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**Mainstreaming Disaster Risk Reduction in housing development: The case of  
Keko Machungwa informal settlement, Dar es Salaam**

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## Abstract

In Tanzania 80% of the population live in informal settlements. Most of these settlements are built in areas that are susceptible to extreme weather conditions such as flooding. Such conditions have significantly contributed to the destruction of housing stock and other valuable properties. There is considerable awareness amongst people living in the informal settlements, government representatives and other key stakeholders about the various flood risks affecting informal settlements. Based on this understanding, several attempts to minimize flood risks have been initiated in Dar es Salaam, Tanzania yet these initiatives have largely failed to deliver the desired impacts. This article aims to investigate core reasons for this through a case study of Keko Machungwa informal settlement in Dar es Salaam City. The study explores the extent to which mainstreaming of disaster risk reduction (DRR) in housing development in informal settlements has been considered and implemented; and recommends measures for improvement. Key methods employed for the research included physical observation, household interviews, mapping, photographing, and in-depth interviews. Overall, the study found that mainstreaming of DRR in housing development was hardly practiced at the household level, as houses are predominantly being built without resistant building materials and supervision of relevant professionals. In order to mainstream DRR in housing development in informal settlements, it is recommended that the government direct its efforts towards regulating, controlling and monitoring the housing development sector by emphasizing the use of flood resistant building materials and establishing resilient infrastructures for flood mitigation in every flood prone informal settlement.

**Key words:** Disaster; Disaster risk reduction; Flooding; Housing, Housing development; Mainstreaming

## 1. Introduction

In Tanzania 80% of the population lives in informal settlements [1], this means that informal settlements have a significant contribution in solving the housing problem over and above the capacity of the government. A number of Acts and policies in Tanzania recognize the significance of informal settlements in solving the problem of housing in urban areas. These include the Land Policy of 1997, the Human Settlements Development Policy 2000, Land Act 1999 (Act No. 4 of 1999) and Urban Planning Act 2007 [2-4] as well as MKURABITA programme [5]. Although there are laws and policies which recognize the importance of informal settlement in solving the housing shortage, it is argued by many scholars that little attention has been paid to addressing disaster risk in these informal settlements [6, 7]. Certainly, many projects in Tanzania initiated for the purpose of spatial reorganization of informal settlements and improving physical infrastructures<sup>1</sup> have been unsustainable. For example, government has implemented various strategies to ensure that environmental conditions in informal settlements are improved to reduce disaster risk. The strategies included regularization and squatter upgrading programmes. In principle, these strategies aimed at improving the physical infrastructure so as to minimize disaster risk in vulnerable informal settlements. Meager financial resources and insufficient management capabilities have undermined these projects. Squatter upgrading which was introduced in 1970s by the World Bank, collapsed in the middle of 1980s [8].

Nevertheless Kombe and Kreibich [9] noted that in 1960 there were 5000 housing units in the informal settlements of Dar es Salaam, but increased to 7000 and 28,000 in 1963 and 1972 respectively. Thirty years later as reported by UN-HABITAT [10], 68% of the total population in Dar es Salaam city lived in informal settlements. As time goes on, the situation of the growth of the informal settlements and number of people living in these settlements is becoming dire. Lupala *et al.* [11] also established that 66.34% of the spatial form in urban Tanzania is occupied by informal settlements. In addition, recent studies by Sakijege *et al.*[1], Kyessi and Sakijege [12] in the city of Dar es Salaam, show that up to 2014, 80% of all residential houses were found in informal settlements. The increase in the number of informal settlement and the increase in the number of people living in informal settlements is a challenge in

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<sup>1</sup> Physical infrastructure, include: dwelling structures; basic urban services such as water, drainage channels, sanitation facilities; social amenities like schools and health facilities.

developing countries. It is a challenge because most of the informal settlements are often located in marginalized, low-lying and environmentally fragile areas that are susceptible to extreme weather conditions including flooding [1, 7, 13]. This condition has significantly contributed to the destruction of housing stock and other valuable properties.

There is considerable awareness amongst people living in the informal settlements, government representatives and other key stakeholders about the various flood risks affecting informal settlements. Based on this understanding, several attempts to minimize flood risks have been initiated in Dar es Salaam, Tanzania yet these initiatives have largely failed to deliver the desired impacts. Unfortunately, the initiatives failed because residents in the informal settlements still face problems of dampness, destruction of properties and water logging [1]. Given this background it is worth investigating reasons for increased vulnerability of buildings and structures in informal settlements in the search for practical intervention measures.

Findings from previous studies that address disaster risk have focused on aspects including, perceptions and practices within international aid organizations regarding the existing and potential roles of urban planning as a tool for reducing disaster risk [14], assessment of adaptation strategies to flooding [1], Mainstreaming disaster risk reduction into development [15], mainstreaming DRR in urbanization [16]. Yet, in these studies, **mainstreaming DRR in housing development** in informal settlements is hardly addressed. There are very few analyses on how aspects of disaster risk reduction are applied in housing development in areas that are prone to flood disasters. Many scholars have argued that houses and structures meant to prevent disaster (particularly flooding) are destructed during rainy season and thus aggravate flood hazards [1, 13]. This warrants the rationale for conducting this research, with Keko Machungwa informal settlement in Dar es Salaam City Tanzania being the case study under investigation. The aim of this research was to understand the process of housing development in flood prone areas and identify underlying factors contributing to risk. Based on research findings the final part of the paper outlines important recommendations for mainstreaming DRR into housing development in flood prone informal settlements.

The main objective of the study was to explore the extent to which DRR is considered in housing development in the flood prone informal settlement of Keko Machungwa. Studying how DRR is considered in housing development was central for ensuring that these housing structures were reliable in protecting people and properties against flooding. However, before exploring extent to which DRR is considered in housing development, it was important to explore process of housing development.

## **2. An overview of Disaster risk reduction and housing**

Disaster risk reduction focuses on reducing vulnerabilities and exposure stemming from development within high risk zones, unplanned urbanization, environmental degradation, population growth and climate change. The most commonly cited definition of DRR is one used by UNISDR *“The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events”* [17]. This definition means that disaster risk reduction is vital for building a more equitable and sustainable future.

The widespread failure of governments across sub-Saharan Africa to deal with disasters before they happen has led to destruction of properties [1, 18], diversion of resources into disaster response which have economic implications for state provision of social services [19] and loss of human life. To make the world safer from disaster risks many plans have been established. For example, the Hyogo Framework’s goal was to substantially reduce disaster losses by 2015 - in lives, and in the social, economic, and environmental assets of communities and countries [20]. Since its establishment in 2005, disasters caused total economic losses of more than \$1.3 trillion, made 23 million homeless, and killed more than

700,000 people [21]. This shows that more efforts are needed to minimize the underlying risk factors. Of recent DRR initiative at global level are guided by the Sendai Framework for DRR 2015-2030 [21].

There is no more important factor in reducing a community's risk from flood disaster than mainstreaming the disaster risk reduction in every development undertaken in a flood prone area. This means that disaster risk reduction should be an issue that every member of a community are concerned about; starting from law enforcement, construction of a house by individual households and development of various infrastructures to cope with floods at the community level.

Since house is one of the properties that receive immediate impacts of flooding, there is a need to understand contribution of the government towards ensuring that people in flood prone areas have adequate housing. By definition, "*Adequate housing is the housing that conforms to basic standards with regard to security of tenure, availability of services, materials, facilities, and infrastructures, affordability, habitability, accessibility, location, and cultural adequacy*" [22]. This definition implies that human being has a right to adequate housing. Adequate housing is very difficult to attain because the efforts made by citizens to improve their houses, receive little support from the government. Due to little government support many people have found themselves living in unsafe houses located in high risk areas. While the need to provide safe housing has been recognised since Tanzania's independence in the 1960s, there is a multitude of factors that have prevented government actions from improving housing and general conditions in informal settlements. The primary ones include insufficiency policies, rapid urbanization and financial constraints.

### **3. Correlation between housing quality and vulnerability to disaster**

In this study, it should be understood that there is a strong correlation between the quality of a house and vulnerability of a building to a hazard occurred. Housing quality has many elements, and can be defined in many ways. Housing quality concerns simply the quality of the internal and external structure of a dwelling and aspects of environmental sustainability. Some of the components of housing quality are: structural integrity (building code followed), building materials, maintenance of structures, quality and safety settlement (community facilities e.g drainage channels), regulatory mechanism to enforce land use / building regulations.

Good quality house can particularly be achieved where building codes exist and followed, since the main purpose of building codes are to protect public safety as they relate to the construction of buildings and any other structures [23]. They specify the minimum requirements to adequately safeguard the health, safety, and welfare of building occupants.

Similarly poor maintenance of houses increase vulnerability of a house to various disaster [24], because it weaken the structure and thus easily destructed when disaster happen. It should be noted that maintenance is a disaster prevention strategy [25]. Proper maintenance of structures is crucial for minimizing potential adverse impacts of flood and minimise the need for recovery and reconstruction [24, 26].

### **4. Previous study on disaster risk reduction**

There is a wide range of literature on disaster risk reduction [14, 27, 28], a paper by [27] identified the ways in which government and other stakeholders can support the needs and address the vulnerabilities of at-risk communities. They noted that flash flood triggered by Typhoon Ketsana in 2009 heavily damaged many houses in poor communities. Through the support programme developed, it was proposed that building materials loans for house repairs should be paid to the affected communities. This conclusion means that, improvement on housing conditions is vitally important in risk reduction.

It was noted by [14] that dwellers in 15 slum communities in El Salvador cope with disaster risk, and reveals the variety of strategies they have to reduce risk. The strategies are based on different patterns

of social behaviour, with a strong focus on individualistic behaviour for survival. It was concluded that the applied strategies are huge and crucial but they are weak coping strategies and thus very difficult to protect houses from being affected by disaster and minimize disaster risk in general [14].

Increasing scale of disaster occurrence and impact is a growing concern of all countries and people [28]. Therefore, it is important to understand where and how the disaster occurs in order to deal with it. Likewise, it is important to understand knowledge of the affected communities as far as disaster is concerned and how they cope with such a situation, this in turn will make possible implementation/improvement of DRR measures and increase resilience of such community (*ibid*).

Disasters impact on all aspects of development [29], they cause damage to service infrastructure, housing and productive assets, they also cause loss of human. These researchers argued that many developing countries are failing to cope with disasters as a result it create risk through increasing peoples' exposure and susceptibility to disasters. They then suggested that DRR strategies are of paramount importance to reduce or manage risk from disasters. Finally, they concluded that it is important to consider how to empower developing countries to initiate DRR strategies. This is because developing and developed countries differ in capacity and because, on average, developing countries are less in capacity than developed countries (*ibid*).

These studies highlight that in order to reduce disaster risk there is a need to consider disaster risk reduction measures when building houses in areas that are prone to flood hazard.

## 5. Research methods and design

### 5.1 Procedure

Case study were carried out at the household and institutional<sup>2</sup> levels in Keko Machungwa in 2015 to document the underlying factors contributing to risk and to determine process of housing development at the household level in Keko Machungwa. Understanding factors contributing to risk and the process of housing development are vital especially when one wants to establish whether or not DRR is being mainstreamed in the process of housing development.

Data was collected using multiple qualitative methods and the household level investigation included observation, photographing, semi-structured interviews, in-depth interviews with selected respondents. Approximately 60 of the interviews were conducted with households living in Keko Machungwa informal settlements.

Since the purpose of the research was to explore the extent to which DRR is being mainstreamed in housing development in the informal settlements of Keko Machungwa, purposive sampling was adopted as a viable sampling method for this study. Purposive sampling was employed so as to include household who are affected by floods and exclude those who are not affected by floods. However, to ensure reliability of data sample random sampling was applied when selecting the 60 households to be interviewed. The sample of 60 households was thus selected randomly among the households living in high risk area within the river valley of Keko Machungwa informal settlement. The emphasis was on exploring: the underlying risk factors, the process for housing development as well as DRR initiatives.

Group discussion and semi-structured interview were the main data collection tools used at the institutional level. Institutions interviewed included: sub-ward office (which is the lowest organ of local governance in Tanzania), ward office, engineering department and town planning department of Temeke

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<sup>2</sup>Institutions include: Keko Mwachungwa Sub-ward office, Miburani ward office, engineering department and town planning department of Temeke Municipal Council.

Municipal Council. The focus of discussion with institutions was on analysing existing procedures for housing construction and whether those procedures are followed.

## **5.2 Site selection**

In Dar es Salaam, most informal settlements exist on risky areas which are vulnerable to floods and other hazards [30]. However, flood severity is not equal in all the informal settlements and in order to identify and select a case suitable for conducting the study, four criteria were developed for evaluating potential sites; these were, (i) An area where residents have been affected by frequent floods, (ii) The immediate impacts of flooding e.g. damage to houses, among others (iii) Good practice cases (the residents are proactive in learning and implementing different ways to curtail floods) and (iv) Accessibility and possibility for doing research. On the basis of the aforementioned criteria Keko Machungwa informal settlements was chosen as an appropriate case study settlement for the research.

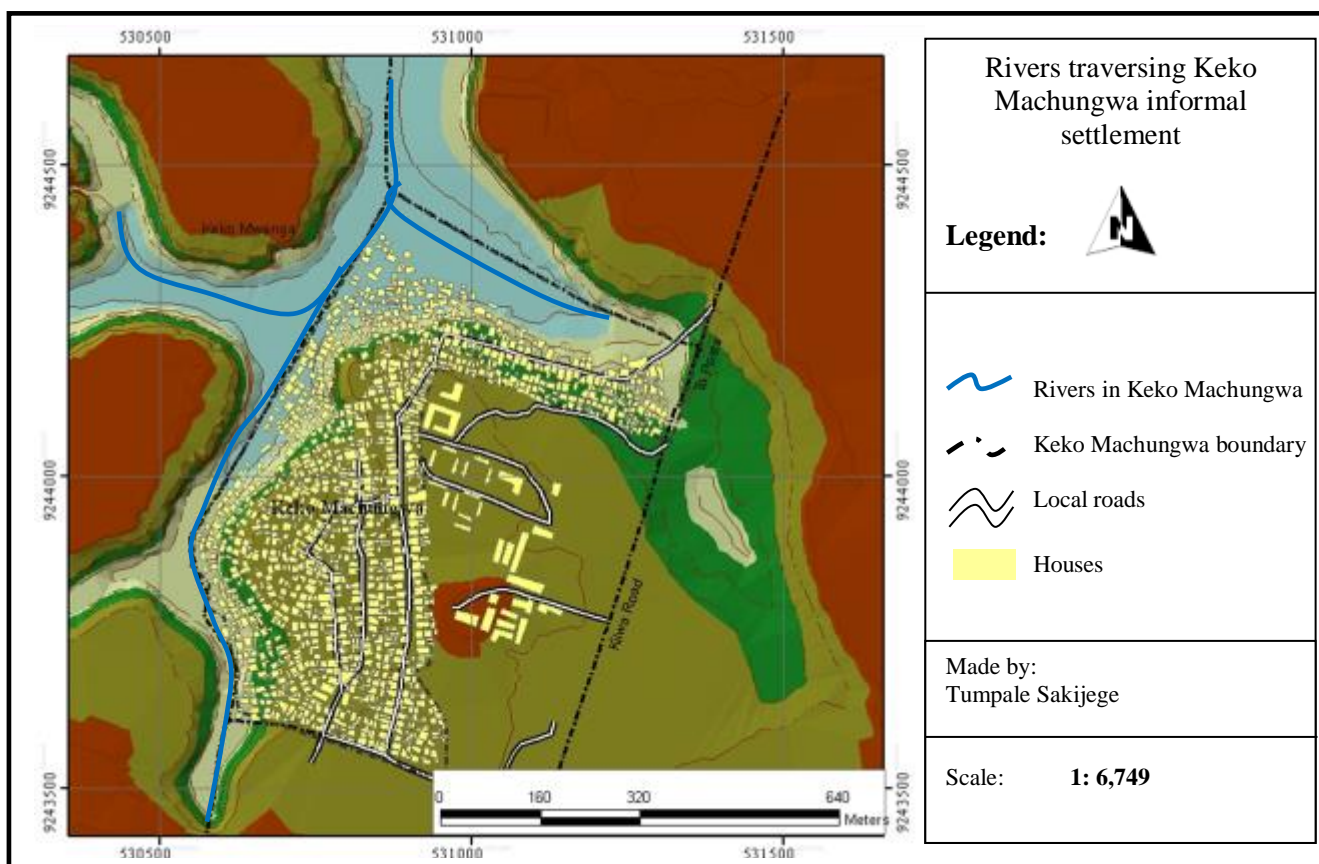
The area affected by flood is within the valley (Keko Machungwa Bondeni). Formerly it was a wetland used for agriculture; it was also a water course accumulating storm water from different elevated parts (for example Kurasini and Chang'ombe) towards the Indian Ocean. The fact that Keko Machungwa is located on a low-lying terrain, and not well drained, it is obvious that the settlement is susceptible to floods. In addition, to being affected by floods, Keko Machungwa has a problem of land use changes within the valley. Indeed, according to the Dar es Salaam Master Plan of 1979 [31], the valley was earmarked as a hazard land. At present it is no longer considered as hazard land, instead it has been turned into settlement for shelter informally.

It should be noted that Keko Machungwa Informal settlement is located about 3 km from the city centre and close to industrial areas of Chang'ombe (2 Km), and as such the proximity to important areas attracted residents and investment (despite being a flood prone area). This in turn led to high population density and concentration of buildings. Therefore, the settlement is expanding in term of increasing in the number of people and buildings, which in turn triggered disaster risks.

## **6. Findings**

### **6.1 Settlement vulnerability to flood disaster**

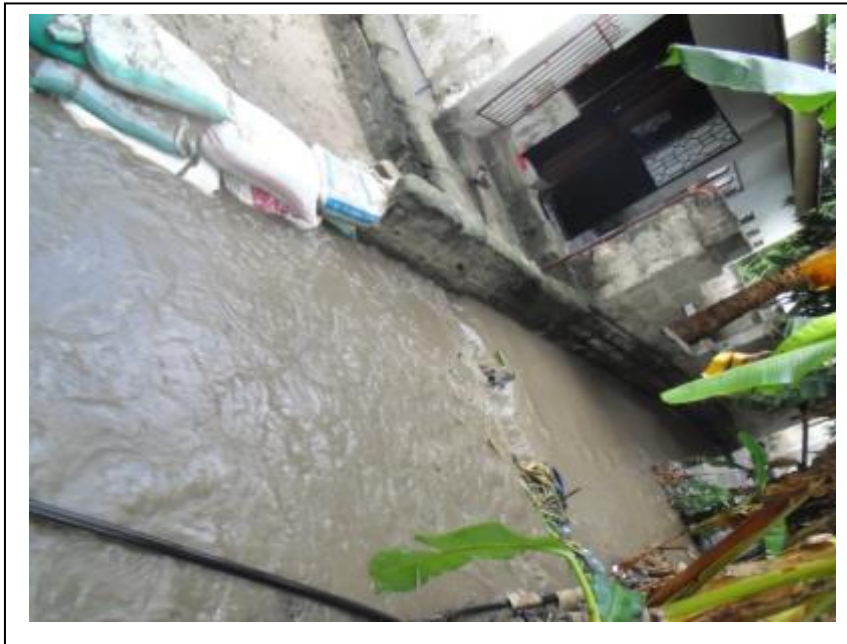
As stated in section 5.1, Keko Machungwa informal settlement lies within the Keko Machungwa River valley (see Figure 1), which frequently experiences flooding caused by heavy rains. The rain is therefore relatively high during rainy season (March-May). Risk of flooding in the settlement is aggravated by encroachment on river valley, absence of robust flood control infrastructures, haphazard dumping of solid waste, and concentration of buildings.



**Figure 1: Rivers Traversing Keko Machungwa Informal Settlement**

*"I did not like to build my house very close to this river (Figure 2), I was forced to do so due to the low cost of plot. I wish to relocate because this place is not healthier to live, during rainy, flood water fills every part of the house and the floor get damaged by water due to underground water percolation"*

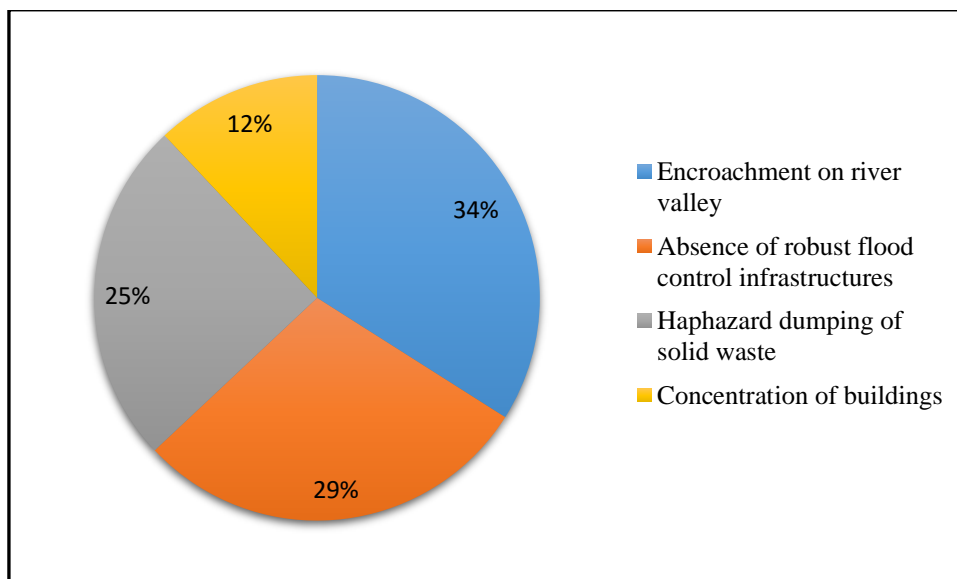
Although the above statement was the opinion of an individual, it shows how vulnerable the settlement is. Furthermore, the damage that happens to the floor is a sign of disregard of DRR strategies (like the use of flood resistant building materials) when constructing their houses.



Source: Photographed by T. Sakijege

**Figure 2: A house constructed at the edge of the river in Keko Machungwa**

The factors that increase the risk of flooding in Keko Machungwa are summarised in Figure 3. The most severe floods recorded in Keko Machungwa and Dar es Salaam City, in general, was the flood event of December 2011, causing estimated deaths of 40 people and over 1000 families displaced [32]. The Keko Machungwa informal settlement was one of the sub-wards affected by floods in 2011, in addition, the settlement has been affected by floods every year during rainy season, although intensity of floods depends on the amount of rainfall for that particular year.



**Figure 3: Factors that increase the risk of flooding in Keko Machungwa Informal settlement**

*“As you can see my house is flooded (Figure 4). In fact, we are frequently affected by floods in every rainy season; it is very hard to specify how many times we experience floods. Sometimes we are affected by*



*floods even though it is not raining here, this is due to rainfall from surrounding upper areas. Rainfall intensity determines frequency of flood; a good example is the heavy rainfall in 2011 where flood depth was 1.5 meter”.*

The statement above is a quote captured during household interview when one woman explained about the frequency of floods in the area. In practice, the respondents’ statement means that Keko Machungwa is affected by floods in every rainy season, and the frequency of floods depends on rainfall intensity. The area is also affected by floods as a result of rainfall from upper catchment areas.

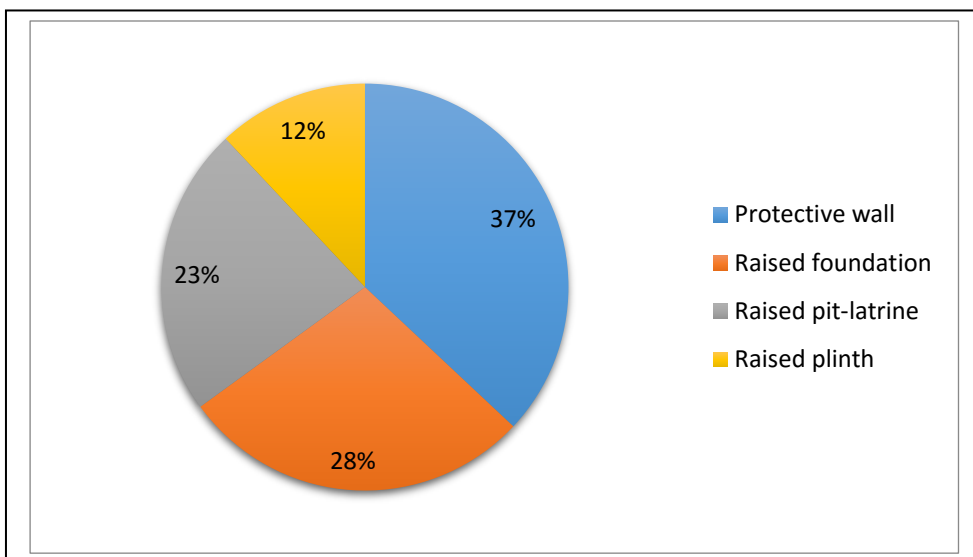


Source: Photographed by T. Sakijege

**Figure 4: One of the respondent’s houses surrounded by floodwater**

## 6.2 Adaptation strategies undertaken to reduce flood risk

As a way of reducing impacts of flooding, residents in Keko Machungwa informal settlements have resorted to the use of structural adaptation strategies. Some of them include: Protective wall; raised foundation; raised pit-latrines; raised plinth, in Disaster, these strategies are referred to as structural adaptation strategies. The uses of these strategies were meant to block flooding water. Figure 5 illustrate survey results of the adaptation strategies to flooding in Keko Machungwa settlement.



**Figure 5: Adaptation strategies in Keko Machungwa**

According to figure 5, construction of protective walls is one of the options preferred by residents in Keko Machungwa, it was revealed by 37% of the respondents. A protective wall is a defensive structure which is built as a fence surrounding a house. One household reported that:

*“I constructed this wall for protecting flood water from entering my house, however the wall is useless because even if there is little rain my compound get filled with rain water, we are therefore forced to stay with this wet condition for a month. He added that in the period of heavy rainfall the wall is helpless. Water overflows them and enters inside the house”.*

The above explanation shows the efforts made by a residents and how vulnerable they are. This means that, given the high water table, it is possible during heavy rainfall to have flood that cannot be contained by the available strategies.

As a result of flooding and the fluctuating water table, some households raised their foundations of their houses and pit latrines to prevent the storm water from filling up their houses and pit latrines. Of 60 interviewed households, 28% had raised foundation of their houses and 23% had raised their pit latrines. The height of the raised foundation and pit-latrines depends on the financial ability of individual household, but the height range from 0.5 to 1 metre above the plinth level. It was reported by one interviewee that;

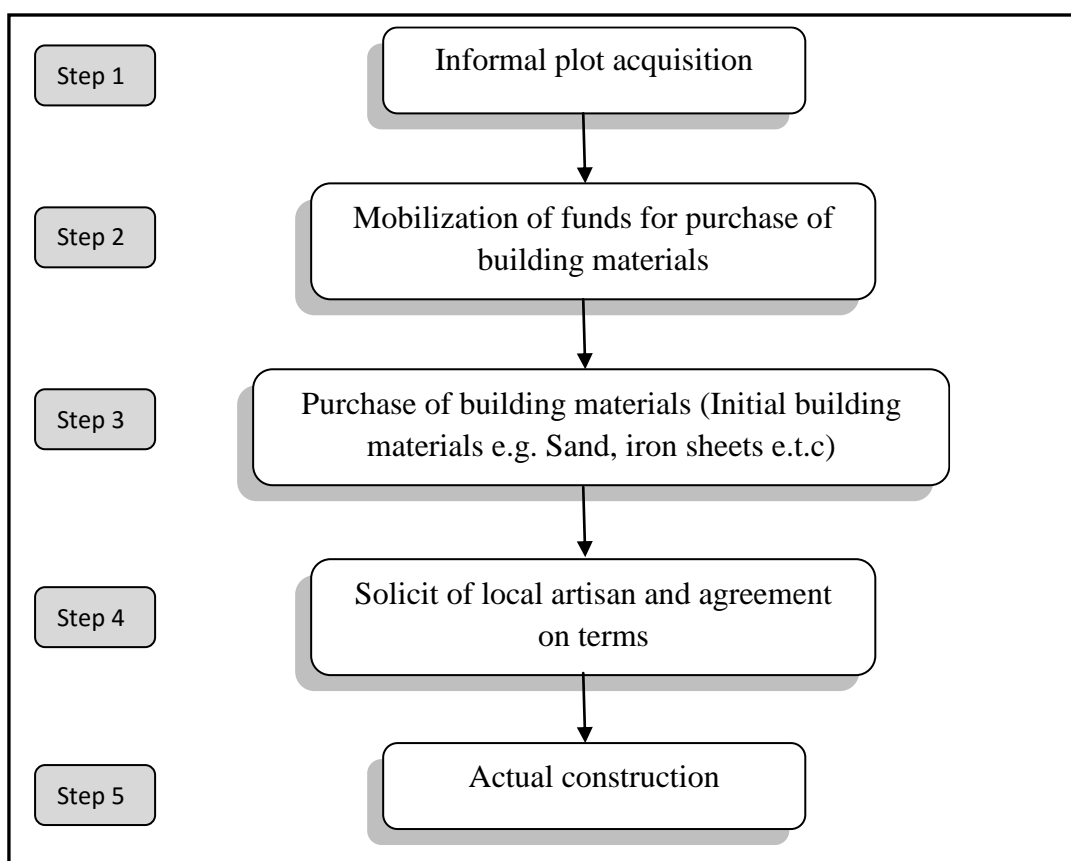
*“What I want is someone to assist me move out of this place. I am tired of spending large part of the little income I get to reconstruct my toilet which has been collapsing regularly”.*

Drawing from the above quote one issue is pertinent: DRR is hardly practiced when constructing the houses as well as adaptation strategies. Generally, it was determined that flood mitigation and risk minimization measures through the above mentioned intervention were hardly achieved at the household level, as adaptation strategies were constructed with no attention to DRR measures.

### **6.3 Housing development processes**

Building of houses together with infrastructures to prevent flooding in Keko Machungwa informal settlement does not differ with other informal settlements in Dar es Salaam city. A common building

practice that is being used is through untrained local artisans. Out of 60 interviewed households, 57 (equivalent to 95%) admitted to build their houses and infrastructures to cope with floods through untrained local artisan. One of the questions raised during interview was how do you get a plot and what type of method do you use to build a house? 83% reported to buy their plots informally, after purchasing they seek for untrained local artisans who builds such houses (i) at a cheap price, (ii) without any construction map and (iii) without any breakdown of the types of building materials relevant to the local conditions. Houses and even flood prevention infrastructures are built on the experience of the untrained local artisans as well as by copying from other people who live on these areas or somewhere else. Similarly it was reported that buildings in Keko Machungwa are built without application of building permits to the responsible authorities, also there is no building inspection conducted by the responsible authorities. Figure 6 provides a summary of land development stages / process in Keko Machungwa.



Source: Household Interview, June 2015

**Figure 6: Land Development Process in Keko Machungwa**

Figure 6 shows that, constructions of houses as well as other structures within the settlement (for example structural adaptation strategies) are contingent upon local artisan (refer Stage 5). It should be noted that, local artisan are untrained, they therefore do construction activities based on experiences. In support of this argument one household reported that:

*"I like using local artisan because they are easily available within our settlement and they charge relatively low price compared to engineers".*

Where structures are designed and constructed by untrained local artisan, it is very hard to have structures that can withstand adverse flood action. With the practice of using untrained local artisan in the design and construction works, the inevitable conclusion is that the vulnerability of buildings is increased.

Moreover, because Keko Machungwa is a flood-prone area, it was expected that, care must have been taken in the selection and purchase of building materials and hence construct houses that are resilience to flooding. The act of developing land with the use of untrained local artisan means that consultation and supervision by engineers is ignored; therefore it is very difficult to have buildings that can withstand flooding for a prolonged period.

#### **6.4 Structural integrity (building code followed?)**

Although Tanzania has many laws prohibiting construction of houses in high-risk areas (for example Environmental Management Act, Act No. 20 of 2004 [33]), there is inefficiency in the implementation of these laws. As such many have consequently built their houses in high-risk areas. 71% of the interviewed households reported that they prefer building in such areas due to (i) low cost of plot, (ii) bureaucratic procedures of accessing plots in planned areas as well as (iii) absence of specific building codes for housing development in informal settlements. Through interviews with officials it was established that a number of houses are being constructed without building codes that govern the design, construction, alteration, and maintenance of such houses. 81% of the interviewed households conceded that their houses were constructed without following building codes. Since the purpose of building codes is to have houses that can withstand floods, non-compliance with these codes results into construction of unsafe buildings hence increase vulnerability of various disasters.

#### **6.5 Building materials**

It was observed that there were variations in terms of building materials used to construct houses which impacted durability of the houses. 86% of the interviewed households in Keko Machungwa reported that building materials used for construction of houses (from foundations to walls) consisted of sand and cement blocks. On the other hand, the remaining 14% of interviewees reported that they construct their houses using soil bricks. These types of building materials are vulnerable to floods when there is a prolonged flood event [34]. The most surprising practice is the way the blocks are being produced (i) they are produced by untrained local artisans who do not have modern facilities for brick making (Figure 7), and (ii) 45-50 blocks are being produced per 50 kg bag of cement, while recommended standard of number of blocks per 50 kg bag cement is 33 blocks [35]. 72% of the total households surveyed have been using this old way of block making and the remaining 28% reported to buy machineries blocks. Due to the fact that majority (72%) used blocks that are locally produced (using untrained local artisans) it is very common in Keko Machungwa to find many houses being faced with the problem of dampness resulting from underground water percolation.



Source: Photographed by T. Sakijege

**FIGURE 7: Local way of sand cement blocks manufacturing**

### 6.6 Maintenance of structures,

*"I cannot do maintenance in time because of life hardships, sometimes I have to just do maintenance after 5 years, I usually do that after feeling that more damage will occur to my house"* (a quote from one of the interviewed household).

*"We have the mechanism of going around our settlement after occurrence of every flooding; the aim is to encourage people to do maintenance to the destructed parts of their buildings. However, the response is very poor, maintenance is given low priority for reasons like (i) high cost of living and (ii) maintenance is not part of their daily plans of life"* (a quote from Keko Machungwa sub-ward leader)..

The above quotes as reported by one of the interviewed household and a chairman of Keko Machungwa sub-ward shows that maintenance is not given priority by the residents living in Keko Machungwa. This is despite the fact that the settlement is frequently affected by floods. Likewise, where necessary maintenance is done in a reactive manner, where the size of the damage to the house choose the direction.

Overall, when maintenance of the buildings after flooding was examined, it was revealed the lack of maintenance as reported by 81% of the interviewed households. One of the reasons reported is that they failed to do their due maintenance of buildings due to construction costs as well as other costs of living. This situation of disregarding timely maintenance of buildings led to weakening of buildings, rendering them vulnerable to failure when severe floods hit the settlement.

### 6.7 Quality and safety settlement

Despite the fact that the ability of a house to withstand impacts of floods depends on the adherence to specific construction procedures and the use of flood resistant building materials, availability, suitability and durability of infrastructure to prevent flooding in that specific area has a great contribution in mitigating the effects of floods to the houses. As mentioned in section 6.1 that, Keko Machungwa settlements is one of the informal settlements that is frequently affected by floods, despite that fact, there are no sincere efforts made to set specific infrastructure (e.g. storm water drains) to prevent/minimize the impact of flooding in the area. Construction of infrastructure to cope with flooding is done by local people themselves without considering quality and flood resistant building materials (see Figure 8). This situation contributed to the increase in settlement vulnerability. Lack of infrastructure to minimize the impact of flooding at the settlement level implies that, the effects of floods go directly to individual households.



*Source: Photographed by T. Sakijege*

**Figure 8: A tree log bridge made by Keko Machungwa residents to simplify crossing in one of the stream traversing the settlement**

## 7. Discussion

Information provided by the interviewed households indicated that flood is one of the biggest threats to the durability of their houses especially when considering the fact that floods occur frequently. This indicates that residents in Keko Machungwa have a greater understanding on the severity of flooding in their settlement. Under normal circumstances it was expected that this understanding would instigate residents to build strong buildings in order to mitigate the impact of flooding to their houses. Disappointingly, the situation is different from what was expected; whereas, many buildings are built without taking into account the realities of the impact of flooding in the settlement.

While a flood by nature does not constitute disaster risk, underlying vulnerabilities lead to disaster risk and resulting losses. As discussed in Section 6.1, the major factors contributing to the increase in flooding and hence increased vulnerability of buildings and people are encroachment on river valley, absence of robust flood control infrastructures, haphazard dumping of solid waste, and concentration of buildings. Moreover, housing related development in Keko Machungwa does not consider the effects of flooding and mainstreaming of DRR in housing development is not practiced in Keko Machungwa. A number of views were evident with regard to disregard of mainstreaming disaster risk reduction in housing development. Firstly, it was revealed that there is no specific authority to supervise the construction of buildings in Keko Machungwa and in other informal settlements in Tanzania. Thus, in terms of supervision of constructed buildings residents in informal settlements have been doing that by themselves. Secondly, there is lack of skilled human resources for constructing houses. This was evident in the type of human resources used to construct their houses, whereas, it was reported by the majority (95%) that they use untrained local artisans. The untrained local artisans lack knowledge on the construction techniques that can reduce vulnerability of building stocks in flood prone areas. Thirdly, disregard of the use of flood resistant building materials, instead of using material that can withstand flood impact, they use building materials that are easily affected by flooding. About 86% of the interviewed household uses sand cement blocks. Sand cement blocks according to FEMA 2008 are susceptible to floods when there is a long-lasting flood event. Despite disregard of the flood resistant building materials, another thing contributing to the vulnerability of buildings is the way sand cement blocks are being prepared. They are prepared locally, meaning that with the use of untrained local artisan and without considering appropriate ratio of sand and cement. Fourthly, many residents have been ignoring the necessity of maintaining their houses, while maintenance is a core disaster risk reduction strategy.

Flood victims (residents in Keko Machungwa) have attempted to apply certain flood adaptation strategies. However, the initiatives (adaptation strategies) were ineffective in minimizing flood impacts. This is a challenge because despite these efforts, the vulnerability of people and properties in informal settlements is increasing. However, it is an opportunity that residents in Keko Machungwa informal settlement are proactive in taking measures to contain the situation (flood risk), as a way forward, the initiatives at household level need to be enhanced by making sure that mainstreaming DRR is practiced.

Compared to planned areas, where for anyone to build a house construction procedures<sup>3</sup> must be followed, the action of the absence and disregard of such procedures in informal settlements implies that the government is not paying adequate attention to the informal settlements.

As mentioned earlier (see section 5.2), large parts of Keko Machungwa are on hazardous land, with buildings constructed on waterways, which endangers the lives of residents and buildings, and is contrary to the rules and regulations. Despite this situation, still, there is lack of sincere efforts made (particularly by the government) to build robust flood control infrastructures to prevent flooding in the settlement. Through self-organization residents have ended up building substandard flood control infrastructures (for

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<sup>3</sup>Procedures for housing construction in planned areas include: (1) application of building permits to relevant authorities (2) scrutiny of design drawings, (3) site inspections by qualified and authorised personnel, (4) issuing of construction consent and (5) monitoring the construction process

example tree logs) but most of the infrastructures constructed to minimize impact of flooding does not prevent flood water from affecting their houses.

## **8. Recommendations**

The reason as to why issues associated with mainstreaming DRR are inadequately administered is a serious shortage of trained human resources. Tanzania should learn from other developing countries and build a culture of training disaster experts to strengthen human resource capacity to design and develop houses that are resistant to flooding and hence manage disaster risks at all levels.

Where houses have to be built in flood prone locations, design must incorporate construction materials resistance to locally experienced hazards. As a way forward, there is a need to promote the use of flood damage-resistant material so that buildings should not be easily affected by floods. This is possible where disaster experts are in place.

Having trained disaster experts and the use of flood damage-resistant material alone is not enough to ensure that disaster risk is minimized in the settlement. Therefore, there is a need to analyze local environment critically to determine the suitable infrastructure that may be constructed to contain and redirect rain water that would otherwise cause floods in the Keko Machungwa community. The Temeke Municipal Council, Sub-Ward government, interested development partners and the local community constitute the key stakeholders in implementing this in Keko Machungwa.

Above all, development control measures, including adherence to provisions in the Urban Planning Act No.7 of 2007, and Township building rules be enforced to control development in hazard lands. Moreover, the construction of houses in Keko Machungwa and in other flood prone informal settlement should be regulated and controlled to follow current procedures for housing development. That is, following a procedure that involves, (1) application of building permits to relevant authorities, (2) scrutiny of design drawings, (3) site inspections by qualified and authorised personnel, (4) Request and receive pre-construction inspection (5) Request and receive construction consent and (5) monitoring the construction process to ensure that the prerequisite DRR aspects are considered and implemented.

## **9. Conclusion**

Informal settlements have become a refuge for many people living in developing countries; this is despite the fact that most of these settlements are located in flood-prone areas. In order to reduce the impact of flooding to the people and the buildings in flood-prone informal settlements transition is urgently required from ignoring the quality of houses being built in flood-prone informal settlements towards monitoring all housing related developments to ensure mainstreaming of disaster risk reduction measures. For this to succeed, it will require joint efforts of local people, government authorities, civil societies and disaster experts.

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