landscape, and hence do not provide sufficient differentiation to address the degrees of disaster risk (Table 2). During discussions with community members involved in hazard mapping, this situation is attributed to the difficulties in estimating the probability of their occurrences, and the linkage of such hazard events with social, economic and environmental conditions at the community level. Through the weighting of hazard and disaster impact, the community ranked natural hazards at the top compared with other hazards and disasters (Table 2). The ranking and weighting factors were in terms of the number of people, houses and public services (health, electricity and water supply) that are likely to be affected.

Table 2: Community Participatory Hazard Mapping and Assessment

Type of Hazard	Location/ land units (LU):				Ranking of overall hazard type in respect to expected impacts
Natural hazard	Vb	Gs	Ss	Int.	
Flash flood	xxx	xx	x	x	
Flood	xxx	xx	x	x	1
Storms	x	xx	xxx	xxx	
Landslides	x	xx	xxx	xxx	
Epidemic hazard					
Malaria	xx	xx	xx	xx	
Cholera/diarrhoea	xx	xx	xx	xx	2
HIV/AIDS	xx	xx	xx	xx	
Human made hazard					
Fire	xx	xx	xx	xx	
Accidents	xx	xx	xx	xx	
Robbery/Stealing	xx	xx	xx	xx	3
Drug addiction	xx	xx	xx	xx	
Human induced hazard					
Air pollution	xx	xx	xx	xx	
Water pollution	xx	xx	xx	xx	
Deforestation	xx	xx	xx	xx	4
Soil erosion	xx	xx	xx	xx	

Key: Vb =Valley bottom; Gs = Gentle slope; Ss = Steep slope; Int. = interfluves
x = Low probability; **xx** = Medium Probability; **xxx** = High probability

Source: Field data (2017).

During the household survey most of the respondents (90%) mentioned that they had been affected at least by one of the natural hazards listed in Table 2, while 10% who are in the category of high-income earners had not suffered any natural hazard. The process of hazard mapping and assessment in the study areas revealed that there was a dominant hazard in each land unit. The common and dominant hazard was represented by high probability of occurrence ('xxx') (see Table 2). Valley bottoms were identified as the areas with high probability of flood and flash-flood hazards. This is also in line with the findings from household interviews, where 34% of the respondents who are living in ravines and in flood plains reported to have been affected by flash-floods and flood hazards.

According to the household interviews and discussions, elements at risk to flash-floods and floods in valley bottoms include people, houses, vegetable gardens, garages facilities and petty businesses. Table 2 also shows that there is a medium probability of flood and flash-flood hazards on gentle slopes. However, the respondents reported that these hazard events had not occurred on steep slopes and interfluves. This indicated that ravines and flood plains areas are more susceptible to flash-flood and flood hazards, respectively.

As Table 2 indicates, there is high probability of storm hazards on high elevated areas and interfluves. However, 95% of the respondents on hill slopes and interfluves mentioned they have built their houses on hillsides to avoid frequent flooding and flash-flooding that occurs in flood plains and on ravines. However, they further mentioned that although such areas are more susceptible to storms, for most of them these have not happened so far in their lifetime. Only 5% of the households interviewed affirmed that they have experienced storm hazard events in the area even though these are not common disasters in Arusha city.

According to the community hazard mapping team, epidemics have a medium probability of occurrence (Table 2). About 97% of the households mentioned to have experienced at least one epidemic hazard listed in Table 2. Out of these, 57% had suffered malaria, 27% had been affected directly or indirectly by HIV/AIDS, while 13% mentioned the prevalence of cholera and diarrhoea. These findings agree with the information given during the community hazards mapping. During the hazard mapping, epidemics hazards ranked the second in severity and impacts. The frequency of these hazards is also attributed to domestic water pollution caused by discharge of liquid waste from pit latrines into streams and rivers (such as the Themi River).

Human-made hazards—namely fire, robbery, accidents and drug addiction—are evenly and spatially distributed in the study areas (Table 2). During the community hazard ranking, these were ranked third in severity and magnitude compared to other hazards. According to the household interviews, there has been an increase in the incidences of robbery and drug addiction since the 1990s. Most households (54%) attributed the prevalence of these hazards to the increase of in-migrants into the city who are unemployed. According to the community hazard mapping team, human-induced hazards—namely pollution, deforestation and soil erosion—are spatially evenly distributed in the study area. This is also in line with the study findings: 39% of the interviewees mentioned soil erosion, while 52% mentioned air and water pollution.

These results show that the severity of human-induced hazards is low when compared to other hazards at household level, while in reality water pollution and soil degradation have been the sources of conflicts and epidemic hazards in the study areas. In other words, the impacts of these hazards spill over for a long period of time, and thus may not be noticed easily. The community hazards mapping team noted that an accurate perception of the relationship between human actions and the physical environment is a key component in the assessment of disaster risk and vulnerability in informal settlements within cities in Tanzania.

3.3 Community Perception on Hazards and Disaster Risk in the Neighbourhoods

The surveyed community were given an opportunity to mention hazards and disasters that have occurred, or are likely to occur in their areas. They mentioned

11 hazards that have occurred or are likely to occur. These are: floods, storms, drought, fire, accidents, diseases, HIV/AIDS, drug addiction, water pollution, air pollution and noise pollution. When asked to rank these according to threat, the first was drug addiction (29%), followed by floods (25%), accidents (25%), HIV/AIDS (24.5%), and diseases (21.9%) in the first five ranks (see Fig. 6).

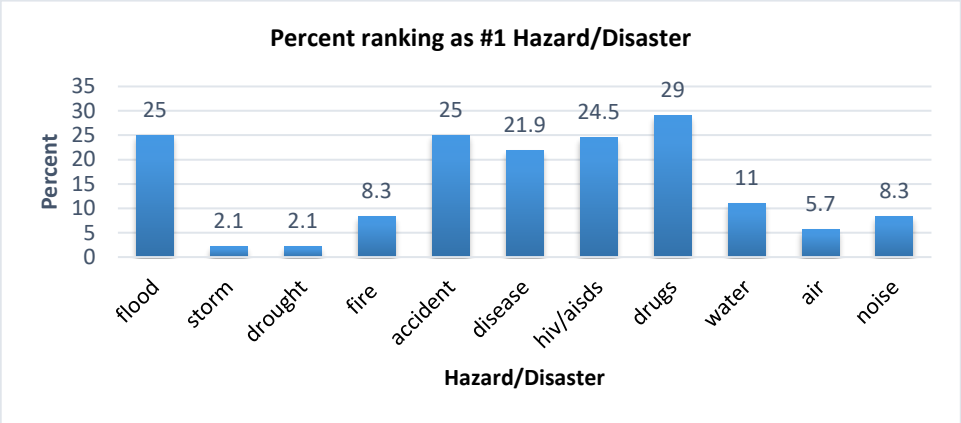


Figure 6: ***Community Perception on Hazards/Disasters in Arusha City***
Source: Field data (2017).

Also, the respondents were asked if the trends of those hazards ranked were increasing, decreasing, or remained the same. Most (62%) said that the trend was increasing at an alarming rate. About 20% mentioned that the trend is decreasing, while 15% mentioned that there was no change in the situation. Interestingly, 3% said that they were not aware of hazards and disasters in their areas. Probably these were newcomers in the area.

In comparing the results in community risk mapping and community risk perception, the vulnerability of a community and resources to hazards and disasters are unevenly distributed throughout the study areas. Therefore, this strongly support the variation in the degree of vulnerability to hazards and disaster risks. Any intervention plan on the basis of these community perceptions are likely to result into variations in response: both in timing, resources and in locational priorities. For example, the vulnerability of a community to diseases, human-made and human-induced disasters (nearly evenly distributed) might suggest deploying resources throughout the study area; whereas vulnerabilities to floods and storms would need concentrating personnel and other resources in specific areas/locations, as shown in Table 2, to address areas that have the greatest needs compared to others.

These results reflect the necessity of specific intervention on mitigation and preparedness measures to a particular hazard in a particular area singly and/or cumulatively. When variations in disaster risks are added, the need for

particular intervention on mitigation and preparedness measures becomes even more specific and cumulative in nature. The results in Arusha city shows a difference in the spatial distribution of disaster risks. As indicated in the study, Ngarenaro ward faces comparatively low disaster risks, thus requiring less interventions on disaster risk mitigation measures compare to Daraja Mbili ward.

3.4 Natural Disaster Profile in the Study Areas

A documentary review at the regional level showed that there is an evidence of the presence of natural disasters in the study areas as Table 3 shows. The flood hazard was reported 12 times in the period between 1968 and 2016. Also, in between 1968 and 2016 there were 5 cases of droughts. However, the total number of people affected by floods and their estimated losses are higher compared to the same in the drought hazard/disasters. The figures in Table 3 reveal that about 998,089 people were affected by floods in the study areas, causing an estimated loss of US$2,060,094,885. Table 3 also shows that drought affected 413,000 people in the period 1974 to 2014, with an estimated loss of US$1,059,420. The trend in Table 3 also indicates an increase in the number of people affected, and of the loss of property over time and space.

Table 3: Historical Record on Climate Related Natural Disasters in the Study Areas

Hazard/Disaster	Date occurred	Location	Human Affected # of people	Loss estimates (US$)
Drought events	1974	Arusha	34,000	Not given
	1984	Arusha	87,000	Not given
	1994	Arusha	102,000	150,234
	2004	Arusha	190,000	304,098
	2014	Arusha	390,000	605,088
		Total	**413,000**	**1,059,420**
Floods/Diseases	1968	Arusha	1,500	Not given
(Malaria, Cholera	1970	Arusha- Mto wa Mbu	51,000	69,000
Typhoid)	1975	Arusha	2,000	Not given
	1976	Arusha Mto wa Mbu	410	61,500
	1979	Arusha Mto wa Mbu	13,000	500,000
	1-2/051995	Arusha	19,170	728,954
	29/4/1995	Arusha	8,798	18,810
	Dec.-April 2006	Arusha Mto wa Mbu	10,758	19,345
	Jan.-April 2007	Arusha Mto wa Mbu	5,890	9,876
	Dec. 2011	Arusha	15,563	687,400
	Jan.- April 2014	Arusha Mto wa Mbu	750,000	1,400,000,000
	Jan.-April 2016	Arusha Mto wa Mbu	120,000	658,000,000
		Total	**998,089**	**2,060,094,885**

Source: Field survey and documentary review (2017).

As mentioned earlier, most of the climate-related hazards (droughts, floods and their respective outcomes) that have threatened human populations in the study areas are well known to the communities. The results reveal that 58% of the respondents had heard about those hazards and disasters, 25% have been directly affected by flood hazards, while 27% mentioned to know someone that had been affected by flood hazards. However, although the residents acknowledge the existence of floods and their associated risks in the areas, interviews with government officials at the regional and district level reveal that they do not recognise the presence of flood hazards and disasters in those areas. This might be due to the fact that any government official who declares a hazard or disaster in his/her area must have a strategy for mitigation and prepare people for the coming hazards or disasters, otherwise s/he might be endangering her/his employment. This is also in line with the argument made during the interview with the households, whereby 87% of the respondents did not declare that they are living in hazard-prone areas: doing so might make the government evict them from the areas.

The output on community mapping of disaster risks (Table 2) and the evidence shown on disaster profile (Table 3) do not mean that measures and strategies to reduce disaster risks would be similar within and among the categories of low, medium and high probability disaster-risk areas. Although the existence of socially and physically vulnerable populations and resources in areas with high disaster risk is a major concern, consideration must also be given to specific categories of people and resources in need, or issues associated with such people in disaster-risk areas. This can only be achieved through assessing community adjustment to physical and people's vulnerability to hazards over time and space.

The household interview also revealed that the main cause of flooding in study areas was poor infrastructure (75%), blockage of culverts (54%) dumping of solid waste in the streams (36%), and building on waterways (10%).

3.5 Community Hazards and Disaster Risk Management

Risk management of hazards and disasters in an area is a function of institutions and their operations. These includes institutional arrangements at different levels (local, national and international), and community adaptation measures and strategies at a household level.

3.5.1 Institutional Arrangements and the Management of Disaster Risks

Institutional arrangements and functioning of both formal and informal institutions play a great role in disaster management in cities. Formal institutions such as government departments, non-governmental organizations (NGOs), community-based organizations (CBOs), and international organizations: all influence the way resources are utilized. Similarly, informal institutions (such as traditional healers, weather predictors, etc.)—which are governed by taboos, codes of conduct and norms—are important in guiding local people's perceptions and performance of different activities over time and space.

Local Institutions and the Management of Disaster Risks

Most of the households interviewed (79%) mentioned that local institutions have important key roles to play in the management of disaster risks. This can be in terms of spatial planning and managing structural measures. According to a discussion with a government official, settlement patterns in hazardous areas were governed by taboos. Most of the households living in valley bottoms interviewed (76%) declared ravines as sacred places, and human activities were not allowed in such places. This is done purposefully to appease their gods; in actual fact it is meant to protect soil erosion and river pollution. This is why there are restrictions on the accessibility of this faith knowledge within the community beyond a few trained individuals or families that pass it from a master to an apprentice; or from a parent to a child. This practice considers such knowledge to be 'restricted information'.

When the households were asked about the role of informal institutions in improving human vulnerability, the majority (68%) of the respondents mentioned that tribal leaders, traditional healers and weather predictors (council of elders) have been working together to reduce hazard losses by alerting people to look out for impending damaging events. During the discussions it was reported that when a council of elders diagnoses a damaging event, it sends a team of young people who would pass such a message to all the people susceptible to such an event on what to do and what they needed.

For example, the people living in the Themi river valley in Arusha city had a well-organised system for mitigating impending flood and flash-flood hazards. There were elders who dealt with rainfall forecasting and early warnings (weather predictors). Each household was also required to dig trenches to control the water around the homestead and farmlands. In addition, they were required to avoid cultivation along the valley when heavy flooding was predicted. Most of the households interviewed (63%) mentioned that when crocodiles started laying eggs on the river banks on the high ground, that was a sign to the community of impending floods.

Households (63%) mentioned that another coping strategy against flood hazard was migration to other areas once elders have predicted the hazard. For instance, when floods came, those living on high ground areas were expected to accommodate neighbours displaced by floods in the lowlands. Usually members of groups living in such areas speak the same language and have the same culture. As it has been found out, in most cases informal dwellers tend to cluster themselves on tribal basis as one invites others after settling in an area. Therefore, they have common cultural values that tie them together. The groups are organised in such a way that they have a chairperson, cashier and a secretary. An interview with one group leader divulged that the minimum contribution of a member was TZS1000, and the maximum was TZS5000 per month. These informal groups in the study areas were the only

active local institutions at community level that shared the burden of hazards and disasters beyond the immediate victims by helping those who may lose relatives and/or property.

Policies and Legislation in Disaster Risk Reduction

Like local institutions, government policies have an important role to play in disaster risk reduction in a community. One government official interviewed in the study area said:

> *Disaster risk reduction at the national level in Tanzania started since the 1990s, specifically when the Disaster Relief Act (Act No. 9 of 1990) was enacted by the government. The government efforts gained momentum in the 2000s in response to the two major documents on disaster risk reduction regionally and globally. These are the African Strategy for Disaster Risk Reduction of 2004; and the Hyogo Framework for Action (2005-2015), which has now been replaced by the Sendai Framework (2015-2030). The emphasis of these documents in particular, was more on effective integration of disaster risk considerations into sustainable development policies and planning at all levels, with a special emphasis on disaster prevention, mitigation, and preparedness.*

The interviewee further claimed that the government has implemented the Hyogo Framework for Action by putting in place responsible institutions and policies on disaster risk reduction at national and local levels. But, in reality, most of the households interviewed (90%) during the field survey were neither aware of the disaster management policy, nor had they seen any organisational arrangement in place to that end. When officials at the regional level were asked on the responsible institutions on disaster risk reduction, most (98%) mentioned the organisational structure (on paper) for disaster management stipulated in the National Disaster Management Policy of 2004. In that structure, every region is supposed to have a disaster management committee that should be organising and giving directives on disaster prevention, mitigation and preparedness at different levels of administration, starting from the regional, district, ward, to the village level.

However, government officials interviewed at the regional office mentioned that there was a Regional Disaster Management Committee (REDIMAC) that was formed in 2005 in the region. The committee comprises of the following members: regional secretariats, district commissioners, district executive directors, city directors, city mayors, the regional police commander and the regional medical doctor in-charge, with their respective heads of departments. The REDIMAC is chaired by the regional commissioner (RC). Other members invited by the chairperson in respect with their service to the community include one representative from: NGOs, the Christian Council of Tanzania (CCT), BAKWATA, and one representative from a CSO dealing with child health and community development. The REDIMAC members were trained for one week (in 2005) about their responsibilities and specific roles over time and space; but since then they have not had any other official training.

According to the discussions, since then up to 2016, REDIMAC has never met to discuss issues concerning disaster management in the region, or conducted regular meetings in every three months as stipulated in the disaster management policy. The reason given by most of the members (96%) interviewed was the lack of funds and political will among and within the government officials. By the time of this research, disaster management committees had not been formed at district, ward or street levels in the region. The responsibilities of disaster management committees were delegated to the defence and security committees at each level. This implies that the whole issue of disasters and risk management was left to individual and community efforts in the city.

In the light of the above observation, we can note that there is an institutionalised post-disaster recovery and pre-disaster risk reduction phases for disaster management framework at the regional level: the REDIMAC. However, since its formation in 2005, the committee has not provided clear directives on organisational roles concerning disaster management at the central government or at the local level in the region. This has left a gap in spatial and sectoral coverage of disaster management in the city. According to household interviews no one seems to be responsible and accountable in coordinating post-disaster recovery phases in the area. They cited the situation observed during the flood disasters that occurred in Arusha city in March, 2011: that there was a delay in the whole process of attending the victims who had lost relatives and properties. This calls for an immediate establishment of effective coordination and cooperation between sectors to act accordingly through an institutional networking framework.

3.5.2 Community Adaptations to Natural Hazards and Disasters

As noted earlier, there a number of human adjustment strategies to mitigate the impacts of hazards and disasters (floods and diseases) in the study areas. These adjustments can be categorized into three groups, although the most effective ones often involve a combination of measures drawn from more than one strategy. These measures are: (a) modifications of the expected loss burden, (b) modification of hazard events, and (c) modification of people's vulnerability. As noted during the interviews, all adaptations measures have to be in place before a hazard event strikes to be effective.

Modification on Flood Loss Burden and Events

Modification on loss burden is a process whereby hazard responses seek to spread the financial burden as widely as possible beyond the immediate victims through reliefs and safety-nets of informal groups. These safety-nets are essentially on loss-sharing, rather than on loss-reduction. This is a post-hazard events action whereby member(s) affected by hazard(s) are morally and materially supported. During interviews with city officials, these informal

groups operates locally and are not registered. This hindered their full operation as they lack legal backups. They need to be registered so that they can operate on official grounds and standards.

Modification on hazard events involves reducing losses by adjusting damaging events to the people. This involves designing and building structures to safeguard lives and property from hazards in high-risk areas. During the household interview most of the respondents (76%) mentioned that to reduce the impacts of floods, city authorities should improve the drainage systems by cleaning drains before storms (Plate 1), and by strengthening stream walls passing through settlements (Plate 2).



Plate 1: Cleaning of drains before storms in Ngarenaro ward in Arusha city. Note, this activity is done communally especially few weeks before rain season starts.



Plate 2: Building along the waterways in Daraja Mbili ward in Arusha city. Community members and researchers observing the water quality and the water channel constructed to keep away flash-flood water from houses during heavy rains.

Other respondents (20%) were of the opinion that people should build away from flood-prone areas and waterways; while a few (4%) proposed that people should elevate the grounds of their structures on flood prone-areas. However, we observed during the field survey that none of these ideas had been put into practice, purportedly due the lack of coordination and financial support from the government.

Community Adjustments to Epidemic Hazard

During the household survey, the commonly mentioned epidemics in the informal settlements are malaria, cholera, typhoid, and HIV/AIDS. A number of initiatives have been taken at different levels to contain disease outbreaks and prevalence.

At the household level, some families boil drinking water; and use window wire mesh and mosquito nets to prevent mosquitoes from their houses and beds, respectively. In addition, some have constructed improved ventilated pit latrines whose holes are covered to prevent free movement of flies when not in use.

At the community level, people have organised themselves to regularly clean natural storm water drains to prevent the stagnation of water, which mosquitoes use as breeding grounds. Similarly, a number of activities are carried out at the city level, including inspecting toilets and giving advice on how best to clean and maintain them. The Arusha City Council, for example, has a schedule in place of conducting seminars and workshops, twice a year, for local government and CBO leaders on how to keep the environment clean. In addition, the council conducts ad hoc seminars and continues to provide training for food and vegetables vendors on how to prepare and sell clean and safe food in the city.

An interview with the one health officer in one of the study areas in March, 2016 divulged that the government and private agencies (health service centres) provide free treatment for malaria, cholera, and typhoid to children, pregnant women and old people, and also free vaccinations. Most of the women interviewed (75%) affirmed that the information given by the health officer was true. The interview with health officials also reported that since so far there is no treatment or vaccination for HIV/AIDS, the affected people were registered in ward health offices and given regular free ARVs, counselling, seminars, home-based care and food supplements. However, given the continued increasing number of people living in informal settlements in the city, these efforts by the government need to be supported by international development and humanitarian agencies for the short- and long-term sustainability.

Modification of People's Vulnerability to Hazards and Disasters

According to most of the household interviewed (85%), modification of vulnerability to hazards and disasters involves all measures designed to reduce hazard losses. It is achieved mainly through hazard preparedness measures and avoidance strategies, such as the installation of forecasting and warning systems

and long-term planning for appropriate land use allocations. However, the interviewed households also mentioned the need for assistance in the mitigation and preparedness measures. Most (70%) mentioned assistance from outside the community, while the rest (30%) mentioned assistance from within through community organizations. Those who mentioned assistance from outside their community said this could come from the government (70%), individuals (20%) and NGOs (10%).

When further asked to mention the kind of assistance needed, 78% mentioned education and training on climate-related hazards and disasters; 12% mentioned funds assistance, while 10% mentioned advocacy on natural resources utilization to improve the welfare of the people in the study areas. On the other side, those who mentioned community self-reorganization, mention the need to strengthen community participatory plans (74%), law enforcement (16%) and plans implementation (10%). Furthermore, the community members mentioned the need for continuous monitoring and evaluation of hazards events in the city.

4. Discussion

4.1 Flood and Flash-flood Hazards and Disasters

According to interviews with the households and government leaders, the past decade has been an expressive period in relation to flood and flash flood in the study area. This is a period when the most extensive, damaging and costly floods occurred in the city. The mostly affected ward by flood and flash-flood hazards in the study areas was Daraja Mbili. Because of the havoc wrecked by these hazards, most of the households interviewed (70%) in the flood plains and ravines revealed an increased awareness on mitigation measures and strategies against these hazards. Both structural (i.e., flood control walls and cut-off-drains) and non-structural (seasonal migration) measures have been applied to reduce the impacts of flood/flash-flood hazards.

The interviewed households mentioned that there were losses of lives and properties (see Table 4). This finding concurs with the observation by Hambati (2013) in Mwanza city; and by Smith (2001) in wealthier countries, which despite having engineering works intended to prevent floods, are still adversely affected by flood and flash-flood disasters. According to a study by Haque (1997) and Rugai (2008), flood and flash-flood hazards are essential components of agriculture and ecological systems in many parts of the world because they provide the basis for the regeneration of crops, plant and aquatic life, and of livelihoods derived from them. This is why a majority of the respondents (78%) living in ravines and flood plains areas disagree with attempts to stop floods entirely. Floods are even given different names to allow a distinction between those that are beneficial and those that are destructive. This ambiguous character of floods is important in the context of flood control measures. As noted by Mustaafa (1998) in Karachi, since it is difficult to control destructive flooding

without also preventing beneficial flooding/flash-flooding, the community proposed allowing rivers to be restored to their 'natural' flow regimes so as reinstate the benefits of floods. In the case of Arusha city, most people have not seen the beneficial aspects of flooding in the city: only the destructive ones were mentioned by most of the interviewed households in the study areas.

Findings from studies by Hambati (2013) and Smith (2001) reveal that floods are critical for maintaining and restoring many of the important services provided to humans by riparian ecosystems, including habitat for fish, waterfowl and wildlife; and helps maintain high levels of plant and animal diversity. Flood and/or flash-flood waters also replenish agricultural soils with nutrients, and transport sediment that is necessary to maintain downstream delta and coastal areas. In the same line of thinking, a study done by Haeuber and Michener (1998) in the USA has shown that there are some attempts to restore the ecosystems of valley bottoms to manage floods through the manipulation of water flows from dams and other impoundments to achieve the benefits of flooding.

Moreover, during discussions with officials in the study areas, one of the proposals to avoid adverse effects of flood and flash-flood hazards in city was to prohibit settlements on areas prone to floods and flash-floods. However, this measure has proved a failure elsewhere. It is now common for poor people to evade such restrictions because they are forced by economic pressures to squat on areas prone to floods and flash-floods.

From the above discussion, it is evident that there are some ambiguities on flood/flash-flood mitigation measures. However, what is common in the results of most studies is that sustainable mitigation measures are those owned and possessed by people living in flood-prone hazardous areas.

4.2 Epidemics, Hazards and Disasters

The most mentioned epidemics of human diseases during the household interviews were malaria (97%), HIV/AIDS (82%), cholera and typhoid (31%). Shainy (2010) noted that biological hazards are mainly associated with the prevalence of micro-organisms/insects such as mosquitoes, rats, lice and fleas; just to mention a few. However, Mcharo (2006) also noted that hazards such as floods and storms can have potentially severe biological and epidemiological consequences as secondary effects. For instance, flooding in the study areas is commonly followed by epidemics of diarrhoea and typhoid due to the contamination of drinking water. Air pollution is often followed by outbreaks of respiratory problems. Wisner (1998) made a similar observation in Tokyo city, where people who survived from the Kobe earthquake immediately suffered health crises from consequent air and water pollution.

As Choguill (1993) and Tumbo (2007) indicated, humans have developed social (as well as biological) resistance to epidemic hazards. According to the WHO (2000), epidemic hazards are preventable, especially for diseases such as

malaria, diarrhoea, typhoid and cholera, where people can be vaccinated and treated. The household survey in the study areas revealed the same practice as more than half of the respondents (58%) living in valley bottoms and ravines prevented themselves from epidemics through household micro-environment sanitation, vaccination and treatment. However, these household efforts were not acknowledged in any reports on disaster risk management in the city: even disaster literature elsewhere has tended to neglect epidemic hazards.

The WHO (2000) and World Bank (2002) reports noted that epidemics and other biological hazards were also excluded in the main themes of the International Decade for Natural Disaster Reduction (IDNDR, 1994). With increased public awareness of the potential of biological terrorism and high-profile epidemics such as HIV-AIDS, both general and more specific writings on the subject are increasing. This is a positive development since an understanding of biological (epidemics) hazards has a wider application to the field of disaster risk management. This is because it permits a better comprehension of how health problems contribute to people's vulnerability to other hazards, and also allows an understanding of health impacts of other hazards, for example, where floods expose people to new health risks.

5. Conclusions and Recommendations

5.1 Conclusions

It is evident from the above analysis and discussion that natural, human-made and human-induced hazards and disasters that are climate-related have threatened and destroyed poor household economies, both in terms of their frequency and severity. The adaptive capacity of a community faced with the risk of natural and human-made disasters can be defined as the vulnerability of that community before a disaster strikes, and its resilience after it occurs. Therefore, the adaptive capacity of a community is not externally determined, but related to its level of local development over time and space.

Generally, the findings reveal that communities living in Arusha city are exposed to varying degrees of natural, human-made and human-induced hazards. Over the years, these have responded to those hazards to reduce the threats posed by the hazards and disasters, whilst simultaneously accepting unmanageable risks, and maximizing the use of any related benefits. Thus, they have developed some of their own mitigation measures and strategies to manage specific hazards individually or communally; singly and/or cumulatively. Such measures and strategies aim at reducing physical and human vulnerabilities to hazards and disasters related to climate changes.

Households address physical vulnerabilities through structural or engineering measures. These included flood control walls, uplifted house foundations and cut-off-drains. Also, they mentioned tree-planting, reinforced house foundations, landscaping and houses reinforcement as long-term

measures aimed at improving water movement in the low-lying areas. In addition, the community also applied non-structural measures to reduce flood disaster risks. These included seasonal migration to the highlands during the rainy season and traditional spatial physical planning. These measures and strategies, developed and tested over the years, have sustained the lives of the community in the city over time and space. However, as seen earlier, the current status of knowledge possessed by the community and the prevailing socio-economic and political conditions with respect to saving lives and property during hazards, as well as simultaneously conserving the environment, are undoubtedly inadequate. Thus, strengthening working relations between and among international, national, regional, district and local institutions in hazard-prone areas is necessary through joint strategizing and sharing best community practices on disaster risk reduction measures.

5.2 Recommendations

To improve the quality of life and safety in communities prone to flood hazards in informal settlements, there should be measures and strategies to reduce the severity of such disasters, and improve the safety and security of people and their properties. For example, embankments could be built to reduce flooding and flash-flooding; and/or trees could be planted to increase the rate of water infiltration and slow down the speed of water run-off. Similarly, advocacy and training should be used to influence policies that address climate change issues that are increasing the frequency and severity of some natural hazards.

Moreover, vulnerable groups should be encouraged to take part in decision-making to ensure that conditions do not worsen for the poorest and most vulnerable people. Therefore, any measures and strategies aimed at managing disaster risk should address the whole set of issues leading to disparities within the community.

To reduce vulnerability to flood hazards in urban ecosystems, community adaptive capacities in terms of resources and skills should be improved through the development of local institutions that should train on appropriate skills and education to reduce dynamic pressures. For example, NGOs, religious organisations and people of good will can work to strengthen a community's adaptive capacity; and also be an important source of support in times of disasters.

Disaster management is vital in addressing underlying causes of disaster risks by challenging any ideology, political and economic systems that increase the vulnerability of a community to disasters. This increases the access of vulnerable groups to power, structures, and resources. Some structures and processes may help reduce the risk of disaster because their political and economic approaches and values are fair and just. To encourage these values among negative pressures, a community can use advocacy in awareness creation at local, national and international levels.

References

Choguill, C. L. 1993. Sustainable Cities: Urban Polices for the Future. *Habitat International Journal,* 17(3): 1–12.

Haeuber, R. & W. Michener. 1998. Natural Flood Control. *Issue in Science and Technology*, 15(1): 74–81.

Hambati, H. 2011. Population Increase and Vulnerability to Disasters in the Informal Settlements of Mwanza City, Tanzania, *Tanzanian Journal of Population Studies and Development,* 18(1): 55–80

—. 2013. Weathering the Storm: Disaster Risk and Vulnerability Assessment of Informal Settlements in Mwanza City, Tanzania. *Journal of Environmental Studies,* 70(6): 919–939.

Haque, C. 1997. *Hazard in a Fickle Environment*. Bagladesh, Dordrecht, Netherlands: Kluwer Publishers.

Healy. 1997. *Collaborative Planning, Shaping Places in Fragmented Societies*. Hound Mills, Basingstoke, Hampshire, Macmillan Press Ltd, London.

International Decade for Natural Disaster Reduction (IDNDR). 1994. *Yokohoma Strategy and Plan of Action for a Safer World*: *Guidelines for Natural Disaster Prevention, Preparedness and Mitigation.* World conference on Natural Disaster Reduction, Yokohoma, Japan, 23–27 May, http://www.unisdr.org/unisdr.resyokohoma.htm; retrieved on Wednesday, 25th November, 2009.

International Federation of Red Cross and Red Crescent (IFRR). 2012. *Final Report: Tanzanian Floods*. Red Cross Tanzania, Dar es Salaam. Accessed on 15th March 2017 at http://reliefweb.int/report/united-republic-tanzania/tanzania-floods-dref-operation-n% C2%B0-mdrtz013-final-report, 2012.

Mcharo, J. 2006. Knowledge and Awareness of Occupational Health Hazards/Risks Among Workers in Road Transportation in Four Cities in Tanzania Mainland. MA dissertation, University of Dar es Salaam, Tanzania.

Mustaafa, D. 1998. Structural Causes of Vulnerability to Flood Hazard in Pakistan. *Economic Geography Journal*, 74(3): 289–306.

Pelling, M. 2003. *The Vulnerability of Cities: Natural Disasters and Social Resilience*. London: Earth Scan Publications Ltd.

Rugai, D.S. 2008. Combined Hydrological and Hydrodynamic Modeling for Flood Hazard Assessment: A Case Study of Upper Kaluganga Catchment, Ratnapura, Sri Lanka. MSc thesis, Ardhi University, Tanzania.

Shainy, B. V. 2010. Culture, Ethical and Spiritual Implications of Natural Disasters from Survivors Perspectives. *Critical Cave Nursing Clinics of North America*, 22(4): 515–522.

Smith, K. 2001. *Environmental Disasters*: 3rd Edition. London: Routledge.

Tumbo, M. 2007. Community Vulnerability and Adaptation to the Impacts of Climate Change Variability and extremes on Wetlands, The Case of Simiyu Wetlands, Lake Victoria Basin. MSc dissertation, University of Dar es Salaam, Tanzania.

United Nations (UN). 2011.*World Urbanization Prospects*. United Nations.

United Nations-Habitat (UN-HABITAT). 2004. Cities Without Slums. Sub-Regional Programme for Eastern and Southern Africa. Information Brief. www.habitat. settlement.

United Nations Centre for Housing and Settlements (UNCHS). 1996. *An Urbanizing World: Global Report on Human Settlements.* London: Oxford University Press.

United Republic of Tanzania (URT). 2012. *National Census Report.* Dar es Salaam: Government Printer.

—. 2000. *National Human Settlement Development Policy*. Dar es Salaam: Government Printer.

Wisner, B. 1998. Marginality and Vulnerability: Why the Homeless of Tokyo Don't Count in Disaster Preparedness. *Journal of Applied Geography*, 18(1): 25–33.

Wisner, B., P. Blaikie, T. Cannon & I. Davis. 2005. *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. London and New York: Routledge.

World Bank. 2002. Upgrading Low Income Urban Settlements: Country Assessment Report – Tanzania.

—. 2009. *Environmental Crisis or Sustainable Development Opportunity? Transforming the charcoal sector in Tanzania*.

World Health Organisation (WHO) & UNICEF. 2000. *Global Water Supply and Sanitation Assessment.* http://www.who.int/water_sanitation/Globassessment/Global4.1htm Retrieved on Thursday, 10th December, 2013.