Issues and Challenges of Urban Flood Hazard Management in North Colombo Region (*A case study of 2016 Flood Affected Kolonnawa Urban Council)*

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Abstract

Floods are one of the meteorological events that often record as sever catastrophic natural hazard in the world. Flooding ranks as the most damaging forms of natural disaster in Sri Lanka. Since the most of the populated urban spaces are being subjected to the flood hazard, urban flood hazard management has come to the fore in the field of disaster management. Many urban areas of the Western Province in Sri Lanka, especially North Colombo Region were severely affected due to the flood hazard in May 2016. Therefore, the main objective of the study is to identify the issues and challenges of urban flood hazard management process and introduce the appropriate framework for enhancing the existing flood hazard roadmap. The methodology of the research focuses to select one Urban Council in the region: Kolonnawa. In the methodology, among the 13 GN divisions in the Kollonnawa Urban Council (KUC), two GN divisions were selected by using judgement sampling method for the convenience of the study and 10% of the affected households due to 2016 flood in the selected two GN divisions were selected using snowball sampling technique for primary data collection. Collected likert scale type of data according to the conceptual framework were analysed by using one sample t-test and proved that there are more than 60% of negative impact of selected variables on issues and challenges of urban flood hazard management. The research findings shows that evacuation and emergency response mechanism in relation to 2016 flood hazard was only successful in short run. Several issues and challenges are still evident in terms of finding long-term solutions. Several constrains related to the existing regulations, institutional cooperation, availability of resources, involvement of the government and the attitude of the people are evident particularly in the phases of preparedness, rehabilitation and mitigation. Therefore this paper has recommended implementing long-sighted policies for overcoming such issues and challenges.

Keywords: Urban Flood Hazard, Disaster Management, Issues and Challenges, Sri Lanka

1. INTRODUCTION

A disaster is a sudden calamitous event producing great material damage, loss and distress.The definition of Asian Development Bank (2008) highlights two main types of disasters; Natural and Anthropogenic.

Due to the high modification of hydrological process in the urban areas, river basins have become more vulnerable to floods. Much of the urban space is impermeable such as paved roads, concrete yards etc. thus the infiltration is reduced and runoff volume is rapid. So only high rainfall or some time both of overflowing of rivers and rainfall can lead to floods in urban areas. As causes for urban flooding heavy rainfall, flash flooding, lack of lakes, silting, and population pressure, trespassing on water storm drains, urbanization, poor water and sewerage management has been identified and explained in the publication of National Institute of Disaster Management in India (NIDM) called 'urban flooding and its management'.

Theflood hazard management in urban areas is critical. Since several such as high concentration of commercial, industrial, recreational, government and residential activities and high density of population. Hence a proper management for urban floods must be needed. For this matter whatever the type of flood, basic flood management principles and concepts under the disaster management should be taken into consideration.

According to Carter (2008) disaster management is a cyclical process for any hazard. Here as this is mainly focused on flood management, this cyclical process should be looked in the lenses of flood hazard management. So following basic steps should be considered in flood hazard management with parallel to the disaster management cycle;

Mitigate the flood hazard preparedness to flood hazard, response to flood hazard and recovery from flood hazard.

Although these steps are implemented by lot of countries to manage the urban flood hazard, there are many issues and challenges can be seen around the world especially in urban flood hazard management. Many of the contemporary researches have focused the issues and challenges of urban flood hazard management.

Sri Lanka has been experiencing from this long time wide array of natural hazards such as tsunami, droughts, landslides, floods, storms etc. Among those hazards, flood is the most frequently occurring natural hazard in Sri Lanka. Riverine floods are the key type of flood hazard in Sri Lanka. This riverine floods and other causes related to the urbanization, Sri Lanka is now facing severe urban flood hazards consecutively.

In May 2016 Sri Lanka was hit by severe tropical storm called "Ronu"and as a result high intensity of rainfall occurred almost all the part of Sri Lanka. Specially more than 200mm rainfall occurred in Vavunia, Colombo, Gampaha, Kegalle districts. Many of the river basins such as Maha oya, Daduru oya, Kelani River, Kalu River, Gin River flooded. The upper and lower catchment of Kelani River got high intensity of rainfall at same time many of the area of the lower catchment of Kelani Riverwere affected. Especially in Colombo and Gampaha districts urban areas such as Kaduwela, Kolonnawa, Meethotamulla, and Hanwella were flooded. As a result of this flood situation, 237,240 people displaced from their places of origin and have moved to 369 temporary safe locations. It is reported that at least 503 houses reported have been destroyed with more than 3,793 partially damaged.

2. STATEMENT OF THE RESEARCH PROBLEM

The seasonal flood hazards in Sri Lanka has become a most affected calamitous event in terms of impact population, sequence and time which caused to emerge severe economic and social problems inside in Sri Lanka. A huge flash flood occurred in May 2016 in western and Sothern part of Sri Lanka especially in the region of lower catchment of Kelani River. One of the most affected region of this flood hazard was North part of the capital city of the country; Colombo. Among those affected urban areas in north Colombo region, Kolonnawa Urban Council (KUC) is significant due to many reasons. Among 13 Grama Niladhari Divisions (GND's) of Kolonnawa urban council (KUC), 43591 people belongs to 9111 families has been affected due to this flood according to the statistics of Kolonnawa Divisional Secretariat Division (DSD). Most part of the Kolonnawa urban council (KUC) are located in the flood plain of Kelani River. As kolonnawa urban area located in flood plain of the Kelani River, many times floods has been occurred. As an urban council many of the development activities have taken place in Kolonnawa area. Illegal settlements have been constructed very closer to the flood plain areas which is protected from a bund created by Irrigation department. Many parts of this Floodplain has

been disturbed and filled residents for different purposes. Hence, the urban flood hazards are significant in this urban clusters and flood hazard management activities are not seemed to be properly maintain in the region. Due to one of the flood affected garbage dumping zone called Meethotamulla in Kolonnawa urban council (KUC), health issues can also be identified as emerging issues. Several issues and challenges in the process of urban flood hazard management in KUC is evident. Following research questions can be identified in this area related to the urban flood hazard management.

- What are the strengths and weaknesses of urban flood hazard management process in Kolonnawa Urban Council (KUC).
- What are the urban flood hazard management issues in this area?
- What are the challenges faced by the relevant parties in the process of urban flood hazard management?
- What would be the action to be taken to minimize the issues?

Based on this research questions, the research was conducted with 3 objectives;

a) To review the strengths and weaknesses of urban flood hazard management process in KUC.
b) To identify the issues and challenges of urban flood hazard management in KUC.
c) To identify solutions to overcome the issues and challenges of the urban flood hazard management process in KUC.

3. LITERATURE REVIEW

In 1978 Dennis J Parker has done a research on the topic of **"Floods in Cities: Increasing Exposure and Rising Impact Potential"**. In his research, Parker has attempted to explain the links between urban growth and flood impacts. Further it discussed the problems and possibilities of reducing urban flood hazards. Bianca Stalenberg and Han Vrijling (1978) has done a research on the theme of **"The Battle of Tokyo and Dhaka against Floods".** In this research, researchers attempted to identify the present condition of flood management in Dhaka and Tokyo cities. Taking as one of the poorest and one of the richest cities in the world, they have evaluate the similarities and varieties of the urban flood management structures in those two cities. And also they have introduced some suggestions to enhance the urban flood management in deltaic countries as well. In 1993 Francis O, Odemerho one of the professors in the Department of Geography of University of southern Illinois has done a research and published in the GeoJournal, volume 29 under the topic of on "**Flood control Failures in a Third world City: Benin City, Nigeria – some environmental factors and policy issues".** By studying this publication it can be identified that how geographers have attempted to study the urban flood hazard management issues. As problems to the flood management in Benin City, Francis has identified land use and physical development control problems, gaps in basic hydrologic data, design and implementation problems, cultural factors and policy issues as well. As recent studies, in 2002 Hans Reinhard Verworn has done a research on the title of **"Advances in Urban-drainage management and flood protection".** He has explained how urban drainage become as an integrated approach in flood protection. And also in 2010 Hanong Vinh Hung has done a study on **"Flood risk management for the riverside urban areas of Hanoi; The need for synergy in urban development and risk management policies".** In this research, it has been investigated the reasons for an unusual over development of Flood prone areas outside the river dyke in Hanoi City while analyzing the urban development and disaster management policies, and suggested policy measures for regulating the rapid urbanization incorporating catastrophic flood risk planning. In most recently 2015, Chen Kun Chung has done a research on the topic of **"Applying the 3 layer approaches to urban flood management".** This is one of thebest studies on urban flood management because by giving some theoretical approaches to the study it has been explained the urban flood hazard management procedures. And also by analyzing a case study, it has been identified urban issues due to the floods and suggested better solutions. Likewise many of the researchers have attempted to study

the urban flood hazard management and issues of that process.

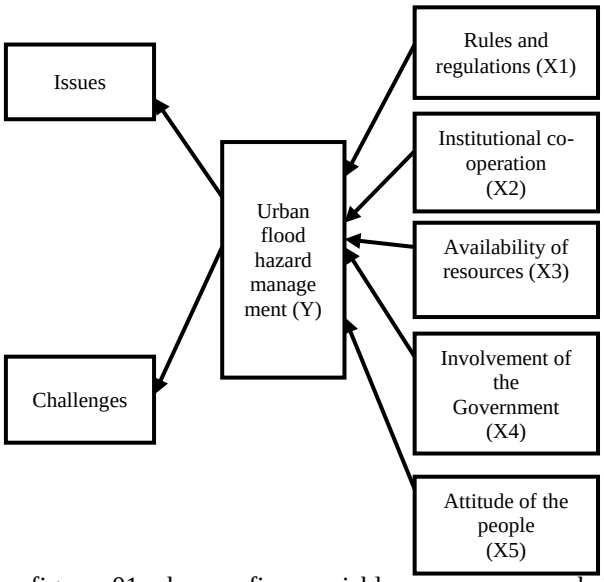
According to the project on "SLUMDMP, (1999), Disaster mitigation Action plan for Rathnapura Demonstration Project, Sri Lanka urban Multi-Hazard Disaster Mitigation Project April" it has been explained the urban flood hazard controlling strategies in Rathnapura urban area. But in the context of urban flood hazard management and related issues and challenges in Sri Lanka, lack of the available literature is significant. By understanding that lacuna of the literature this study attempts to fill the gap of knowledge in this field.

4. METHODOLOGY

4.1 Conceptual framework

The Issues and challenges of urban flood hazard management is the dependent variable (Y) of the study while several factors assumed to be affected in positive and negative mean on urban flood hazard management were identified as independent variables (Xi-Xn) as shown in the Figure 01;

Figure 01: Dependent and independent variables



As figure 01 shows, five variables were assumed in identifying the issues and challenges of urban flood hazard management. In understanding and explaining the ways of measuring above mentioned independent variables, firstly as one of the variables, rules and regulations which was leading to issues and challenges of urban flood hazard management was identified. When it comes to understand urban flood hazard management in Sri Lanka, there is no exact policy for urban flood hazard management. Due to outdated and updated rules and regulations relating to hazard management might be leading to some issues and challenges of the process of urban flood hazard management. By reviewing the applicability of related acts, rules and regulations to the urban flood hazard management process in practical scenario, it was identified the impact of rules and regulation on issues and challenges of urban flood hazard management.

As another possible variable, institutional co-operation could also be identified in this process. These variables tested with collected data from formal discussion with the relevant institutions and also with the opinion of the affected people.

Availability of resource and involvement of the government were also possible variables here. By discussing with relevant authorities and the people it was recognized.

Attitude of the people also one of the possible leading variables in the urban flood hazard management process. Attitude of the people towards local disaster management

4.2 Hypotheses

H_0 – "There is no impact of selected variables such as rules and regulations, institutional co-operation, availability of resources, involvement of the government and attitude of the people on issues and challenges of urban flood hazard management''

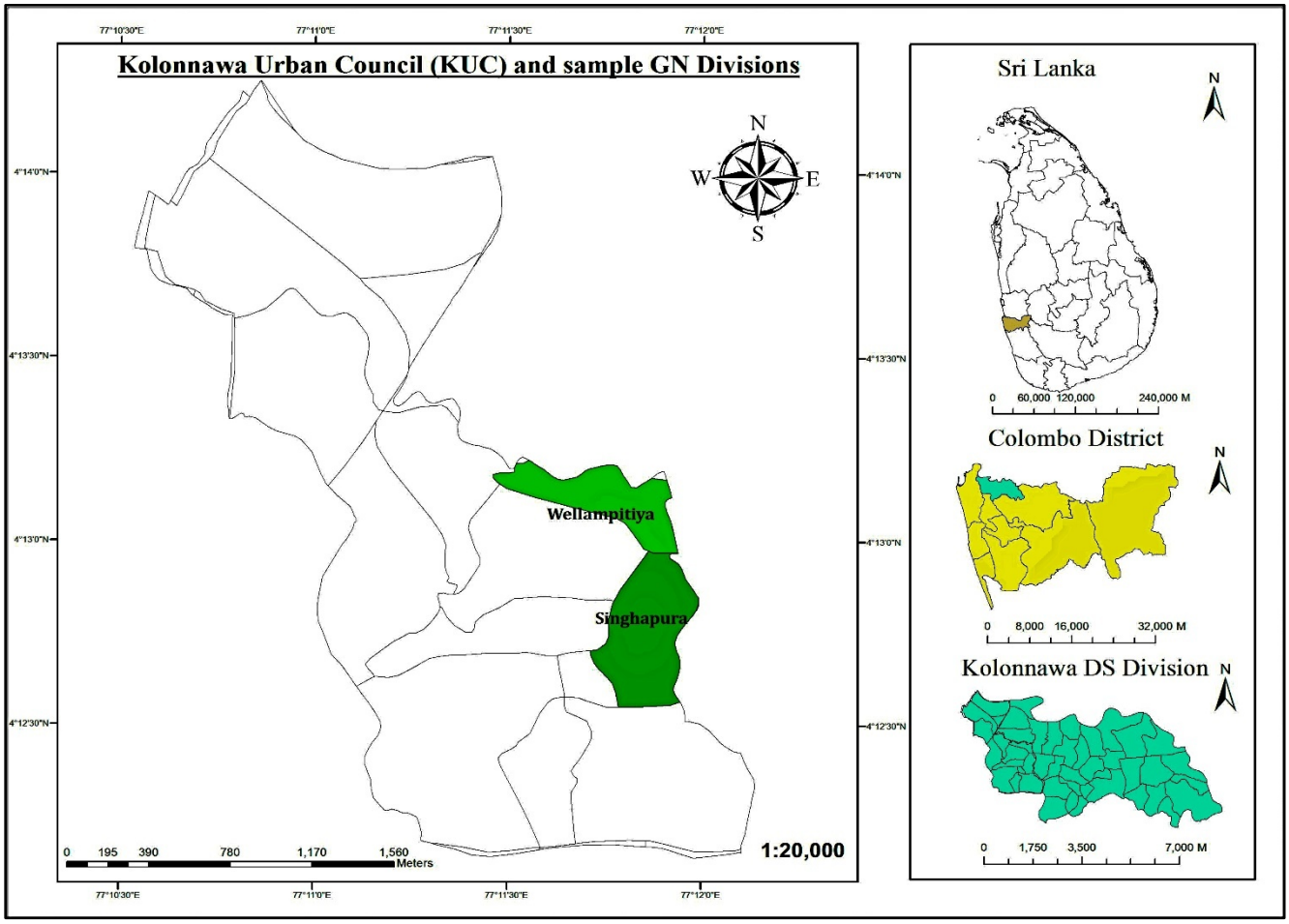
H1 – "There is an impact of selected variables such as rules and regulations, institutional co-operation, availability of resources, involvement of the government and attitude of the people on issues and challenges of urban flood hazard management''

4.3 Sampling

The total population of this study represent the most flood affected urban center in Colombo district; Kolonnawa.

Figure 02 shows the location of research site including selected sample GN divisions.

Figure 02: Research site and sample GN divisions



Source – Created by using 1:50000 digital data (survey Department of Sri Lanka)

For this research two mostly flooded GN divisions were selected by using judgment sampling. Approximately 5% of the affected population due to 2016 flood of selected GN divisions were selected by using snowball sampling method as shown in the figure 03;

Figure 03: Purposely selected GN divisions, number of affected families due to 2016 flood and sample sizes.

GN divisions	Number of affected families	Expected percentage	Sample size (Number of families)
512 B, Singhapura	796	5%	40
511 Wellampitiya	204	5%	10
Total	**1000**	**5%**	**50**

4.4 Data collection and analysis

Data were gathered by using primary and secondary data collecting methods as follows;

Primary sources – Questionnaire, Observations, Formal and informal discussions.

Secondary sources –books, journals, institutional reports, web sources.

As this study mainly based on qualitative methodology, when analyzing data, basically descriptive statistical methods such as measure of central tendency and measure of dispersion were used. To quantify the qualitative data, likert scale is used to build indexes as follows;

- Highly disagree 1
- Disagree 2
- Neutral 3
- Agree 4
- Highly agree 5

Through that quantified data percentages of the responses were calculated then descriptively analyzed the impact of variables. Then to test the impact of the independent variables on the dependent variable, one sample T-test was used.

Qualitative recorded through informal and formal discussions were analyzed descriptively in confirming the quantitative analysis.

5. RESULTS AND DISCUSSION

5.1 Strengths and weaknesses of Urban flood hazard management in Kolonnawa Urban council (KUC).

The strengths of existing flood hazard mechanism in KUC are seemed to be somewhat different. Some of key points are;

- Well established operational cabin while the hazard.
- Integration of relevant institutions to operational cabin.
- Proper evacuation mechanism.
- Co-operation of people while providing basic needs for the affected people with the unity.
- Property damage estimation mechanism is in good level.

Weaknessesin the process of urban flood hazard management in KUC can be summarized as follows;

- Flood preparedness measures are not adequately maintained.
- Flood early warning system is not functioned properly.
- Officers are not enough for pre-disaster management activities.
- Slow functioning of rehabilitation measures.
- Mitigation measures are not enough adequately.

5.2 Issues and Challenges of Urban flood hazard management in Kolonnawa Urban council (KUC).

In understanding the issues and challenges of urban flood hazard management in KUC area, significance as well as the impact of the following five variables were tested.

- Rules and regulations
- Institutional cooperation
- Availability of resources
- Involvement of the government
- Attitude of the people

As mentioned in the methodology part of the study, to identify whether there is an impact of selected variables statistically on the issues and challenges of urban flood hazard management in KUC, one sample T-test is used. Before perform the t-test, indexes are built in using likert type positive questions used in the questionnaire related to five variables.

Before building the combined indexes, it was tested the reliability and the validity of the collected likert type data. Accordingly the summery of the reliability and the validity of collected likert type data is shown in following figure 04;

Figure 04: Measurement summery of the reliability and the validity test of collected data.

Variable	Cronbach's Alpha	KMO and Bartlett's Test	P value
Positive likert statements	.949	.709	0.00

Source: Field survey data (2017)

According to the above table, in testing the reliability of the data, Cronbach's Alpha value should be higher than 0.7, in testing the validity of the data KMO and Bartlett's test value should be higher than 0.5 and p value should be lower than 0.05. It is clear that all these conditions are fulfilled in the collected data set. So the reliability and the validity of the data set is ensured.

In analyzing data to identify the issues and challenges of urban flood hazard management, the mean, median and the skewness of the built indexes is explained. (figure 05)

Description	Sample (N)	Mean	Median	Skewness	Min	Max
Index of the negative impact of variables	50	12.331	10.374	4.115	0.00	100

Figure 05: Measurement summery of indexes.

Source: Field survey data (2017)

As the result shows, the mean impact of the variables is 12.331 and the median impact is 10.374. Skewness is reported as 4.115 confirming positively skewed distribution of data.

As one of the variable testing method in statistics, one sample t-test is significantly applied in many situations. It is compulsory to fulfill the population distribution assumptions in order to test the variables in statistics. Therefore few assumptions to be fulfilled in this test. Accordingly, the data should be in ordinal scale and also in normal distribution. Significance level of the means is tested in this test. Accordingly in order to test the negative impact of selected variables on issues and challenges of urban flood hazard management in KUC, t-test is performed with two hypothesis as shown below.

H_0: The negative impact of selected variables on issues and challenges of urban food hazard management is equal or lower than 60%.

H_1: The negative impact of selected variables on issues and challenges of urban flood hazard management is higher than 60%.

Figure 06: T-test for negative impact

Variable	Test Value = 60, significant level= 0.05 df =49,						
	N	Mean	St.dev	T value	P value	95% Confidence Interval of the Difference	
						Lower	Upper
Negative impact	50	12.331	19.01	-17.725	.000	-53.0732	-42.2644

Source: Field survey data (2017)

The negative effect of selected variables on issues and challenges on urban flood hazard management is 12.331 and standard deviation is 19.01. Accordingly, the calculated t value is -17.725. Compare to the 0.05 significant level, calculated p value is lower than the significant level. So statistically null hypothesis (H_0) is rejected and alternative hypothesis (H_1) is accepted. It means that there are more than 60% negative effect of selected variables on issues and challenges of urban flood hazard management in KUC.

Hence, the impact of selected variables on issues and challenges of urban flood hazard management can be accepted.

Not only quantitatively but alsoqualitatively the impact of selected variables on issues and challenges of urban flood hazard management was proved. By calculating the percentages of the negative responds for the positive likert type statements given by the respondents related with five variables, negative respond percentage for each statement of the every variables were identified. Finally as a summery among all responds to the positive statements related with selected variables, more than 50% of negative responds were able to be identified considering the each sets of statements relating to each variables. So that can also be used as an indicator to identify the negative effect of selected variables on issues and challenges of urban flood hazard management in KUC.

Under the variable of rules and regulations, the inadequacy and the less flexibility of the existing rules and regulations which mainly impact on forced evacuation process while the hazard, regulation related to mitigation mechanism such as permanent removal of illegal settlements in flood prone areas and also clash of the rules and regulation with the authority of different institutions in the disaster management process were mainly identified.

Even though there were good institutional contribution and co-operation in different institutions while the hazard, the rest of the phases of the hazard management process, inadequate contribution and co-operation was identified.

Although the three forces of a Sri Lanka involved in the hazard management phases in KUC, the Lack of material and human resources mainly in the evacuation phase and also in the rehabilitation phase were identified in terms of evacuation people by boats and helicopters, providing temporary shelters and basic needs and also providing long term solutions for resettlement.

Involvement of the government through government bodies were evident in all the phases but the inadequacy of the involvement and also creeping actions of providing long term solutions such as compensations, resettlement were identified.

Under the variable of attitude of the people, the less awareness of the people and also less preference of the people in preparing to the hazard in preparedness phase, less awareness of the people about existing rules and regulation in constructing illegal settlement in lowland areas of the river banks and also the low level of attitude of less educated people about the standard procedures in providing temporary and long term solutions in each stages of flood hazard management were identified.

6. CONCLUSION AND RECOMMENDATION

Even though there were some weaknesses of urban flood hazard management process in KUC, there were some strengths such as Well-established operational cabin while the hazard, integration of relevant institutions, proper evacuation mechanism, and co-operation of people while providing basic needs for the affected people with the unity and satisfaction level of property damage estimation mechanism etc.

The impact of the each variables were proved by calculating the negative responses percentages as well as the negative impact of all variables proved by using one sample t- test. Rather than the issues and challenges related with the selected independent variables, following issues and challenges were also identified in the process of urban flood hazard management in KUCtoo.

- Officers are not enough in different stages in flood hazard management process.
- Problems in hazard subsidies providing regulations.
- Lack of adequate temporary relocation places for evacuated people.
- Hardness of providing facilities in temporary locating places according to the racial differentiation.
- No fulfilment of the vacancies of the officers.
- Unethical activities of certain gang of people.
- High political interference and bureaucracy.

It can be concluded that there are both hidden and visible issues and challenges in urban flood hazard management process which should be highly considered in preparing an effective Disaster management mechanisms.

Following suggestions can be proposed according to the selected variables;

- **Rules and regulations**
  - Flexibility and the power of the existing rules and regulations should be enhanced and the outdated and creeping regulations should be updated.

(Mitigation rules related to evacuation of the people from illegal and vulnerable areas should be formalized)

- **Institutional cooperation**
  - Institutional cooperation should be enhanced in each stages of hazard management by decreasing the gap of cooperating while hazardous situations.
- **Availability of resources**
  - Both physical and human resources should equally be focused to the

requirements. (vacancies of the officers should be filled, financial allocation should be increased and local authorities should be strengthen)

- **Involvement of the government**
  - Even though the local authorities responsible for many regional activities, those activities related to the hazard management should be under the supervision of the central government. (involvement of the government in each stages of hazard management should be ensured)
- **Attitude of the people**
  - To enhance the way of people thinking about the hazardous situation and related activities, public relation bureau in GN division wise should be established.

Apart from the above recommendations in order to overcome the issues and challenges, following recommendations can also be highlighted.

- Preparedness measures and an early warning system should be established.
- Pre-defined temporary location places for evacuated people should be identified.
- Compensation payment mechanism should be accelerated.
- Mitigation measures should be well focused and sustainable.
- Contribution of urban council should directly be focused on each phases of flood hazard management.
- Expertise knowledge should be used to mitigate the flood hazard.

It is finally mentioned that, unless there are well established disaster management plan and policy this may be an elusive target.

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