

PLANNING FOR NATURAL HAZARDS: AN INTEGRATED APPROACH INTO URBAN RISK ASSESSMENTS – A PERSPECTIVE ON SETTLEMENTS LOCATED IN HIGH-RISK AREAS IN MASERU, LESOTHO

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ABSTRACT

With the advent of climate change and increasing urbanisation of the cities and towns, poor new residents in urban and peri-urban areas settle in high-risk locations with limited access to basic services and unfit structures which cannot resist harsh weather conditions. Therefore, managing and proactively identifying the risk by applying proper urban management and governance tools will improve the safety and liveability of cities. Maseru, like many other African cities, does not have proactive planning for natural disasters, and there is a common development of new settlements and extension of older settlements into high-risk locations. The majority of these settlements are located in areas susceptible to rockfalls and flash floods. Consequently, this paper focuses on planning for natural hazards in high-risk located settlements. A hazard impact assessment is conducted to measure the hazard risk and identification of physical assets and populations at high-risk hazards areas. A mixed method approach is used which includes an analysis of documents. Also, an observation and a transect walk and secondary data is utilised for the primary level risk assessment. The results of this study revealed that there is no planning for natural hazards in Lesotho. The results further reveal that more people are building in high-risk locations because these places are not zoned to alert people that they cannot reside within them. The study, therefore, recommends a clear working relationship between the Maseru Municipal Council and the Disaster Management Authority, to sensitise people about the dangers of constructing houses in high-risk locations. High-risk locations should be assessed properly by engineers and rezoned to prevent people from residing on them.

Keywords: high-risk location, natural hazards, climate change, rockfall, flash floods, urban risk assessment.

1 INTRODUCTION

Many cities of the global south are faced with the challenge of planning and managing natural hazards key amongst most being the floods. Therefore, due to its terrain, Lesotho is generally susceptible to natural hazards and the situation is worsened by the adverse effects of climate change [1]. Hence, heavy summers rainfall between December and March causes flooding in high risk locations in Maseru. Looking at Lesotho's status as a vulnerable and poor country which is generally prone to natural hazards, it is important for her to prepare and plan for these hazards. However, the previous vulnerability assessment indices have only focused on the impact on livelihoods, that is; how disasters have affected the food production and erosion hazard map [2]. In this context, Maseru recently experienced heavy rainfalls that resulted into flooding of settlements located on high risk areas, such as below the dams and within the natural water paths. These are areas where if an urban risk assessment index are adequately conducted, there would be no settlements located.

2 NATURAL HAZARDS

Natural hazards are physical phenomenon that occur unexpectedly globally and has major contributions on the landscape of the earth. The natural hazards have always been in existence



even before the appearance of man, these phenomenon endangers human life because they damage manmade infrastructures and natural features. Furthermore, urban development exacerbated the impact of natural hazards more especially in the developing countries, hence it is worth noting that natural hazards tend to occur frequently more than our capabilities to redress the damage they cause [3]. Lesotho is highly exposed to natural hazards as it experiences extreme weather conditions which causes hail storms, floods and heavy snow in winter [4]. In the country, these phenomenon does not occur specifically on specific locations but it is rather influenced by the land size and environment vulnerability. However, it is important to note that natural hazards vulnerability is also increased by the improper land use and unplanned development beside natural occurrences only [5].

3 LAND USE PLANNING FOR NATURAL HAZARDS

Land use planning is a key instrument for reducing natural hazards risk and in turn increasing resilience and sustainability. Also, risk-based planning presents an opportunity to plan beyond just natural hazard but to also plan for the aftermath of an event. Equally important, this includes land use assessment and strict planning standards as the risk of hazard increases [6]. In addition, another important issue in risk-based land use planning is the capability to differentiate between various stages of risk such as acceptable and unacceptable and being able to link them to land use policies. Usually, when addressing natural hazards land use planning is based on the probability of the occurrence of an event, without considering the consequences linked to the natural hazard events [7]. That is; in most cases urbanization on flood plains seem to increase the probability of flooding hence it causes disasters. Despite building storm water controls and channelization of water through dams, floods thrive in floodplains and damage properties [8]. Most importantly, land use and natural hazards have a two-way relationship because natural hazards have an ability to change the landscape which then affects the land use. But also, changes in land use can as well cause natural hazards [9], [10].

Ultimately, to reduce the risk of natural hazards it is important for planners, decision-makers and engineers to consider the physical constraints of an area and its susceptibility to natural disasters. Therefore, it is worth employing land use planning based on natural hazard maps to be able to conduct land suitability in areas which promote sustainable urban development. This is important as it focuses on land use planning for the reduction of natural hazards of different types such as landslides, land degradation and floods

4 INTEGRATED URBAN RISK ASSESSMENT FRAMEWORK

This is an approach that enables improved understanding of the city's risks from climate change and disasters. This approach allows for customization in terms of its application depending on availability of data relating to population and hazards, institutional capacity as well as the financial resources. This is done through phases where each level of assessment is linked to gradually detailed and complex tasks [11]. It is important to note that the URA allows for city managers to choose various components from each pillar which have the capability to either individually or collectively improve the risk understanding in a particular city. The structure of URA is such that it can integrate both rapid on-set events such as landslides and floods as well as the slow-on set hazards such as sea-level rise and droughts which are generally associated with the long-term effects of climate change [11].

The URA is based on three important pillars which are institutional, socio-economic and hazard impact. Most importantly, the framework is centred around the hazard impact assessment pillar, whose main purpose is to identify the intensity, type, and where there is potential loss as a result of climate change and future hazards. In actual fact a risk purports a



hazard, hence vulnerability of the people and the ability to respond [11]. This then means, the assessment considers the institutional roles and socio-economic situation within the city. This helps to understand whether there are agencies that exists with responsibility to manage the risks ascending from climate change and disasters. Similarly, there is a need to identify vulnerable populations and understand their adaptive capacity [11].

Table 1 shows the three levels of urban risk assessment from primary level, secondary and tertiary levels as proposed by the World Bank, it reflects the tasks at each level and objectives to local governments [11].

In the three levels of urban risk assessment framework in Table 1, the primary level is actually based on risk identification. At this level the most important thing is to conduct a base mapping for preparing for disasters and conducting a socio economic profile of the city. Short term plan is to identify the safe routes during the time of disaster and what needs to be done in responding to disasters. Regarding long term planning at this level, the end product should be the development of a new city to avoid high risk areas.

On the secondary level, here an assessment is done in depth, at this point hazard exposure maps are being developed and populations at high risk areas are being identified. Regarding shortterm planning for disaster preparedness, it is worthy to note that at this point an improved understanding of coordination requirements for urban areas is properly planned. Regarding long term planning, the most important issue is to develop building control codes and planning of new development to avoid high risk areas and improve climate adaption measures. These measures are also extended into the tertiary level of assessment. However, at this level a key emphasis is on promoting climate adaption measures by engaging in non-structural and structural measures. It is worth noting that this framework is key in reducing the risk of natural hazards more especially within the urban areas where rapid development also plays a role in exacerbating the risk.

5 NEW ZEALAND CASE EXPERIENCES WITH LAND USE PLANNING AND NATURAL HAZARDS

Between 2007 and 2008 the northern region of New Zealand experienced severe flooding with several communities cut off by floodwaters. It is important to note that some towns were repeatedly flooded within a period of 4 months. This was an issue of great concern amongst different categories of people and stakeholders including the then Prime Minister Helen Clark who was concerned about allowing development in high-risk areas and the urgency to relocate the communities to safer areas. During the same period, an issue of allowing development on high risk areas became a concern to the public generally more especially in other regions which were not affected by these floods directly. This prompted the North City Council to decide not allowing new development in undesirable areas for urban growth purposes [12].

Notably, the planning options in New Zealand are shaped by the historical land use decisions which have shaped the risk management choices. Many of the towns are located in high risk areas especially flooding because they were established during the bygone era. Therefore, communities were used to protecting themselves through flood levee banks which were later ineffective because of rapid urban development This is mainly because such works only protect the communities from hazards that are within the design parameters [12].

Although, New Zealand have been facing these challenges regarding natural hazards, some amendments and establishment of new laws focused on land use planning for natural hazards became imminent. It is worth noting that the Resource Management Act of 1991 is one particular act which provides for the sustainable management of natural resources, which



Table 1: Urban risk assessment framework [11].

Urban risk assessment	Tasks	Link to climate change	Objectives/benefits to local government
Primary	Basic institutional mapping for disaster preparedness and response and climate change. Development of a physical base map if one doesn't exist or updating an existing map.	Limited: Generally identifying climate risks based on the information available regarding regional models.	<i>Short term:</i> Planning and preparing for disaster (identifying shelters and safe routes in times of disasters, disaster response protocols, accessibility to emergency funds). <i>Long term:</i> Planning new city development to avoid high risk areas.
Secondary	In depth institutional analysis for disaster response, climate change adaption and risk management. Hazard exposure maps development and scenario-based risk models.	Risk modelling includes downscaling of regional climate change models.	<i>Short term:</i> Improved understanding of policy and coordination requirements for city and necessary interventions for target areas. <i>Long term:</i> conducting annual disaster risk management budget, and planning new development to avoid high risk areas, policy/attention for target.
Tertiary	Financial capacity assessment for institutional delivery of resilience building programs. Constant streamlining and assessments of web-based application depicting populations and areas at risk.	Costs of climate change adaptation defined and prioritized. Adaptation strategies for key affected sectors.	<i>Short term:</i> Planning for disaster preparedness (Early Warning Systems, ability to simulate losses during a disaster event). <i>Long term:</i> engaging in non-structural and structural measures to reduce climate change and disaster risk impacts defined.



includes climate change and natural hazards management [13]. It requires the communities to avoid the risk of hazards, whereas the greatest challenge is that the responsibility lies with the community to make such decisions and choices. Hence, it does not actually say how they should avoid and mitigate such risks, it is therefore difficult for the communities to stop developing in hazard prone areas because they see development as an eminent social imperative.

However, the establishment of laws such as Building Act of 2004 have made it better to plan for natural hazards as it does not only provide for what should be done in the aftermath of an event, but also how it is to be done and executed. This law has provisions that hazard related information and warnings about high risk areas should be made available to the general community and this information is a requirement upon the building consent. More also, Authorities in New Zealand have made important strides in an attempt to plan for natural hazards as tools like evacuation and warnings plans have been placed in flood prone areas and this is seen as huge success especially for hazards that have a greater chance of return such as floods [14].

Having looked at this experience, it is worth noting that Lesotho as a country still has a long way to go in terms of land use planning for hazards and early warning systems. The key lesson issue identified with the New Zealand experience is the importance of including climate change and natural hazards in planning law.

6 THE SITUATION IN MASERU CITY, LESOTHO: THE CASE STUDY

Lesotho has some varied topography and as result spatial occurrences of the natural hazards is different. The whole country is vulnerable to natural hazards due to it being mountaneous, however the most prevalent to the study area is flash floods and rock fall. About 70% of the population in Lesotho lives in the fragile mountainous terrain [15]. It is therefore, important to note that the lack of land use planning is also a major challenge because people end up building in high risk areas where they are susceptible to rock falls and flash floods. However, what is common in Maseru is that people tend to locate to these high risk areas because of the expensive plots of flat land.

7 NATURAL HAZARDS STATISTICS

Table 2 presents a summary of events counts for natural hazards, the total deaths caused these hazards as well as the total number of people affected [16].

Table 2: Lesotho natural hazard statistics [16].

Natural hazard 1900–2020	Events count	Total deaths	Total population affected
Drought	8	0	4,148,015
Flood	4	28	2,334
Storm (convective storm)	2	48	85,000

Table 2 shows the natural hazards that Lesotho has endured since 1900s to 2020, these include drought, convective storm and floods. From Table 2 above from 1900 to 2020 there has been eight counts of drought, four event counts of floods as well as two event counts of storms. Also, it is shown that there have been no deaths caused by drought, but floods have caused a total of 28 deaths during the same period. Similarly, convective storms have caused 48 deaths, with total population of 85,000 affected. Also the floods have affected 2,334 people in total within the same period, while 4,148,015 people in Lesotho have been affected by the drought between 1900–2020. From this statistics we can deduce that drought is more

common in Lesotho as compared to floods and storm. However, flood causes more damage than drought as more people have died from it and similarly convective storm is more deadly than both floods and drought. While drought may not have a direct relationship to unplanned development, we can deduce that floods may have a direct relation to unplanned development because they are mostly riverine floods. Also, when comparing the total deaths between these hazards, the no deaths by droughts are a reflection of less physical vulnerability caused by this natural hazards but the social vulnerability is very high as it is shown by the total population of 4,148,015 affected. However, the statistics for floods and storms reflect high physical vulnerability due to the total number of 76 deaths. It is worth noting that physical vulnerability is related to topography hence floods and storms are more likely to occur in Lesotho as water flows from the highlands to the lowlands.

8 POLICY DOCUMENT CONTENT ANALYSIS

8.1 Provisions from the Disaster Management Act No. 2 of 1997

This act provides for an establishment of the Disaster Management Authority (DMA); to regulate its functions and to provide for emergencies from natural hazards including mitigation, prevention, preparedness as well as the response measures in the aftermath of a disaster to protect lives and properties. In Section 5(1) the Disaster Management Act provides that the Authority is tasked to prepare a National Disaster Management Plan, which must cover working areas of disaster preparedness, recovery and response and mitigation [17]. Further, in Subsection 2 the provision indicate that the prepared National Disaster Management plan should be integrated into other national development plans. Interestingly, Subsection 3 dictates that this national disaster management plan has to be reviewed on annual bases. However, it can also be reviewed whenever necessary sometimes after a disaster occurred [17]. On the same note, Section 6 articulates the disaster relief plans, it reads that the chief executive of the authority will prepare a national relief plan which then has to be approved by the board and the cabinet. Further in Subsection 2 it is indicated that each district shall have to prepare their own relief plans following the chief executives approval [17].

From this act we can deduce that its provisions are mostly reactionary, it emphasise mostly on what should happen in the aftermath of a disaster. The Act does not give provisions on what is to be done to assist the communities resilient from disasters, though the act provides that a national disaster management plan should be prepared these plans are not prepared.

8.2 Provisions from the Town and Country Planning Act No. 11 of 1980

This act provides for an orderly land development, to improve and preserve the amenities so that economic efficiency will be promoted. Section 5(1) of this acts provides that the commissioner of lands who is the planning authority has to prepare the development plan in respect with areas where it shall apply. Notably, in Subsection 2 it is articulated that the the development plan shall guide development of an areas where it is proposed and how it shall be done through each stage [18]. Interestingly, in Section 9, Subsection 1, the act provides that subject to the prescription of the minister land and building uses may receive permission to be developed. When looking at these provisions, one can note that they are development specific and they do not talk to the relationship between different land uses, as opposed to what a land use plan should do.

In as much as in Section 17 the Act outlines the enforcement of the planning control. The situation on the ground does not reflect the enforcement of the land planning control, people build in hazard prone and high risk areas and this process put their lives at risk. However, this act provides that anyone who has been found with non compliance case should be served with an enforcement notice within the period of 4 years from an alleged failure to comply [18]. Furthermore, if found guilty such a person should be liable to a penalty; generally this law is development driven and not land use oriented, hence problematic when it comes to disaster risk management. It provides for land planning control instead of land use control hence it opens a room for the use of discretion when making a decision. The risk of natural hazards is not anticipated in this act hence there is a need for land use regulation that shall incorporate issues of sustainability.

8.3 Provisions from National Strategic Development Plan II 2018/19–2022/23

The NSDP II indicates that Lesotho has over the years experienced harsh weather conditions characterised by heavy rain falls, droughts, floods as well as snowstorms in the highlands areas. Furthermore, the plan articulates that the country is experiencing extreme climate change consequences which forces the limited finances to be directed to relief efforts as opposed to other economic development measures [19]. The plan also emphasises that inadequate physical planning and lack of implementation of existing policies have exacerbated environmental degradation. And in return there is inappropriate land use where there is a noticeable sprawl of settlements towards areas that are prone to natural hazards.

Equally important, the NSDP II established the strategic interventions and objectives to address these outlined challenges. Notably, the plan aims to improve the country's resilience to climate change and to improve compliance and enforcement with environmental standards and regulations [19]. The interventions are that enforcement tools should be developed, and environmental impact assessment and other enforcement tools should be mandatory. Also, the plan outlines that environmental education programmes are to be promoted to raise awareness. As provided by the National Disaster Management Act 1997, the expectation is that the prepared National Disaster Management Plan should be integrated into other national development plans. It is important to note that these plans have not been integrated in the NSDP II. We can deduce from this research study that the country is not well prepared to reduce the risk of natural hazards within the population. When looking into this 5 year strategic plan the risk of these hazards is outlined but the document is silent on how the country is the risk is going to be managed. The implication is that when there is a lack of National Disaster Management Plan, it is difficult to prepare an urban risk assessment to be able map, prepare and to plan a new development to avoid hazard prone areas.

9 RESULTS AND FINDINGS OF THE RISK OF FLOODS BASED ON FIELD OBSERVATION

It is important to note that some natural hazards are exacerbated by unplanned development and land use. The destruction of the landscape can contribute to the increase and risk of natural hazards, hence in some cases people decide to build their houses on the flood plains, below dams and lakes. For those that have build their houses on the floodplains and along the natural flow of water it is always a challenge when there is a persistent heavy rainfall. This situation becomes problematic as it causes floods. During an observation of the study area (see Fig. 1), we identified the risk which these households are faced with. They are vulnerable and exposed to rock fall which can cause damage to infrastructure and loss of human life. On the same picture there is a house highlighted in red which is located just below a big rock, should



any thing happen this could lead to a loss of human life and infrastructure. Unplanned use of land is one important component that needs to be down to reduce the risk of natural hazards. This together with lack of urban risk assessment strategy in the planning phase of settlements is a major contribution to the populations vulnerability to natural hazards.



Figure 1: Settlements susceptible to rockfall in Maseru. (Source: Authors Field Survey, 2022.)



Figure 2: Flooded houses in Maseru in January 2022 [20].

As shown in Fig. 2, the residents of Borokhoaneng in Maseru experienced flash floods in January 2022. The streets were waterlogged while the houses were flooded. It is worth noting

that during the transect walk it was observed that these floods can mainly be attributed to poor drainage system and channels, also there is car wash around the area which blocks the water collected by the drainages to flow into the dam and when there is a heavy rainfall this water is diverted into peoples yards. Similarly, it was observed that the terrain on the settlements could be one attribute that contributes to this flooding. Given these findings, it is equally important for planners to take note of how critical it is to plan for natural hazards and the need for monitoring and evaluation of the built environment for any contraventions.

10 CONCLUSION

Planning for natural hazards is critical in reducing their effects to the lives of the people, this paper discussed what natural hazards are in the context of our study. The paper further discussed land use planning in regard to natural hazards, and the urban risk assessment and its relevance to this study was also discussed in this article. On the same note, the paper discussed and share the case experience of the situation in Lesotho regarding planning for natural hazards and whether the relevant authorities do plan for natural disasters by conducting an urban risk assessment. Ultimately, the study revealed that the relevant authorities in Maseru do not conduct urban risk assessment, hence settlements are located in high risk areas. During the transect walk it was observed that many settlements are either located at locations where they are at the risk of rockfall, whereas others are located along the flood plains. With the situation being exacerbated by poor drainage systems which is a result of unplanned development. In conclusion, this paper recommends that the Maseru Municipal and Council should engage in land use planning for natural hazards to reduce the risk of damage to infrastructure and loss of human life. Similarly, the Disaster Management Authority together with the Municipality should conduct an urban risk assessment to be able to warn people about areas which are more vulnerable to natural hazards. There is also need to improve on the gaps in both the policy and legislative responses to the vulnerable communities and individuals whenever the need arises.

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