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The Vulnerability of Urban Communities to Flood Hazards In Tanzania: A Case of Dar es Salaam City

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Abstract

Losses from environmental flood hazards have escalated in the recent decades, prompting a reorientation of emergency management systems away from simple post-event response. The degree to which populations are vulnerable to flood hazards is not solely dependent upon proximity to the source of the threat or the physical nature of the hazard—social factors also play a significant role in determining vulnerability. This paper presents a participatory disaster risk method for assessing vulnerability in spatial terms using both physical and social indicators. It reveals that the most physically vulnerable places do not always spatially intersect with the most vulnerable populations. This is an important finding because it reflects the likely 'social costs' of hazards. While economic losses might be large in areas of high physical risk to floods, the resident population also may have greater safety nets (insurance, additional financial resources) to absorb and recover from the loss quickly. Conversely, it would take only a moderate hazard event to disrupt the well-being of the majority residents (who are more socially of vulnerable, but perhaps do not reside in the highest areas of physical risks to floods) and retard their longer-term recovery from disasters. This paper advances theoretical and conceptual understanding of the spatial dimensions of vulnerability. It further highlights the merger of conceptualizations of human-environment relationships with geographical techniques in understanding contemporary public policy issues.

Keywords: *floods, hazards, vulnerability, disaster, city, Tanzania.*

1. Introduction and Background to the context

Most natural hazards—such as those related to climate (rainfall and temperature)—are foreseeable in that it is possible to predict locations where next events will occur in the near future. In this regard, areas lying in lowlands in Dar es Salaam city are highly prone to floods and flash-floods. By the same token, the most likely elements at risk (including human and their properties) can also be foreseen (Hambati, 2013). This paper advances that climate-related hazards are created predominantly by nature, but disasters are mainly socio-economic and cultural in setting. The destructive events are human-induced, and it is asserted that climate disasters and development are closely interlinked in urban areas given that most of the people earn their livelihoods from resources of Mother Nature. Thus, it is certain that the so-called natural

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hazards and disasters such as floods, flash-floods and storms are also a function of social systems and their related power relations that influence the way hazards are translated into disasters.

Because disasters are not but are made, it is a prudent for this paper to examine climate-related disasters in the context of human activity processes among Tanzanian urban communities. Within this framework, a complex combination of climatic disasters and human activity processes results in multiple and mutually reinforcing catastrophes to households and their livelihoods; and indeed to communities, nation states and global village. It is advanced here that the resilience of communities to nature-triggered disasters should be analyzed in a social context pegged on the degree of the local community's access to social, economic and political power that underlies resource ownership and control. In this regard, disasters do not only adversely affect community development, but there is also a significant relationship between development strategies and the extent to which a country is prepared to respond when a disaster strikes. It is hypothesized that people's capacity to cope with nature-based disasters should be pegged on a better understanding of the resilience of the socioeconomic and ecological systems in place. The bottom-line should be in enhancing local community's capacity to live with hazards, thus promoting their resilience.

In this context, the paradigm shift should inform the formulation of policy options to minimize climate change related disaster risks and promote sustainable development. It is in this vein that 2005 United Nations World Conference for Disaster Reduction advocates that, only through people's sustained efforts, including those of hazards and vulnerability analyses, mitigation and preparedness, can local and national capacities to cope with impacts of disasters be promoted and sustained. Given the ingenuity of local communities in combating the adverse disaster impact coupled with support from development partners, recovery measures directed towards supporting livelihood systems have been high on the post-disaster management agenda.

This paper shows that, at a national level, a highly vulnerable and hence poor people may suffer frequent disasters from climatic changes. This in turn prevent national development, and thus from improving national resilience. Examining root causes of disasters, Hambati (2011), Wisner, et.al. (2005), and the International Decade for Natural Disaster Reduction (IDNDR) (1994) convincingly point out that in real life, the role of human activities in the occurrence of a disaster is significant in so far as human actions and inactions relate to their outcomes. In this case, as extreme climatic hazardous events, floods, storms and flash-floods translate into disasters when they cause serious disruption of the functioning of a society, resulting in widespread human, materials or environmental losses that exceed the ability of the affected community to cope using only its own resources (Wisner, et. al., 2005; URT,

2004). It is in this context an attempt is made to assess community's and development partners' awareness levels and capacity in coping with disasters related to climate changes (i.e., floods and storms) with a view of formulating community-based strategies for disaster risk reduction, and for improving human well-being. As correctly noted by Stefan (2011), disasters and development are intricately related and they are, in real life, two sides of the same coin! It is advocated that there is need to identify ways and means of socially, economically, and culturally empowering local communities in Africa to map out, utilize and manage resources of nature sustainably to build resilience to the prevalent climate related disasters.

1.1 Communities' Vulnerability to Floods and Related Risks in Urban Areas

In Africa, communities had well-developed traditional knowledge systems for environmental management and coping strategies, making them more resilient to climatic changes and related risks (FAO, 2008). This knowledge had, and still has, a high degree of acceptability amongst the majority of populations in which it has been preserved (Cutter, 2010). These communities can easily identify with this knowledge, and it facilitates their understanding of certain modern scientific concepts for environmental management, including disaster prevention, preparedness, response and mitigation measures.

In Sub-Saharan Africa, like in many developing countries, climate related hazards like flood disasters are an increasing hindrance to sustainable development. Over time, climate-related disasters like floods, flash-floods and storms have caused serious disruption of the functioning of society, leading to widespread human suffering, and material, financial and biodiversity losses. This is more so given that *disasters do not follow people*, but *people follow disasters* (Walter, 2006). In this regard, there is an urgent need to better understand the capacity of communities that are exposed to climate-related disasters. Experiences shows that local people's informed actions, coupled with support from development partners, have a profound impact on disaster prevention, preparedness and response. Hence, a blend of approaches and methods from science and technology, and from traditional knowledge opens avenues towards better disaster recovery.

Globally, there is an increasing acknowledgement of the relevance of local ecological knowledge as an invaluable and underused knowledge reservoir, which presents developing countries, particularly Africa, with a powerful asset in environmental conservation and natural disaster management. Specifically, from time immemorial, flood disaster management in Africa has been deeply rooted in local communities, which apply and use indigenous knowledge to master and monitor climate and other natural systems, and establish early warning indicators for their own benefit and future generations.

In the African world view, environmental resources (land, water, animals and plants) are not just production factors with economic significance, but also have their place within the sanctity of nature (AU, 2006). Certain places have a special spiritual significance and are used as locations for rituals and sacrifices, for example, sacred grooves, shrines, mountains and rivers. These locations are often patches of high biodiversity which are well conserved and protected by the community. For example, for the traditional people of Northern Ghana, gods, spirits, shrines, ritual crops and animals, food items and cash crops are all inter-related (UN-Habitat, 2003).

Therefore, ecological knowledge is an essential element in the development process and the livelihoods of many local communities. A major challenge that African countries continue to face is how to reconcile ecological knowledge and modern science without substituting each other; respecting the two sets of values, and building on their respective strengths (Hambati & Rugumamu, 2005). Regarding land-use conservation, shifting cultivation was a traditional practice in which land was never over-used, or repeatedly cultivated season after season. Land was left to rest and covered again with plants and leaves to enable it to accumulate vegetable manure. Mixed crop cultivation practice enables leguminous crops to restore nitrogen in the soil for other food plants. Knowledge of when to expect long or short rainy seasons enables farmers to appropriately plan which crop is suited for a particular season.

As for coping with changes in the weather, traditional indigenous knowledge of storm routes and wind patterns enables people to design their disaster management long in advance by constructing types of shelter, wind break structures, walls, and homestead fences appropriately. A hydrological disaster is obviously unmanageable when it starts. Similarly, knowledge of local rain corridors enables people to prepare for storms. Knowing the colour of clouds that may carry hailstones enables people to run for cover. Similarly, knowing that prolonged drought is followed by storm, thunder and lightning during the first few rains enables people to prepare or expect a disaster. Also, a change in birds' cries or the onset of their mating period indicates a change of season.

Similar application and use of indigenous knowledge for disaster management is also prevalent in Swaziland. Floods can be predicted from the height of birds' nests near rivers. Moth numbers can predict drought. The position of the sun and the cry of a specific bird on trees near rivers may predict onset of the rainy season for farming. The presence of certain plant species (for example, Ascolepis capensis) indicates a low water table (Rugumamu et. al., 2009).

These examples underscore the importance of harnessing ecological knowledge not only as a precious national resource, but also as a vital element in environmental conservation and natural disaster prevention, preparedness

and response. However, despite the prevalent application and use of ecological knowledge by local communities, it has not been harnessed to fit into the current scientific framework for environmental conservation and natural disaster management in Africa. As a result, there is a general lack of information and understanding of the need to integrate or mainstream ecological knowledge into scientific knowledge systems for sustainable development in the continent. To achieve this integration, there is the need to reveal the communities' vulnerability to natural hazards in urban ecosystems, which is the essence of this paper.

This paper is organized into five parts. The next section focuses on the theoretical understanding of community vulnerability to flood hazards, which is in turn followed by the methods used in eliciting information from the households, and the findings and discussion of the results. The paper concludes by drawing attention to specific findings that hold relevant implications for public policy and decision-making on sustainable urban ecosystems.

1.2 Theoretical Understanding on Community Vulnerability to Flood Hazards

Studies on disasters in Tanzania have revealed that hazardous urban ecosystems are settled and developed, despite the efforts of the government and city authorities to prohibit settlements in those areas (URT, 2000; PMO, 2004). These ecosystems are prone to hazards and disasters, and are characterized by epidemics, floods and storms (URT, 2004).

The theory underpinning hazards and disaster risks analysis 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 and also to reverse the processes (Fig. 1). 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 that 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) are referred to as all distant causes of vulnerability. They are also simply defined as a set of well-established, widespread processes within a society and the world economy. 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. These 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).

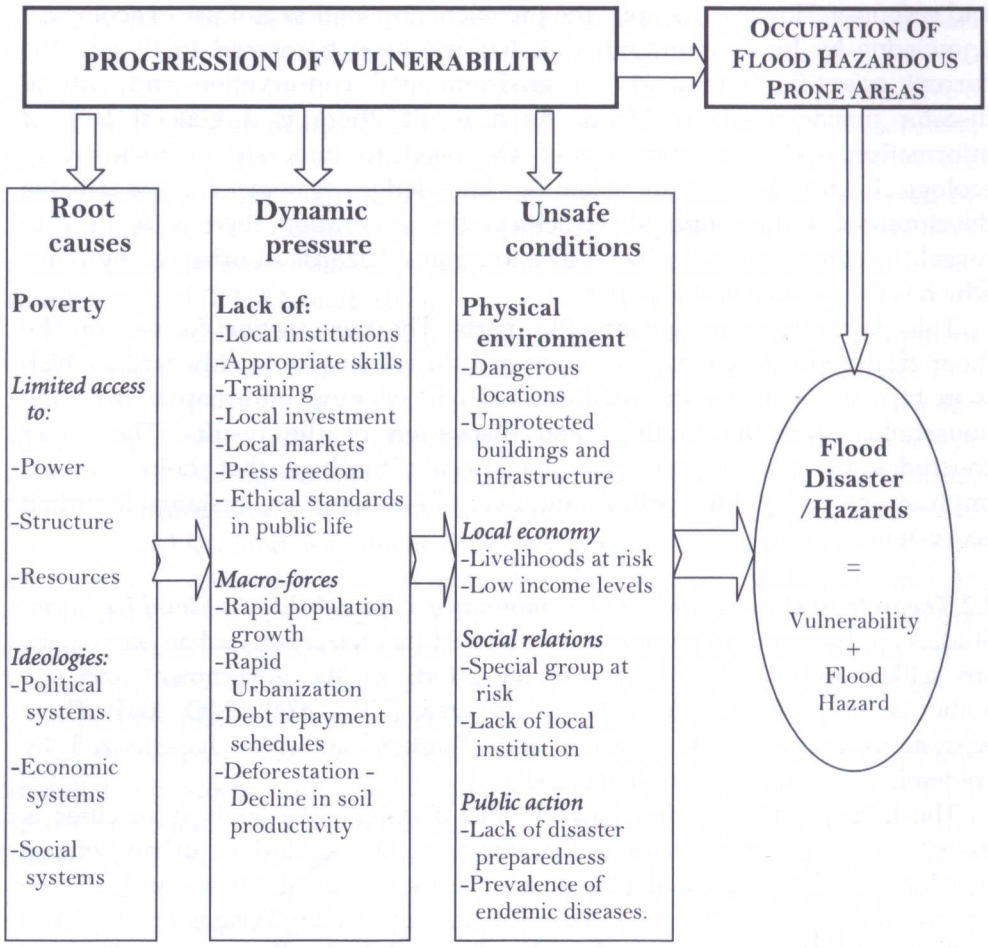

Figure 1: ***The progression of vulnerability to Flood hazards/Disaster***
Source: Modified from Wisner et al (2005:51)

Dynamic pressures are processes and activities that 'translate' the effects of root causes into 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 particular people. These include lack of local institutions, training and local markets: all these 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. Example 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 entitlement that are prone to rapid disruption.

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

2. Methodology

Participatory disaster risk assessment (PDRA) methods were used to get the information on flood risk(s) in the study area areas (Table 1). The PDRA was supported by field observations, interviews and household surveys to verify and cross-checking of information.

Table 1: Participatory Flood Risk Assessment Design

Steps	Objectives	Output
Step one	Describe Climate related hazards in the City	List and nature of Climate hazards.
Step two	Conduct community climate related hazards mapping	Flood Hazards and related risks mapped.
Step three	Describe vulnerability and capacity of the community	Capacity Vulnerability Analysis (CVA)
Step four	Determine Climate related hazards/ risks	Comprehensive list of Climate related hazard/risks faced the communities
Step five	Rank hazards/risks	Prioritized list of hazards/ risks
Step six	Decide on the acceptable level of hazard/risk	Agreed level of risk(s) for family and community security.
Step seven	Decide whether to prevent, reduce, transfer, or live with the disaster risk(s)	Agreed community adaptation measures and strategies.

Before PDRA was conducted, the top two highly ranked wards in Dar es Salaam city susceptible to flood hazards were identified based on the output of Landscape-Distance-Population (LDP) criteria model. The identified wards were Tandale and Kigogo (Fig. 2). The aim of selecting the two wards was to make a comparison between community perceptions on climate related hazards/risks in relation to socio-economic and physical vulnerability within the city.

The study identified the physical vulnerability within the city through the use of Digital Elevation Model (DEM) and GIS techniques. Three main factors were considered (landscape, distance and population) when assessing the vulnerability of community to flooding. The first is obviously elevation. For example, in Dar es Salaam City, a number of the stream channels that have been heavily developed actually have elevations at or below sea level. These areas are obviously at greatest risk for flooding either from storm surge, tsunami or extreme rainfall event. Through community flood hazard mapping

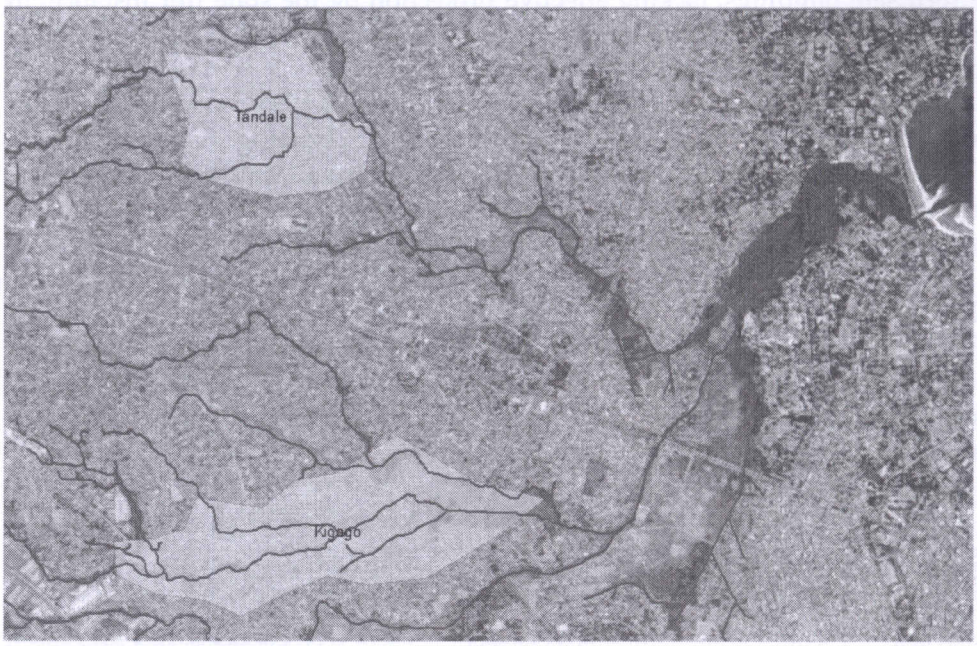

Figure 2: ***Sample Wards and their drainage distributions in Dar es Salaam City***

on the community experience over year in Dar es Salaam city, elevation ranges were categorized as having high flooding risk—acceptable risk based simply on elevation using the following classes:

Elevation	**Flood risk**
0 and below	High risk
1-5 meters	Medium risk
5-10 meters	Low risk
10 meters and above	Acceptable risk

Of course elevation does not tell the whole story of flood risk, while this is a perhaps a good indicator for coastal and inland lowland flooding, the nearness to the ocean (Indian Ocean) is also a significant factor. Our flood hazard and vulnerability assessment model take into consideration the distance from the coastline and distance from stream channels.

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. Streams were digitized at a scale of 1:6000, which resulted in acceptable accuracy of the stream channels (Fig. 3). Streams were identified along visible channel features, when the channel was obscured by vegetation/construction or clouds the channel position was estimated closely following additional visual clues, especially riparian vegetation. Streams were

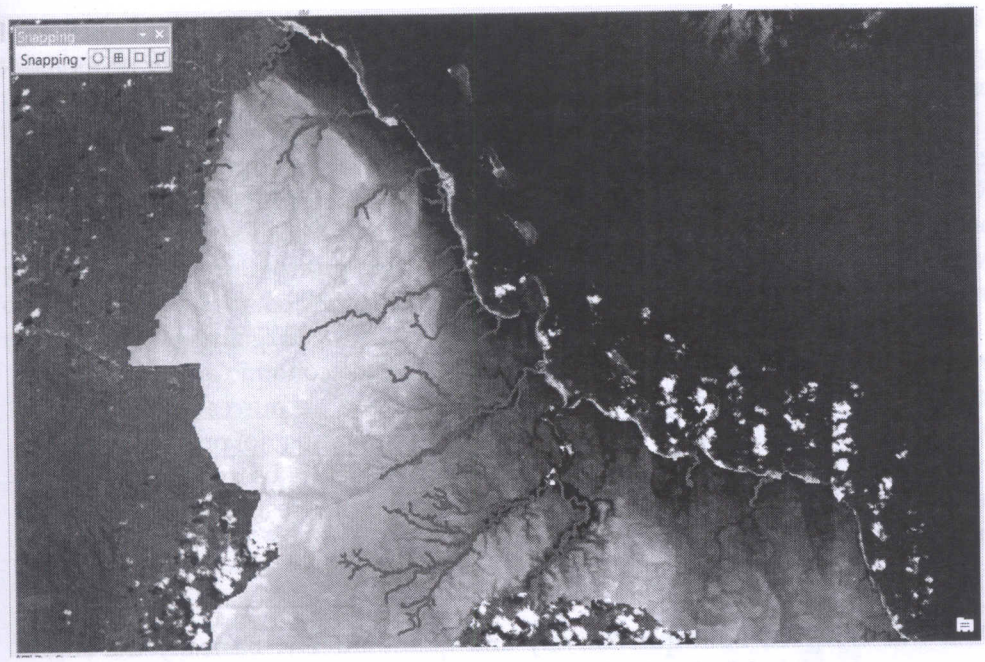

Figure 3: ***Rivers and streams distributions in Dar es Salaam City***

digitized as continuous poly-lines. No indication of culverts or other potential channel barriers was recorded for the streams. Streams were buffered at 100 meters. Our model is additive with higher values, indicating progressively higher threats for flooding. The highest risks for flooding are in areas below sea level, within 500 meters of the coast and within 100 meters of a mapped stream. As the distance from coast and 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 500m buffer zone from the coast, or 100m buffer from stream channels (inlands), are also assumed to be at higher risk to flooding in the study areas.

2.1 Data Collection

The unit of analysis in this study is the household, and includes mixed methods that are both quantitative and qualitative (Tashakkori & Teddlie, 2003). Qualitative data includes interviews, focus group discussion, field observations, and survey questionnaires. The questionnaires were monitored to 192 household members who were above 18 years old. This is the age practicing flood disaster mitigation and preparedness measures in the study area.

The respondents were proportionally selected from 8 streets in the study wards. With the assistance of the street leadership, we identified the list of the members of each street who were above 18 years old. From each street member

list, a proportionate sample size of 5% was drawn randomly. The structured questionnaires were administered to household heads--be it the father or mother or any member of the household who was above 18 years old.

Twenty respondents were involved in in-depth interviews, and 5 focus groups were formed (with 8 respondents each), drawn from all the 8 streets. Respondents were asked questions regarding their perceptions and experience on flood disaster risk reduction in the city. Focus group discussions were formed with 5 groups of 8 respondents each. These groups provided general information on disasters and the susceptible flood prone areas.

Field observations on flood prone areas assisted in gaining on-the-spot information about flood disaster in relation to socio-economic activities, policy implications and cultural perceptions towards land resources and land use patterns. Field observation also included photographing to provide pictorial evidence of flood disaster in the study areas. Field observation increased reliability and validity of the data collected through questionnaire and focus group discussions.

2.2 Data Analysis

Data was analysed both qualitatively and quantitatively. Basically the study focuses on households that had experienced flood hazard/disaster, as well as those that had not experienced flood hazard/disaster. The responses from the interviewee were coded 0 or 1 to understand how many times or the frequency with which the flood hazard/disaster occurred. The coded data were then inserted to qualitative NVivo 9 software package. The NVivo software has the ability to transform individual open-ended survey responses and interview questions into a series of coded response categories that were, in turn, quantified as binary codes and integrated into the associated survey responses. This process involved three analytic steps: (i) the survey data were entered into an Excel spreadsheet; (ii) the qualitative data were analysed for codes or themes using NVivo; and (iii) the coded qualitative data were then quantified into dichotomous variables 0 or 1 based on the absence or presence of each coded response. For instance, households that had experienced flood hazard/disaster were coded 1, whereas their counterparts that had previously not experienced flood hazard/disaster were coded 0. Similar codes were given regarding their perception on hazard/disasters.

3. Results

3.1 Population Increase and Urban Sprawl in Dar es Salaam City

Dar es Salaam is one among many cities in the SSA experiencing rapid urbanisation. Historically, Dar es Salaam emerged during the second half of the 19th century. It was established as a port and trading centre by Arabs in 1862 (Kironde, 1994: 82). By 1891, Dar es Salaam was just a small settlement with a population of about 4,000 inhabitants (Kombe, 1995: 10; Sutton, 1970). Due to

increased trade and importance, more migrants were attracted and the population increased to 10,000 inhabitants by the year 1894. By 1900, the population had reached 20,000 inhabitants. Population growth slowed down over the war periods (WW I and II), and a steady increase was notable after the 1950s. A faster growth was recorded after independence as a result of the abandonment of colonial policies that inhibited Africans from migrating to towns. The city population reached 782,000 by 1978 and 1,360,850 by 1988. By 1992, estimated population for the city was pegged at 1,550,000 inhabitants, and results from the censuses of 2002 and 2012 indicate a population of 2,497,940 and 4,364,541, respectively (Lupala, 2002; URT, 2003, 2014). Fig. 4 illustrates these trends.

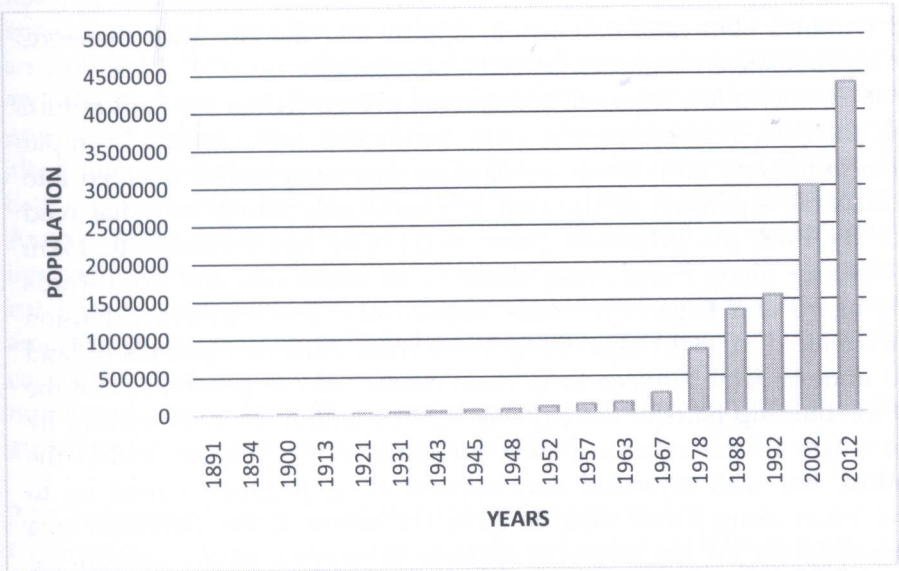

Figure 4: ***Population growth for Dar es Salaam 1891-2012***

Source: National Population Census Reports 1957,1967,1978,1988, 2002, 2012; Kironde, 1994; Strategic Plan, 1998 and Sutton, 1970).

During the period between 1891 and 1948, the City growth was characterised by slow population growth trends, and so was its spatial growth. By 1891, the extent of the urbanised area of the city was limited within a 2km radius covering 122ha of land, and an overall population density of 45 persons per hectare. This figure increased to 463ha of land in 1945. The rapid expansion of the city took place between 1945 and 1963 when the urbanised area extended to 3081ha. Exponential trends were revealed later, especially after independence. The tripling of population from 272,821 to 843,090 between 1967 and 1978 resulted into increased spatial growth to 11,331ha. The same trends pervaded the decade of 1980s. By the year 2001 the urbanised part of the city covered 57,211ha. By 2012 the urbanised part of the city covered 65,545ha, with a radius of 30km.

One can note from Fig. 4 that while there has been a steady increase in population over the decades, the gross population density has been fluctuating with significant decrease after the 1990s. The fluctuating nature of the population density can be attributed to the expansion (spatial extent) of the built-up area. While the year 1945 registered the highest gross population density of 130 persons per hectare, this figure dropped drastically to 40 persons per hectare by 1963, with resurgence in 2002. During the colonial periods, the city spatial expansion was largely confined within the 'planned city'. Until 1945, the built-up part of the city was only limited to 463ha, accommodating a total population of about 60,000 inhabitants. With the exception of a minor low-rise low-density development at Oysterbay, the rest of Dar es Salaam was largely confined within a 6km radius. It would appear that the city was, therefore, compact with a relatively high-density settlement pattern.

Until 1963, only a few informal settlements existed within the 6km radius. However, the post-independence growth trends that were fuelled by rapid population influx and individuals developing their own houses resulted into rapid horizontal expansion of the city, predominantly along its radial road networks. By 1978, the urbanised parts of the City had extended to 14km south-westwards along Pugu Road; about 12km westwards and northwards along Morogoro and Bagamoyo roads respectively. The southern extension was rather limited to about 6km along Kilwa road. Although pockets of land remained undeveloped between these main roads, one can generalise that the extent of the built-up parts of the city was limited within the 12km radius. By 1992, the extent of the urbanised area predominantly remained within the 12km radius, but with extended development along Bagamoyo road up to 16km and 10km along Kilwa road. In 2014, the extent of the urbanised area show consolidation on the formerly sparsely developed areas between the major roads and a further extended growth along the roads. The northern extension along Bagamoyo road reached about 35km, about 30km westwards along Morogoro road, about 20km south-westwards along Pugu road, and 15km southwards along Kilwa road.

3.1.1 Migration and Settlements on Flood Hazard Prone Areas in Dar es Salaam City

The influx of rural-urban migrants into Dar es Salaam city has been an influencing factor on hazardous area invasion. During the field, household survey has shown that only 12% of the interviewed were indigenous inhabitants of cities. Of the 12%, only 6% were residing in valley bottoms; while 4% were residing on mixed plan settlements. Most of the households interviewed (88%) were migrants from other regions in Tanzania. According to the households interviewed, the influx of migrants into the flood hazard prone areas started since 1975, and the situation become tense in 1990s. As perceived by the people interviewed, the influx of rural-urban migration could be

attributed to the changes in agricultural policies and the reform programs introduced in Tanzania from 1965 to early 1990s. In the mid-1980s Tanzania adopted structural adjustment programs (SAPs) as a way of improving the country's economy. However, the agricultural sector, among other things, was negatively affected by the SAPs. One of the conditions of SAP was to remove subsidies on agricultural inputs, hence leaving a great burden to farmers, who used to receive subsidies in the form of seeds, fertilizers and farm implements.

With the removal of subsidies, agriculture became more of a burden to farmers. Returns decreased due to low production since most farmers could not afford the high cost of farm inputs and implements. The interview with one of the City council member (male aged 54 years) revealed that, for the younger generation, agriculture has no better future. He further said, "*The younger people are looking for better opportunities in the cities hoping to find something better than agriculture*". Moreover, the price and demand for some agricultural exports has 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 was among the country's highest income earning products. Another factor that could explain rural-urban movement, as narrated during the interview with one government official, was 'urban bias' in development. Most rural areas lack services such as good roads, hospitals, schools, and, worst of all, employment opportunities. Industries and other income generating activities are concentrated in urban centres, particularly in Dar es Salaam city. A great number of respondents (90%) confirmed that urbanization has been the main attraction for rural-urban migration in Tanzania.

3.2 Community Hazard Identification and Mapping

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

The community in the study area identified 12 types of hazards. These types of hazard were classified into 3 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, i.e., the likely loss created by each event over time and space (Table 2). According to the community's physical environment assessment, flood, flash-flood and storm hazards are location specific (Table 2). These hazards vary in probability of occurrence across the landscape. The variation was mainly attributed to the slope aspect, and the configuration of land surface (Table 2).

Table 2: Community Hazard Mapping and Assessment

Type of Hazard	Location/ land units (LU): Vb = Valley bottom; Gs = Gentle slope; Ss = Steep slope; Int. = interfluves				Ranking of overall hazard type in respect to expected impacts
Natural hazard	Vb	Gs	Ss	Int.	
Flood	xxx	xx	x	x	
Flash flood	xxx	xx	x	x	1
Storms	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	3
Drug addiction	xx	xx	xx	xx	
Human induced hazard					
Air/water pollution	xx	xx	xx	xx	
Deforestation	xx	xx	xx	xx	4
Drought	xx	xx	xx	xx	

Key: **x** = Low probability; **xx** = Medium Probability; **xxx** = High probability

Source: Disaster Risk Field Survey (Dar es Salaam), 2014

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 (see Table 2). During discussion with the community members involved in hazard mapping, this situation was attributed to the difficulties in estimating the probability of their occurrences and the linkages 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. 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 whole process of hazard mapping and assessment in the study areas has revealed that in each land unit there was a dominant hazard.

The common and dominant hazard was represented by high probability of occurrence ('xxx') (see Table 2). During the community hazard mapping, valley bottoms were identified as the areas with high probability of flood and flash-flood hazard events. This is also in line with the findings from the household interview, where 35% of the respondents who are living in the ravines and in

flood plains areas reported to have been affected by flash-flood and flood hazards. According to the household interviews and discussions, elements at risk to flash-floods and floods in the valley bottoms include people, houses, vegetable gardens, garages facilities and petty business items. Table 2 also shows that there is medium probability of flood and flash-flood hazards on gentle slopes. However, none of the respondents had witnessed these hazard events on the steep slopes and interfluves. This indicated that ravines and flood plains areas are more susceptible to flash-flood and flood hazards respectively (See Plate 1).

Plate 1: *Houses Flooded with Storm Water in Msimbazi Valley; Kigogo Ward - Dar es Salaam, 12 April, 2014.*

As indicated in Table 2, there is high probability of storm hazards on high elevated areas and interfluves. However, 95% of the respondents on hill slopes and interfluves mentioned that they located their houses on hillsides to avoid frequent flooding and flash-flooding in the flood plains and in the ravines. However, they further mentioned that, though the area is more susceptible to storms, it had not happened so far in their life time. Apparently 5% of the households interviewed affirmed that they had experienced storm hazard events in the area. The storm hazard events were also attributed to the convectional rainfall which falls mainly in the form of showers, storm or thunderstorms. This finding concurs with the information given by the interviewed households. Out of 70% of the household interviewed living in the informal settlements, 35% mentioned to have engaged in stone quarry and crushing as their main economic activities. Stone quarry activities have increased the susceptibility of rock-fall and soil erosion in the areas. During the

field survey, one male whose main economic activities were stone quarry and crushing was asked why he engaged in these activities, and he replied:

> *"I engaged in stone quarrying and crushing in order to get money for family subsistence. However, I know this activity may result in rock- fall or soil erosion especially during the rainy season, but I don't have any alternative to subsist."*

The statement and the reasons given imply that the people who are engaged in stone quarrying in the study areas do so because of unemployment and the economic hardships they experience. The issue of power relations in terms of economic and resource accessibility (land to build a house) is clearly demonstrated by 56% of the interviewed households. The household interviews also revealed that people with low income had no access to power, resources, and participation in decision-making because of their marginality in the community over time and space. These reasons have influenced poor people to invade hazardous areas in cities deemed to be no man's land. This implies the community and resources in cities are vulnerable to natural, human-made and human-induced hazards and disasters.

According to the community hazard mapping team, epidemics have medium probability of occurrence (Table 2). About 95% of the household interviewed mentioned to have experienced at least one epidemic hazards listed in Table 2. Out of 95%, 55% reported to have suffered malaria. Twenty seven percent (27%) have been affected directly or indirectly by HIV/AIDS, while 15% mentioned the prevalence of cholera and diarrhoea. These findings from the households interviewed agree with the information given during the community hazards mapping. During hazard mapping (Table 2), epidemics hazards ranked 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 (Plate 2).

The human-made hazards—namely, fire, accidents and drug addiction—are evenly and spatially distributed in the study area (Table 2). During the community hazard ranking, these hazards 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 drug addiction in the City since 1990s. Most of the households interviewed (56%) attributed the prevalence of these hazards to the increase of in-migrants into the City who are unemployed and remain jobless. According to the community hazard mapping team, human-induced hazards -- namely pollution, deforestation and drought -- are spatially evenly distributed in the study area. This is also in line with the findings from the households interviewed: 39% mentioned deforestation, while 52% mentioned air and water pollution. These results show that the severity/magnitude of these hazards is low when compared to other hazards at household level. In reality water pollution and land resources degradation

Plate 2: *A wastewater open channel in Tandale informal settlement. Wastewater from the pit latrines been channeled into this local drainage system. The channeling of households' liquid waste into local drainage systems has been the source of surface and underground water pollutions. The people living in the area are susceptible to cholera and typhoid diseases (Photo: Hambati, 2014).*

in the study areas have been the sources of conflicts and epidemic hazards. In other words, the impacts of these hazards spill over in a long period of time, of which it may not be noticed easily. The community hazards mapping team noted that the accurate perception of the relationship between human actions and physical environment is a key component in disaster risk and vulnerability assessment in the 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 they were asked to rank according to threat, flood hazards became threat number one in the City (Fig. 5): it was mentioned by 69% of the respondents. This was followed by diseases (12%), drug addiction (8.3%), water pollution (6.3%), accidents (5.2%), HIV/AIDS (5.2%) and noise pollution (4.7%). The rest hazards ranking are as shown on Fig. 5.

The respondents also were asked if the trends of the ranked hazards were increasing or decreasing, or remained the same. Most of the responses were that the trend was increasing at escalating rate. This was mentioned by 62% of the total respondents. About 20% mentioned that the trend was decreasing,

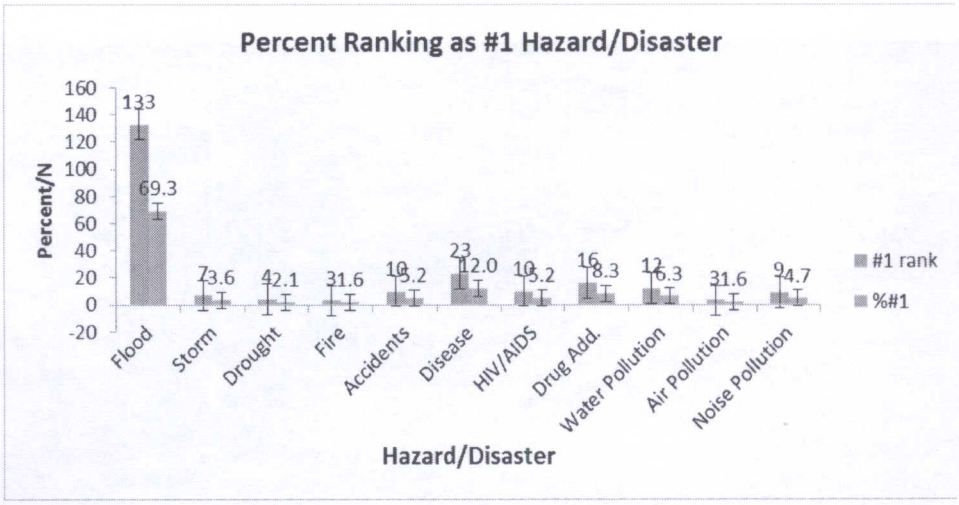

Figure 5: ***Community Perception on Hazards and Disasters in Dar City***

while 15% mentioned that there was no change in the situation of hazards and disasters. This implies that flood hazard is revealed as a threat to the Dar es Salaam city community.

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3.3.1 Causes of flood hazard and disaster in the city

As described in the previous sections, most of the climate-related hazards (droughts and floods and their respective outcomes) that have threatened human populations in the study area are well known to the community. The results revealed that 58% of the respondents heard about those hazards and disasters. Twenty five percent (25%) of the respondents were directly affected by flood hazard in the study area. However, 27% mentioned that they knew someone affected by the flood hazards. This implies the existence of floods and their associated risks in the study areas. This is evidenced by solid waste disposal along the sides of riverbanks and rain water drains in Tandale and Kigogo wards (Plates 3 and 4). Note the plastic materials scattered around the area. Dumping of solid waste and directing of domestic effluents into the river have been a source of choking and water pollution in the study area. In the long-run if measures are not taken, the situation might affect the flow of the river, thence causing floods.

Plate 3: *Dumped solid waste along the sides of a stream in Tandale ward, Dar es Salaam*

Plate 4: *Dumped solid waste along the sides of Msimbazi Valley in Igogo ward, Dar es Salaam. Note the plastic materials scattered around the area. (Photo: Hambati, 2014)*

In comparing the results in sub-sections 3.2 (community risk mapping) and 3.3 (community risk perception), the community and resources vulnerability to hazards and disasters are unevenly distributed throughout the study areas. Therefore, these strongly support the variation in the degree of vulnerability to climate-related hazards and disaster risks. Any intervention plan on the basis

of these community perceptions are likely to result in wide variations in response, both in timing, resources and in locational priorities. For example, the community vulnerability to diseases, human-made and induced disasters (nearly evenly distributed) might suggest deploying resources throughout the study areas, whereas community vulnerabilities to floods and flash-flood hazards, respectively, would result in concentrating personnel and other resources in specific areas/locations as shown in Table 1 to address the areas that have the greatest need compared to others.

These results reflect the need of specific intervention on mitigation and preparedness measures to a particular hazard in a particular ward/area singly and/or cumulatively. When variations in disaster risks are added, the need for particular intervention on mitigation and preparedness measures to hazards becomes even more specific and cumulative in nature. The strategy or plan will obviously address the wards/areas with high disaster risks. The study wards in Dar es Salaam (Tandale and Kigogo) exhibit high floods disaster risk compared to other wards. Consequently, this calls for the highest overall need of interventions on flood/flash-flood hazard and disaster mitigation and preparedness measures.

4. Discussion

A common primary factor linking rapid population increase to vulnerability is the migration of poor population into hazardous areas. As noted during the survey, most of the respondents (88%) in the study area are migrants. According to the 2012 household and population census, the rapid population increase in Dar es Salaam city is a result of natural increase of 3% (births exceeding deaths), and rural-urban migration of 8% (in-migrants exceeding out- migrants) in the period between the 1990s and 2000s (URT, 2014). Kironde (2000) noted that informal settlements in Dar es Salaam city have repeatedly sprung up wherever in-migrants find space, e.g., in valley bottoms, which were declared as flood prone ecosystems. In a study on urbanization and poverty in developing countries, El-Masri and Tipple (2002) had similar findings. They also noted that poverty has pushed poor people to live as cheaply as possible on dangerous, marginal sites, and in poorly built houses (ibid.). Thus, uncontrolled rapid population increases in cities with little care from respective city authorities put many poor urban informal dwellers at the risk of floods, and other human-made related hazards and disasters, which in turn increase their vulnerability to poverty as they spend their little income for rehabilitation and recovery from flood hazards and disasters.

The Dar es Salaam city population growth rate from the early 2000s has stabilised at above 5% per annum (URT, 2014). According to UN-Habitat (2003), this annual growth rate is the highest recorded rate in developing countries cities so far. With this trend of growth, this population is expected to double in 15 years' time. This will require improvement and additional structures in social services and housing. However, this high annual growth

rate has resulted in more proliferation of informal settlements into flood prone hazardous areas that are overcrowded, and which lack social services. As Tolba (1992) comments, this situation of overcrowding and poor social services in cities has exposed informal settlement dwellers and their properties to natural, human-made and human-induced hazards.

As Satterthwaite (2001) has explained, the concentration of people and infrastructure in flood prone hazardous areas not only creates an impressive symbol of the apparent human domination of nature, but also provides a daunting future prospect in terms of flood hazard exposure. According to Birkmann (2006), human development on flood prone hazardous areas has a dual positive and negative impact. On the positive side, well-planned flood prone hazardous areas with strong buildings, efficient public facilities and good emergency services provide a physical shield against natural, human-made and human-induced hazards. Their growth is often a reflection of economic success and rising of per capita income of the residents, while the resulting economies of scale offer opportunities for a better and safer quality of life for many people. On the negative side, urban expansion into flood prone hazardous areas has been accompanied by deforestation, slope modification, and interference with natural drainage channels on a scale sufficient to increase, rather than reduce, the threat from natural, human-made and human-induced processes that result in hazards and disasters that hamper income prosperity achieved so far.

According to Norman (2010), a human activity on hazardous flood prone areas increases the vulnerability of a community and its resources to flood hazards and epidemics in urban areas. As noted during the field survey, most of the respondents claimed that their squatting in valley bottoms have been the source of poor environmental sanitation. This situation of poor environmental sanitation has been aggravated by the lack of sanitary services such as sewage systems and drainage facilities in informal settlements. During the field survey, 75% of respondents working in small scale industries and petty business who resided in valley bottoms mentioned flooding as their major problem during the rainy seasons.

Phong (2010) notes a similar problem of flooding in Hong River basin in central Viet-Nam, especially during rainy seasons due to overcrowding of human settlements in the area, which restricts natural seepage of water and accelerates amount of run-off in the area; resulting into floods, flash-floods and water pollution. Ojo (1996) noted that flowing water in valley bottoms rises up to the surface with a greenish colour during the rainy season. Contrary to Ojo's observation, the flowing water in Msimbazi river valley rises up with a blackish colour, and contains domestic and pit-latrine wastes during the rainy season. What all studies have in common is the understanding that human settlements and their socio-economic activities have been the source of water pollution in the area. As noted by Pelling and Wisner (2009), this could be the evidence of the community and resource vulnerability to disasters over time and space.

As noted during the household interviews, there are ranges of human adjustments to flood hazards and their related disasters (diseases). These adjustments can be categorized into three groups, although the most effective adjustments often involve a combination of measures drawn from more than one category. These adjustments are: (a) modifications of the expected flood loss burden; (b) modification of flood hazard events; and (c) modification of people's vulnerability to flood hazards.

As noted by Sarah (2011), modification on the loss burden in any hazard/disaster is the option where hazard responses seek to spread the financial burden as widely as possible beyond the immediate victims through relief and safety nets. However, as it was observed during the study, there were no community safety nets against floods and other related hazards. The study revealed only informal groups' safety nets, essentially for loss-sharing, rather than loss-reduction. This is the only post-hazard events action, where member(s) who are affected by hazard(s) are morally and materially supported. For example, the flood disasters that occurred in Dar es Salaam city in 2011/2014 made some families homeless for several weeks as their houses were flooded with water (see Plate 1). During interviews with government officials, it was revealed that these informal groups operate locally, and are not registered. This hindered their full operation as they lack legal backups. As noted by Hambati (2013), modification on the flood hazard events in Mwanza city ecosystems involves reducing losses by adjusting damaging events to people. This is a situation whereby hazard-resistant design and engineered structures are deployed to safeguard lives and property from selected phenomena in certain high-risk areas. A similar observation at local scale was also observed during the household interview, where most of the respondents (85%) mentioned that the City should improve drainage flows by cleaning drains before storms and strengthening stream walls passing through settlements in order to reduce the impacts of floods.

5. Conclusions and Recommendations

5.1 Conclusions

Generally, the findings reveal that communities living in Dar es Salaam city are exposed to varying degrees of flood and flash-flood hazards. Over the years, the communities living in the city have responded to those hazards to reduce the impacts of threats, 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 are aimed at reducing physical and social vulnerabilities to floods and related hazards and disasters.

Physical vulnerabilities were addressed through structural or engineering measures. These included: flood control walls, uplifted house foundations and cut-off-drains. Tree-planting, reinforced house foundations, landscaping and houses reinforcement were mentioned as long-term measures aimed at improving water movement in the low laying areas. However, the community also applied non-structural measures in flood disaster risk reduction. These measures 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 lives of the City dwellers over time and space. Therefore, it is evident that the current status of knowledge possessed by the community in the cities under the prevailing socio-economic and political conditions with respect to saving lives and property, as well as simultaneously conserving the environment, is inadequate. However, strengthening working relations between and among international, national, regional, district and local institutions in the hazard-prone areas is necessary through joint strategizing and sharing best community practices on reduction measures of disaster risks.

5.2 Recommendations

There should be measures and strategies to reduce the severity of disasters and to improve safety and security of people and their properties so as to improve the quality of life and safety in communities prone to flood hazards in informal settlements. For example, embankments could be built to reduce flooding and flash-flooding. Trees could be planted to increase the rate of water infiltration, and slow down the speed of water run-off. Advocacy and training could be used to influence policies that address climate change issues, which are increasing the frequency and severity of some natural hazards. Vulnerable groups should be encouraged to take part in decision-making to ensure that conditions do not worsen for the poor and most vulnerable people. Therefore, any measure and strategy aimed at managing disaster risk should address the whole set of issues leading to disparities within the community.

Community capacity, in terms of resources and skills, should be improved to reduce vulnerability to flood hazards in urban ecosystems. Development of local institutions through training of appropriate skills and education reduces dynamic pressures. Not all of the structures and processes will be working in a negative manner that creates or increases vulnerability. Some, such as NGOs, religious institutions/organizations, and local leaders should work to strengthen the community, and be an important source of support in times of disasters. These people could help communities living in hazardous areas by advocating effective measures in order to release negative pressures. Addressing underlying causes of disaster risks by challenging any ideology, political and economic systems that increase vulnerability in a community is a vital role in disaster

management. This increases the access of vulnerable groups to power, structures, and resources. Some structures and processes may help reduce the risk of disasters because their political and economic approaches and values are fair and just. To encourage these values among negative pressures, the community can use advocacy in awareness creation at local, national and international levels.

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