DRAFT

Government of the People's Republic of Bangladesh

Earthquake Contingency Plan for Ward 19

Rangpur City Corporation

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Department of Disaster Management

Ministry of Disaster Management and Relief

Earthquake Contingency Plan for Ward 19

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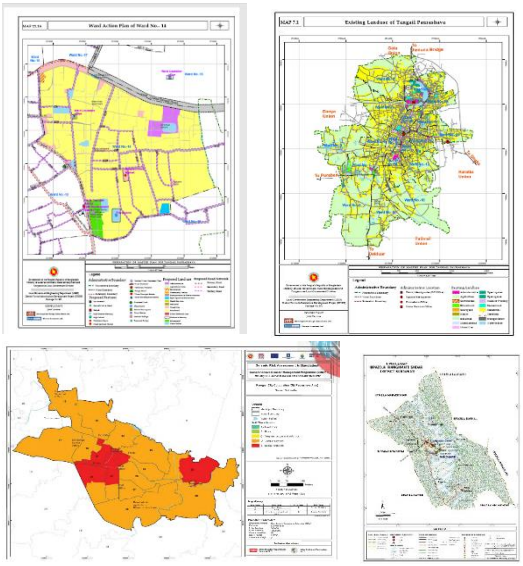

National Resilience Programme

BUET JIDPUS

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EXECUTIVE SUMMARY

Bangladesh is geographically vulnerable to earthquake due to the existence of several fault lines and tectonic plate boundaries. Historical evidences of earthquake including their severity near and within the country compound the future threat. Moreover, rapid urbanization, population growth, migration and development of economic activities are also inducing impetuous increase of vulnerability (CDMP, 2014). According to the seismic zoning map of the Bangladesh National Building Code (BNBC) 1993, Bangladesh is comprised of three seismic zones where Rangpur is located in Zone 2 and Zone 3. In the updated draft version of BNBC 2018, Bangladesh is comprised of four seismic zones, where Rangpur falls in Zone 3 with Seismic Co-efficient value of 0.28g. There are many evidences big damages in the city during the Great Indian Earthquake (magnitude of 8.4) in 1897. The earthquake risk of the city is growing due to haphazard urbanization and sub-standard construction of buildings, residential houses and other infrastructures without any consideration of underlying earthquake risk. The geotechnical and geophysical investigation under CDMP- II shows that almost 90% of the soil in Rangpur City Corporation area is dense or stiff soil and rest 10% is loose or soft soil which has high to very high liquefaction susceptibility. The foundations and supports of structures built on this highly liquefiable sediment can fail, causing damage or destruction during major earthquakes in city. All these evidences represent vulnerability of Rangpur to the earthquake.

This research work has been undertaken to develop community-based earthquake risk reduction and management plan in Ward No. 19 of Rangpur City Corporation. For this purpose, the research team has prepared a contingency plan for the study area. The tasks included assessment of seismic risk, assessment of the building and socio-economic vulnerability, and finally preparation of earthquake contingency plan for the area. Specific objectives of the project are:

- to assess the seismic exposure of Ward-19 of Rangpur City Corporation;
- to assess the structural and socio-economic vulnerabilities of the area; and
- to formulate a contingency plan based on community-based risk reduction approach.

The project is initiated through an inauguration workshop at Rangpur City Corporation on 05th November, 2019. This workshop helped the researcher to understand the issues and to determine the scope of the work.

The study area is located at the central east side of the City Corporation with an area of 2.6 square kilometer. For the convenience of data collection and planning, the study area was divided into twenty four clusters. The population of the ward is 11,467 with the density of 3872.42 per square kilometer. Majority of the population (42%) belongs to 21-60 years age group. The literacy rate of the study area is 65%. The major land use of Ward No 19 is residential. There are ample amount of open and unused space in the ward accompanied with a lot of water bodies. Rangpur Medical Hospital is located within the ward which serves the entire region. There is a stadium and some share of land use is designated for community facilities.

For this research, both primary and secondary data were collected. Engineering surveys and social survey were conducted to understand the soil characteristics, physical vulnerability of structures and socio-economic context of the community. In addition, secondary data on land use were collected from the Rangpur City Corporation office. The collected GIS database updated to fill the gaps and absence of required information. The updating process was conducted in two stages: updating of GIS spatial data through satellite image processing and field verification and updating of both spatial and non-spatial data. To conduct the field verification a checklist was prepared in "Kobo toolbox" interface to collect the non-spatial information. Training program was conducted for the surveyors to introduce "Kobo toolbox" to them and how to collect data using Kobo toolbox. Data on land use, building floor use, building type and storey, road layout with width were collected in this stage and further it was used to update the final GIS database.

In order to assess the seismic exposure of the study area two bore holes up to a depth of 30 meters were conducted in ward no 19 of the Rangpur City Corporation. Disturbed and undisturbed samples were also collected from different depths. Microtremor tests have been conducted using five velocity sensors each having three channels. To assess the buildings' vulnerability of the study area, two methodologies were used: RVS (Rapid Visual Screening) as suggested by FEMA (Federal Emergency Management Agency, USA, 2017 edition) for preliminary assessment and DEA (Details Engineering Assessment). For preliminary assessment, 284 buildings were assessed by Rapid Visual Screening (RVS) method

considering the both public and private buildings. At the time of writing the report DEA has not been conducted. Based on the preliminary assessment of RVS, three buildings will be selected for Detailed Engineering Assessment (DEA) for Rangpur City Corporation. A socio-economic questionnaire survey was conducted with a face to face interview of 246 household using stratified random sampling. Owners or tenants of the buildings surveyed for building vulnerability assessment were also surveyed for socio-economic data.

The collected data from the borehole and micrometer test were analyzed to know the seismic exposure of the study area and to know dynamic characteristics of soil in the study area. For determining the vulnerability of buildings based on collected data, RVS score was calculated for each building considering the probability of building collapse and average expected ground shaking levels for the seismicity region. The buildings which score less than 1.2 were considered as vulnerable. From the Standard Penetration Test it was observed that in one location very thin upper layers contained some clayey silt and silty clay and in other location it contained silty fine sand. As the depth increased the thick layers comprised of medium to dense fine sand and silty sand. At 30 meters the N values were 50 for both the boreholes. According to the soil classification (FEMA 2017) the soil class is D. From the microtremor analysis the natural frequency of the soil is found to be around 1.2 Hz and the shear wave velocity is around 144m/s. These data will be used further to determine index and engineering properties of soil along with determination of liquefaction potential.

From the preliminary vulnerability assessment, it was found that almost 84.5% of the 284 buildings are vulnerable. All the buildings of eight zones among twenty-four show a score below 1.2 thus are vulnerable. 235 buildings were concrete frame with masonry infill which is the dominant type found in ward no. 19. 117 buildings have which comprises 41% of the sample size have a RVS score within the range of 0.4-0.6. 82% of the total buildings show severe vertical irregularity whereas only 5% show moderate vertical irregularity. Only 3% buildings show plan irregularity. Based on these results, Detailed Engineering Assessment will be performed of a vulnerable building of ward no. 19.

Based on data collected from a questionnaire survey of 246 households' statistical analysis was performed to understand the socio-economic context of the area. Gender and age composition, occupation, education level and physical disability status of total 949 members of 246 households were analyzed to prepare the socio-economic profile of the study area. Socio-economic survey reveals that around 20% of the populations are children and elderly

who would require assistance after an earthquake. There are two families which have members with a physical disability. Around 58% of the inhabitants are student and housewife. It is interesting to note that only four percent of the inhabitants of the surveyed households are illiterate where the national illiteracy rate in Bangladesh is almost 40% (UNESCO, 2008). Most of the households have income below 40,000 BDT per month. Among the surveyed respondents, 61% (155 out of 254) of the respondents do not have any idea about the earthquake vulnerability of the area. They don't know the actual reasons and are not aware of the precautions that should be taken for earthquake resiliency. In addition, only eight percent of the respondents showed their interest to get involved with the activities disaster management committee of their ward due to their lack of awareness.

For contingency planning, spatial analyses were conducted based on widely practiced planning standards. Community demand, availability of the facilities institutional set up for earthquake management are also incorporated in the contingency plan. A complete earthquake contingency plan consist of temporary shelter planning, emergency health facility planning, Ward Co-ordination Center planning, evacuation route planning, and household level preparedness planning. Due to time constraints and unviability of necessary information, the aspects of temporary shelters, emergency health facilities and Ward Co-ordination Center planning have been discussed in this report.

For temporary shelter demand, two scenarios were considered. In first scenario, it was assumed that the residents of buildings which will be damaged or collapsed would need shelter. It was estimated that around 8,819 people would need shelter in this scenario. On the other hand, in the second scenario, it was assumed that all the residents of the contingency plan area would require temporary shelter. Considering the availability, preference and acceptability of local people and structural safety, 28 places were identified for probable temporary shelter at different clusters (10 educational institutions, 14 religious institutions, 7 community facilities and 72 acres open spaces). Comparing the supply of temporary shelters with population demand, it can be stated that it is quite difficult to support the population with existing facilities. Again 11 healthcare facilities including hospital, clinics, diagnostic centers and pharmacy were found in this area. These healthcare facilities were proposed to serve the injured people after an earthquake which has been described elaborately in the Chapter 7. Cluster-wise gap or requirement of health-care facilities will be estimated in the final phase of contingency plan.

To ensure proper management of these temporary shelters and emergency health facilities, Temporary Shelters Management Committee (TSMC) and Emergency Health Facility Management Committee (EHFMC) were proposed with their composition, role, and responsibility in different phases of disaster management. These proposed committees need to coordinate their activities in consultation with the Ward Disaster Management Committee (WDMC). Further work on contingency planning will be incorporated in final phase and the recommendation will be given based on the final scenario.

It should be bear in mind that contingency plan is neither a standalone document nor a static document. It should be an ongoing process integrated and coordinated with activities of other documents. It is well understood that earthquake would cause damage at the regional scale. So, a region-wide community level contingency plan needs to be prepared. For successful implementation of the contingency plan, this kind of plan needed to be prepared for the other wards of the City Corporation.

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CHAPTER 1 : INTRODUCTION

An earthquake can occur without any prior warning resulting in widespread damage; high numbers of fatalities and injuries; destroying buildings and other physical infrastructure and facilities. It may have adverse effect on economic, social and political sector which can drive the entire nation to disastrous consequences (CDMP, 2014). To mitigate the earthquake risk proper planning and management are required through investigating the interrelated issues based on earthquake vulnerability assessment.

1.1. Background of the Project

Bangladesh is geographically vulnerable to earthquake due to the existence of several fault lines and tectonic plate boundaries. Historical evidences of earthquake including their severity near and within the country compound the future threat. Moreover rapid urbanization, population growth, migration and development of economic activities are also inducing impetuous increase of vulnerability (CDMP, 2014). A severe earthquake in this country will cause a large number of human casualties, huge damages of infrastructures, social and economic loss etc. and a big earthquake is anticipated in near future (Alam et.al, 2008). To ensure a useful response to a severe earthquake in an area; an organized earthquake risk management planning is essential at local level, including contingency plan based on seismic exposure assessment and building and socio-economic vulnerability assessment. Seismic exposure assessment brings out the seismic risk of an area and building vulnerability assessment provides an understanding about the vulnerability of buildings in an area based on their general characteristics as a whole (NORSAR, 2018). Socio-economic vulnerability assessment reveals the community's characteristics leading to their earthquake vulnerability and the potential impact of earthquake on their social and economic life (Lal et.al, 2011). Contingency planning is a course of actions which aim to prepare an entity to respond well to an emergency and its potential humanitarian impact (CDMP, 2014). Development of a contingency plan may involve decision making in advance about the management of human, physical, technical and financial resources, coordination and communications procedures, and responsiveness of a range of technical and logistical support.

Disaster risk reduction remains a key priority of the Government of Bangladesh, which is reflected in its Five Year Plans, Bangladesh Delta Plan and various national policies. Bangladesh has also adopted global frameworks like SDGs, Sendai Framework, New Urban

Agenda etc. To maintain a holistic approach and to mainstream disaster risk reduction into development planning based on past achievements and lesson, Bangladesh government in association with United Nations Development Programme (UNDP), UN Women and United Nations Office for Project Services (UNOPS) have jointly initiated the National Resilience Programme (NRP) with the financial support of the Department for International Development (DFID) and the Swedish International Development Cooperation Agency (SIDA). It aims at to sustain the resilience of human and economic development in Bangladesh through an inclusive and gender responsive disaster management. The programme intends to provide strategic support to improve national capacity to keep pace with the changing nature of disasters.

The programme consists of four sub-projects. Each sub-project is implemented by one of the agencies from the Government. These agencies are - Department of Disaster Management (DDM) of the Ministry of Disaster Management and Relief, Department of Women Affairs of the Ministry of Women and Children Affairs, Programming Division of the Ministry of Planning, and Local Government Engineering Department of the Ministry of Local Government, Rural Development and Co-operatives.

The subprojects of NRP implemented by DDM aims to work towards improving community resilience by creating replicable, cost-effective models around DRR inclusive social safety nets, pro-active response solutions, earthquake preparedness, search and rescue, community-based flood preparedness that have shown promise in earlier initiatives. The objectives of the Department of Disaster Management part are:

- To advocate for implementation of the Sendai framework and build necessary capacity to monitor the implementation.
- To strengthen disability-inclusive, gender-responsive national capacities to address recurrent and mega disasters (including training of key personnel).
- To strengthen disability-inclusive, gender-responsive community preparedness, response and recovery capacities for recurrent and mega disasters.

As earthquake is a sudden perilous natural disaster and it can cause large scale damage, an inclusive earthquake risk management approach is required to minimize the loss. To ascertain an effective response to severe earthquake event; an organized earthquake risk management planning is necessary at local level, including contingency plan based on soil characteristics,

structural analysis of building and socio-economical context. Realizing this National Resilience Programme (NRP) under the Ministry of Disaster Management and Relief of the People's Republic of Bangladesh has taken initiative to develop a minimum preparedness package for earthquake preparedness for the cities. Activities are implemented in Rangpur City Corporation, Tangail Pourashava, Rangamati Pourashava and Sunamganj Pourashava. This report covers the initial assessment for preparing contingency plan of a ward (Ward no 19) of Rangpur City Corporation

1.1.1. Experience from Mymensingh Municipality

BUET and UNDP conducted similar project in Ward 14 of Mymensingh Municipality in the year 2016-2017. This research work was undertaken to develop community-based earthquake risk reduction and management plan in Ward No. 14 of Mymensingh Pourashava. For the purpose, the research team prepared a contingency plan for the study area in consultation with the local community. The tasks included assessment of seismic risk, assessment of the building and socio-economic vulnerability, and finally preparation of earthquake contingency plan for the area. The project was launched through a workshop at Mymensingh Pourashava on 6th April 2017. This consultation workshop helped the researcher to understand the issues and to determine the scope of the work.

The earthquake contingency plan prepared to reduce seismic vulnerability of the study area includes temporary shelter planning, emergency health facility planning, Ward Co-ordination Center planning, evacuation route planning, and household level preparedness planning. For temporary shelter demand, two scenarios were considered. In Scenario-1, it was assumed that 50% residents of buildings which will collapse or damaged during an earthquake would need shelter. It was estimated that around 2,273 people would need shelter in this scenario. On the other hand, in Scenario-2, it was assumed that all the residents of the contingency plan area would require temporary shelter. Considering the preference and acceptability of local people, structural safety and accessibility of the proposed shelter, 28 places were identified for temporary shelter in dry season including open spaces, educational institutions and religious places and 24 places in wet season including open spaces, educational institutions and religious places. These places could accommodate 11,277 people in dry season and 5,209 people in wet season.

Considering preference and acceptability of local people, structural safety, and accessibility, 26 health facilities including hospitals, clinics, and diagnostic centers in the study area were

proposed to serve the injured people after an earthquake. Comparing the availability and probable requirement it can be concluded that the facilities within the study area are enough to treat the estimated injured persons after an earthquake. In addition, roads that could be blocked were identified. It was found that the roads in the proposed evacuation route have road width less than or equal 6ft. These roads will be only accessible by walking, cycle or motorcycle, one-way rickshaw or van. Thus road widening initiative by the Pourashava is necessary. To access narrow roads, customized non-motorized vans can be used during a rescue operation in disaster.

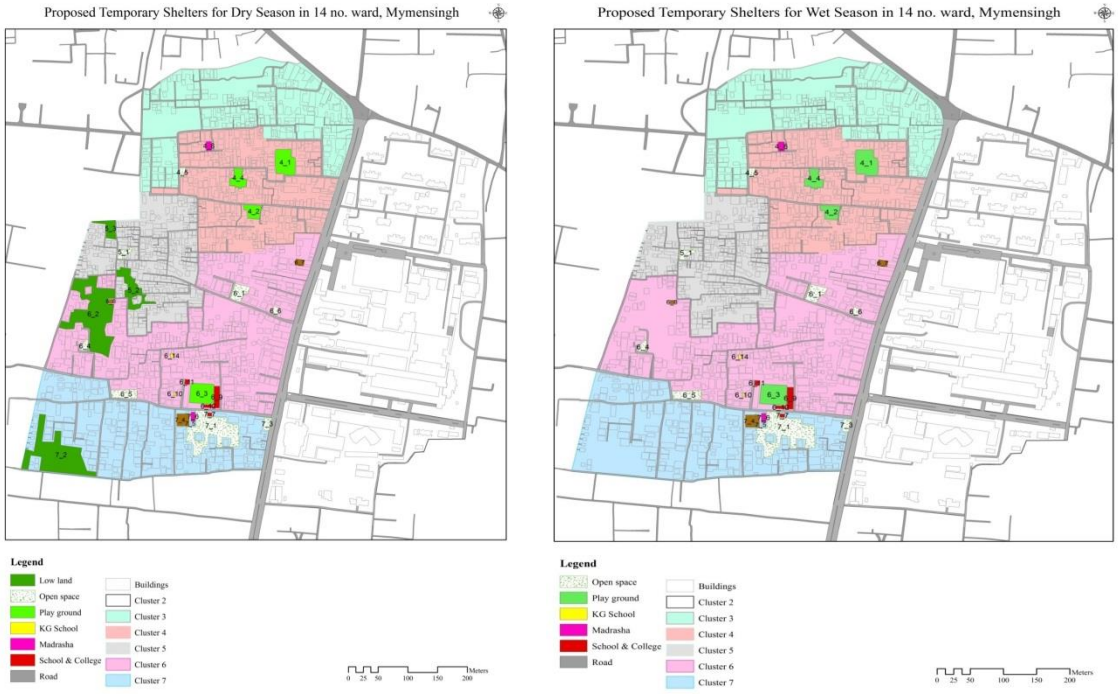

Figure 1.1: Proposed contingency plan for dry and wet season in Ward-14 of Mymensingh Pourashava

To ensure proper management of these temporary shelters and emergency health facilities, Temporary Shelters Management Committee (TSMC) and Emergency Health Facility Management Committee (EHFMC) were proposed with their composition, role, and responsibility in different phases of disaster management. These proposed committees need to coordinate their activities in consultation with the Ward Disaster Management Committee (WDMC).

From this research it was realized that earthquake vulnerability assessment of an area is required to identify the earthquake risks of an area and take precautionary measures to minimize them. A contingency plan based on the result of vulnerability is the pathway to raise awareness among the residents. This contingency plan is neither a standalone document

nor a static document. It should be an ongoing process integrated and coordinated with activities of other documents.

1.2. History of Earthquake in Rangpur

As Bangladesh is located adjacent to the borders of Indian, Burmese and Eurasian plates and is susceptible to frequent earthquakes. Besides, The country is located close to the very active Himalayan front and ongoing deformation in nearby parts of south-east Asia expose it to strong shaking from a variety of earthquake sources that can produce tremors of magnitude 8 or greater. Historical seismicity within Bangladesh indicates that potential for damaging moderate to strong earthquakes exist throughout much of the country (CDMP, 2009). Chittagong, Sylhet, Dhaka, Rangpur, Bogra, Mymensingh, Comilla, Rajshahi are very much vulnerable to a major earthquake . During the last 150 years, Bangladesh faced seven earthquakes of large magnitude (Richter magnitude $M \geq 7.0$) with epicenters in India and Bangladesh (Al Hussaini, 2016). Other than that Bangladesh has regularly faced many small earthquakes. Rangpur is located on active Dauki fault. Besides, Bogra fault line which was active in Palaeogene and Neogene times is very adjacent to the district of Rangpur. Deposition of huge sedimentary pile around Bogra area is evident for this fault (Zaman and Monira, 2017).

According to Revised Seismic Zoning Map of BNBC Rangpur belongs to Seismic Zone 3 (Figure 1.1). The geotechnical and geophysical investigation under CDMP II shows that almost total city corporation area is consist of soil which is dense or stiff which has a high liquefaction susceptibility as Peak Ground Acceleration value ranges between 0.3-0.38 which has been illustrated in Figure 1.2 (CDMP, 2015).

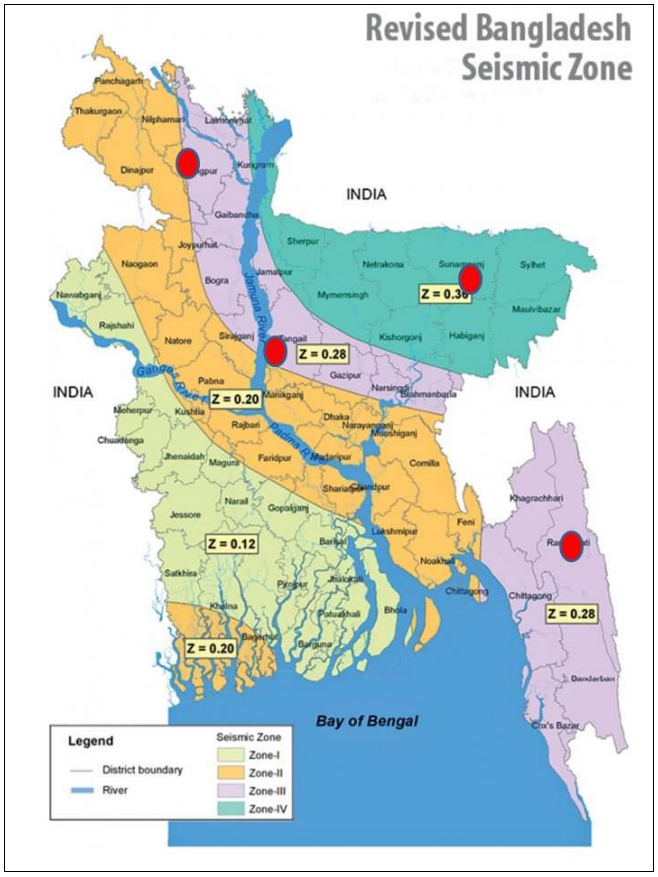

Figure 1.2 Revised seismic zoning map of Bangladesh (Source: HBRI, 2015)

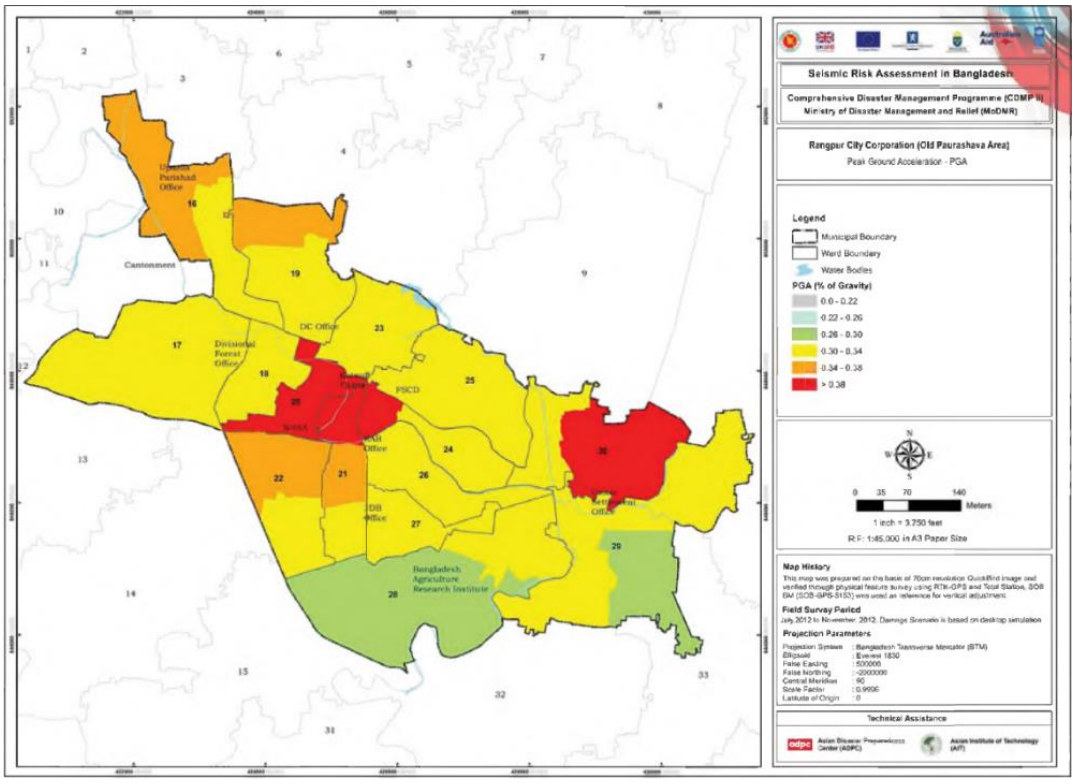

Figure 1.3: Peak Ground Acceleration map of Rangpur City Corporation (Source: CDMP, 2015)

It is evident that Rangpur faced a huge damage in the Great Indian Earthquake in 1897. Some old and historical building got collapsed (Figure: 1.3). Dhubri Earthquake (1930) with a magnitude of 7.1 and the epicenter at Dhubri, Assam caused major damage in the eastern parts of Rangpur district. Some rail track at Rangpur got damaged as the effect of 1997 earthquake (Figure: 1.3).

Figure 1.4: Damage of building in 1897 earthquake and damage of rail track ink 1997 earthquake in Rangpur (Source: Ansary *et al*., 2003)

1.3. Aim and Objectives of the Project

The Preliminary Contingency Plan has been prepared to support the response for saving lives, properties and addressing immediate humanitarian needs of the people affected by an earthquake event.

Preliminary objectives of contingency plan are:

- To save lives and reduce suffering by providing and/or ensuring equitable access to multi-sectoral assistance to affected populations of the ward with particular attention to those most affected and the most disadvantaged groups.
- To protect the rights of those most affected, and promote inclusive and equitable access to humanitarian assistance, with particular attention to the most disadvantaged groups.
- To support the recovery of the most affected by protecting, restoring and promoting their income, livelihoods and well-being with specific focus on the needs of women including women heads of household.

1.5. Scopes of the Project

The scope of the project involves assessment of earthquake vulnerability and response capacity of Rangpur City Corporation and Tangail, Rangamati and Sunamganj pourashavas.

The contents of training on earthquake preparedness would be prepared for trainers and training would be also imparted in this assignment. Guidelines for Risk Sensitive Land Use Planning based on the vulnerability assessment would be developed with Ward level Risk Reduction Action Plan. Ward and household level Contingency Plan also would be developed with household level information. If City/Pourashava level Contingency Plans is not available it will be developed and where it is available it would be updated. To facilitate vigorous awareness campaign in inclusive manner education and communication materials also would be prepared. Adequate policies would be identified for proper building approval, building code enforcement and construction monitoring by the local government.

1.6. Organization of the Report

There are eight chapters in this report. In chapter one, background and objectives of the research have been discussed. Chapter two focuses on the profile of study area including the geographic, demographic and other characteristic of the study area. Chapter three describes the sequential steps of methodology through which the aim and objectives of this research have been achieved. Chapter four and five describes the assessment results of seismic exposure and building vulnerability of the study area. In chapter six socio-economic vulnerability assessment results of the study area have been discussed. Chapter seven includes earthquake contingency planning. Chapter eight concludes with recommendations to ensure proper implementation and functioning of contingency plan during and after an earthquake event.

CHAPTER 2 : STUDY AREA PROFILE

Rangpur City Corporation is situated at Rangpur district in Rangpur division which is located on the Seismic Zone-3 of Bangladesh. The City Corporation was established in 2012 with an area of 205.7 sq. kilometer. The population of this area is 796,556 and the population density is 3872.42 person per sq. kilometers (Source: Rangpur City Corporation, 2013). Among the 33 wards of Rangpur City Corporation, Ward no. 19 has been selected as one of the study areas for this project. It is located at the central east side of the City Corporation with an area of 731.7 acre (Figure 2.1)

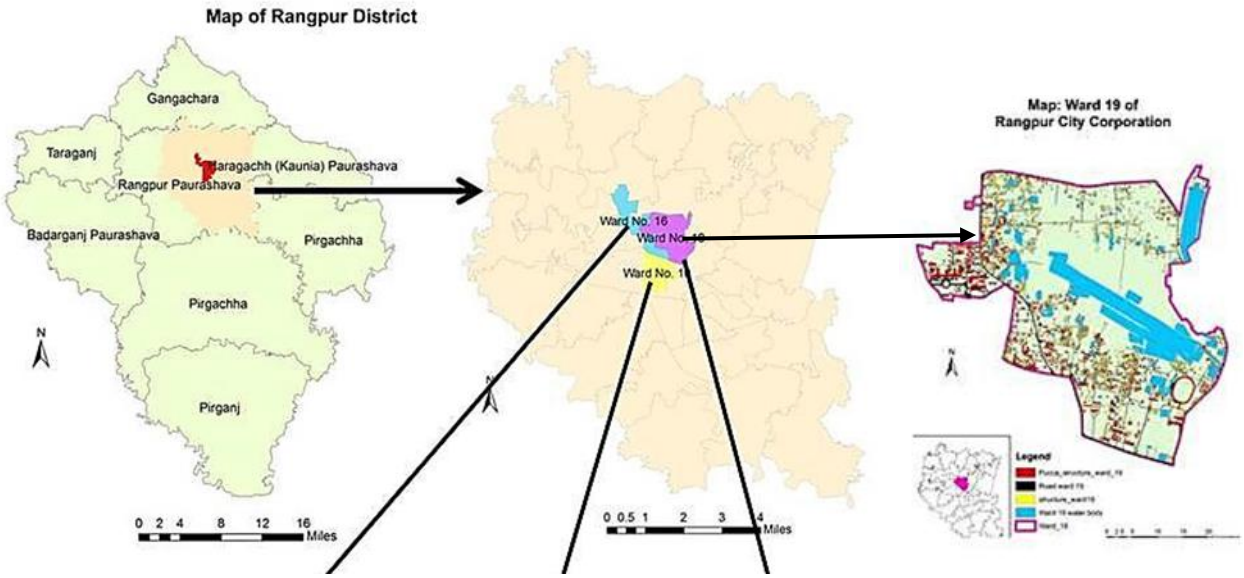

Figure 2.1: Location map of Ward 19 of Rangpur City Corporation
(Source: Rangpur City Corporation, 2013)

2.1 Existing Land Use of the Study Area

Figure 2.2 reveals that the major land use of Ward No 19 is residential. There are ample amount of open and unused space in the ward accompanied with a lot of water bodies. Commercial land use is found very low in percentage. Diversity in land uses is evident along the Rangpur –Dinajpur Highway. Most of the administrative buildings of the ward are also located near the road. Rangpur Medical College Hospital is located in this ward which serves the entire region. There is a stadium and some share of land use is designated for community facilities.

A large chunk of land in this ward is used for agriculture (Figure 2.2). In this part where agriculture is dominant density of population and structure is considerably low than the other

portion of the ward. Besides number of katcha structures is also much higher. Because of low structure density, high number of katcha structure and absence of high rise buildings make it less vulnerable for earthquake.

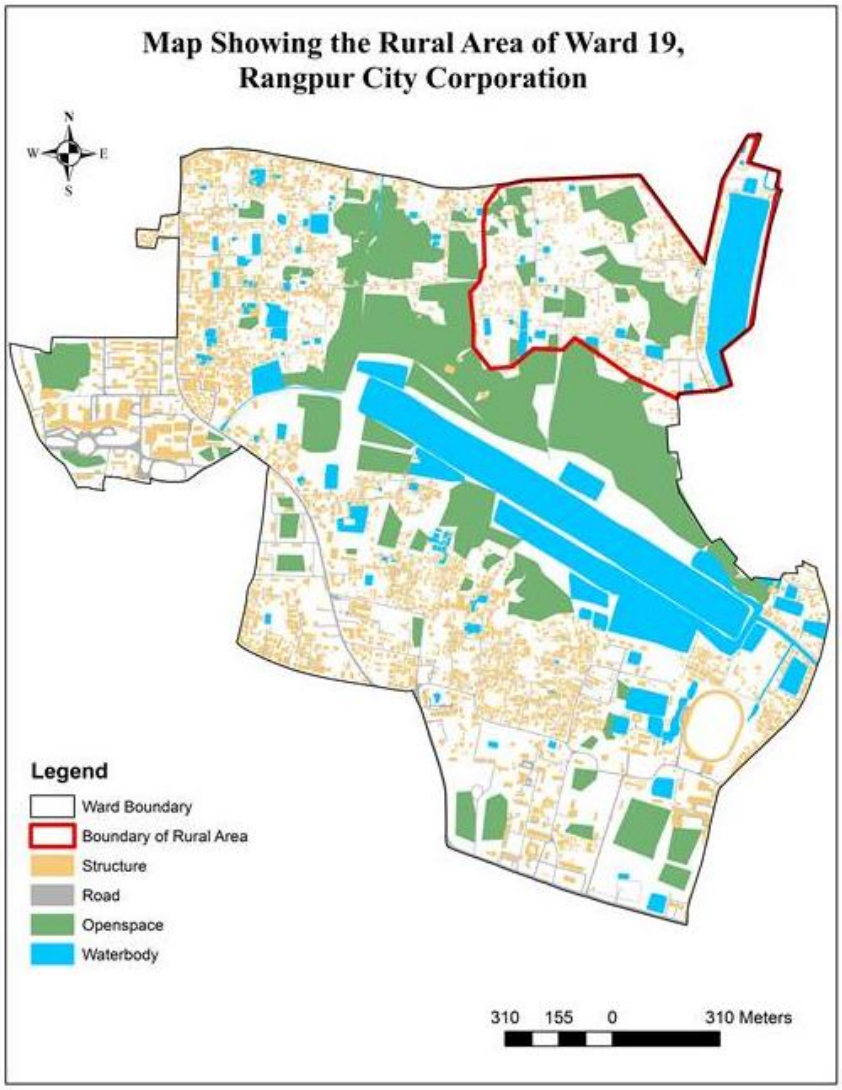

Figure 2.2: Map showing land use of Ward 19, Rangpur City Corporation

(Source: Based on Rangpur City Corporation, 2013 update by Field Survey, 2020)

2.3 Profile of Built Structure in the Study Area

It was found that 36% of the structures of ward 19 of Rangpur City Corporation are pucca, 44% are semi pucca and the rest are katcha. Number of stories varies from 1 to 20 among the pucca buildings. Distribution of pucca building according to their stories is shown in the following Table: 2.1.

Table 2.1: Distribution of pucca structures according to number of story in Ward 19

Number of Story	Number of structure
Number of 1 to 3 storied building	795
Number of 4 to 6 storied building	163
Number of 7 or higher storied building	16
Total	**974**

Source: Field Survey, 2020

According to building use, 84% are of residential use, followed by commercial uses (5%). Apart from these uses, some buildings are used for urban services and socio cultural purposes. The percentage of buildings for educational use and health facilities are almost the same. Figure 2.3 shows frequency of different building uses in ward 19 of Rangpur City Corporation.

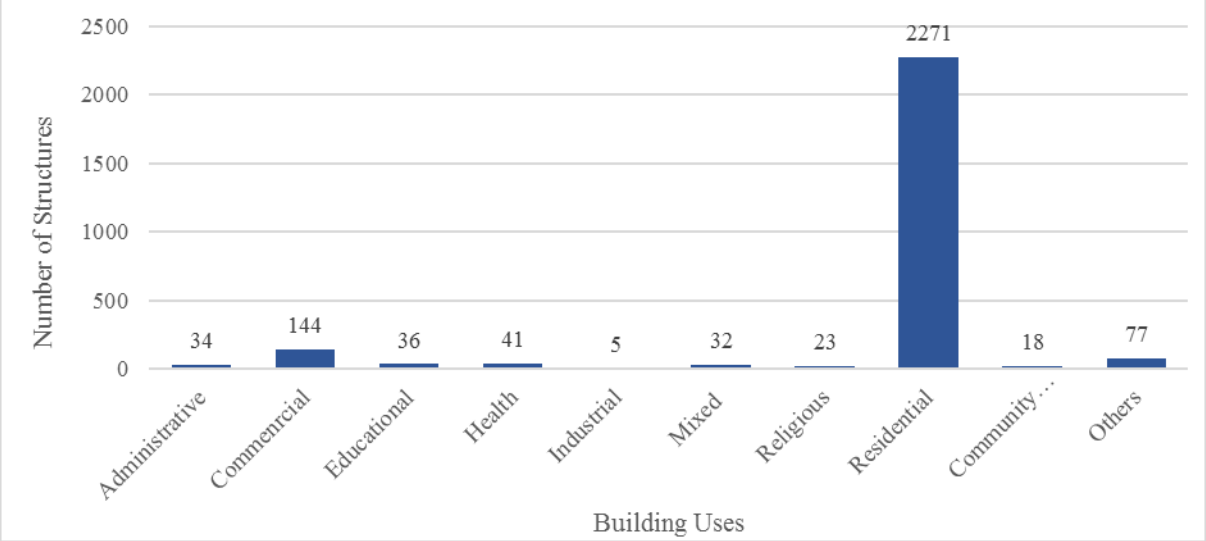

Figure 2.3: Building Use in Ward 19, Rangpur City Corporation

(Source: Field Survey, 2020)

There are total 152 public buildings in ward 19. Buildings that are used for administrative, educational and religious , health and community purposes have been considered as public building in this project. Among them, 34 buildings are used for administrative, 36 buildings for educational, 41 buildings for health and medical , 23 buildings are for religious purpose and 18 buildings for community purposes.

CHAPTER 3 : METHODOLOGY

3.1 Introduction

There is not a single method to determine socio-economic and building vulnerability of community due to earthquake. As contingency plan is dependent upon socio-economic and physical context, a comprehensive methodology is needed to cover the issues. Thus a comprehensive approach has been taken to prepare the contingency plan considering socio-economic vulnerability of community as well as physical vulnerability of the area. For this research, both primary and secondary data were collected. A questionnaire survey and an engineering survey were conducted to understand the socio-economic context and physical vulnerability of the area and structures. In addition, secondary data on land use, institutional capacity were collected. Once, the data were collected, it was verified and analyzed and some data are analyzed already and the rest are in the process. Later community-based approach will be taken for capacity and awareness building and promoting safe construction practices. In this way some initiatives have already been taken which are brought in light at this chapter. The following sections provide the detail description of the methodology.

3.2 Project Initiation

The project is initiated through inauguration workshops in an interactive way in the study area. In Rangpur City Corporation, the inauguration workshop was held on 05th November, 2019 (Figure 3.1). The workshop was chaired by Mr. Mostafizar Rahman Mostafa, Honorable Mayor of Rangpur City Corporation.

Figure 3.1: Inauguration Workshop at Rangpur City Corporation

Prof. Dr. Raquib Ahsan, Ms. Uttama Barua, Ms. Tasnim Tarannum Isaba and Ms. Shamontee Aziz attended the workshop as part of the BUET team. The workshop was also attended by officials from Ministry of Disaster Management of Relief (MoDMR), district administration, officials from UNDP, members of civil society and volunteers from Bangladesh Scout and Bangladesh Red Crescent Society. Vulnerability context of Rangpur City Corporation and possible activities under the project were presented by BUET and UNDP team. There was an open discussion where the role and responsibilities of local people and officials for earthquake preparedness were discussed.

3.3 Secondary Data Collection

One of the most important data for the research is the GIS database of the study area. From Rangpur City Corporation office, the GIS database has been collected which was last updated 2013. The database contains data on area boundary, structures type, land use and road network. This database has been used to prepare the base map of ward 19 of Rangpur City Corporation.

Some policy documents such as Building Construction Rules (1996) and project reports such as Comprehensive Disaster Management Programme (CDMP) Phase II for Rangpur City Corporation have been reviewed to identify the previously collected data on development pattern, soil characteristics etc. of the study area.

3.4 Primary Data Collection

Social survey was conducted to assess the socio-economic vulnerability of the study area. Engineering surveys were conducted to understand the soil characteristics and physical vulnerability of structures. Microtremor test was used to understand the seismic vulnerability. To assess the vulnerability of buildings of the study area, two methodologies were used: RVS (Rapid Visual Screening) as suggested by FEMA (Federal Emergency Management Agency, USA, 2017 edition) for preliminary assessment and DEA (Details Engineering Assessment).

3.4.1 GIS Database Updating

The collected GIS database from Rangpur City Corporation which was last updated at 2013,. Therefore, it was necessary to update the information of this database due to huge development at the study area from 2013 to 2019. At the preliminary stage the team used Google earth image to identify land cover and in some cases land use, by employing Google earth tag. As the Google images are available upto 2018, field verification was conducted to

identify the development between 2018 and 2019 as well as identifying the land use. In the field verification process non-spatial data (for example: building storey, building use, road width etc.) was also updated.

3.4.2 Updating of GIS Spatial Data through Satellite Image Processing

The spatial database of GIS has been updated from the satellite images available at Google Earth. Existing newly built structures, water bodies, open spaces, barren lands etc. were digitized at this stage for the study area. After completion of satellite updating, it has been found that almost 525 new buildings were constructed in between 2013-2018. The field updating has been conducted to trace the development pattern after 2018.

3.4.3 Checklist Preparation

Before collecting the information of newly built structures from the field, a checklist has been prepared. The checklist included building use (in detail extent as much as possible: Residential, commercial, health, educational, religious, community facility, mixed etc.), type of structure (pucca, semi pucca and katcha), number of storey etc (Appendix C). This checklist has been prepared at "Kobo Toolbox". Surveyors were asked to mark road width, presence of open space and waterbody in the hard copy of map during field verification.

Table 3.1: Attributes have been considered at updating stage (Checklist)

Information collected by KoBoToolbox	
Ward No	Type of Structures
Building ID	No of Storey
Holding No	Building Use
Width of Adjacent Road	

3.4.4 Training of the Volunteers

Local community plays the role of first responders in case of any disaster. Therefore, strategies for local empowerment and capacity building are needed in order to ensure effective disaster mitigation (Shaw, 2012). Community-specific training programme is an important tool which utilizes local knowledge and enhances the potential of local residents (Rivas and Kilmer, 2016). Community members of the study area were engaged to collect the data. They were trained so that they can assist in updating the existing GIS maps. The activities under this task involve training the volunteers about how to interpret the maps and update the structures on map, how to enter the information of structures at "KoBoToolbox"

and how to form the groups to conduct the field verification. On 28th November, 2019 (Thursday), an interactive training session was organized at Rangpur Town Hall (Figure 3.2). The session started at around 10.00 a.m. It was attended by 10 (ten) members from Boy Scouts and two (2) members from Girls' Guide of Rangpur District. The volunteers were instructed by four (4) technical officials and two (2) research assistants of BUET-JIDPUS. At first the historical background of earthquake in Rangpur, overall aim and objectives of the project were explained to the volunteers. Representatives from BUET-JIDPUS also discussed about the importance of updated maps in earthquake contingency planning. Then the prepared maps updated through satellite image were presented to them and the rationale of division of the maps into different clusters was clarified. Later the volunteers were trained regarding the survey procedure, i.e. how to read maps, explanation of different variables related to the structures and the process of data collection using 'Kobo Toolbox' mobile application. After the being enlightened about the procedure, the volunteers were divided into six (6) groups and they conducted survey under the supervision of the officials.

Figure 3.2: Training of local scouts regarding the map updating process in Rangpur Town Hall of Rangpur City Corporation

3.4.5 Field Verification and Updating of GIS database

To prepare continegency plan, the Information of all the buildings are needed. It includes the information on buildings that are constructed, developed to higher storied or demolished since 2013. These are done through field survey. During field updating, spatial information (i.e. shape of structures, open space, waterbody) has been drawn at satellite updated Ward map and non-spatial information (i.e., type and use of structures) have been collected using developed checklist format at "KoBo Toolbox".

Once the field survey is completed, the GIS database were updated. The newly built structures of satellite updated map and those that are not even in the updated satellite maps were added in the GIS database. Buildings which no longer exist, were removed from the

GIS database. In addition, data base were updated to edit the number of story and land use of the buildings.

3.5 Primary Data Collection for Assessment of Seismic Exposure

In order to assess the seismic exposure of the study area two bore holes (Marked as 1 and 2 in figure 3.4) up to a depth of 30 meters were conducted in ward no 19 of the Rangpur City Corporation. Disturbed and undisturbed samples were also collected from different depths.

Microtremor tests have been conducted. (marked as red dot in Figure 3.5). Data have been collected using five velocity sensors each having three channels. The channels collected in data in North-South, East-West and Up-Down direction. For each sensor the X axis was aligned with North. Each sensor was placed 25 meters apart. Precautions were taken to avoid noises and vibrations from other external sources so that they do not hamper the recording of the ambient vibration. Figure 3.3 shows the setup of sensors at the filed.

Figure 3.3: Setup of sensor for microtremor test

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3.6 Survey for Preliminary Data Collection of Buildings

One of the first tasks of the project was to validate and update the database collected from secondary sources. For this, primarily a survey was conducted from November 26, 2019 to November 30, 2019. During this survey the previously prepared maps were verified. In this process the whole ward no 19 was divided into 24 clusters and major information was collected regarding the features of the buildings (location, no. of storey, ownership, occupancy, type etc.). From the initial survey and updated maps, the latest number of buildings were determined. Table 3.2 shows the number of pucca buildings with respect to

ownership and number of storey. Beside this there were 640 kutcha and semi-pucca buildings in the ward.

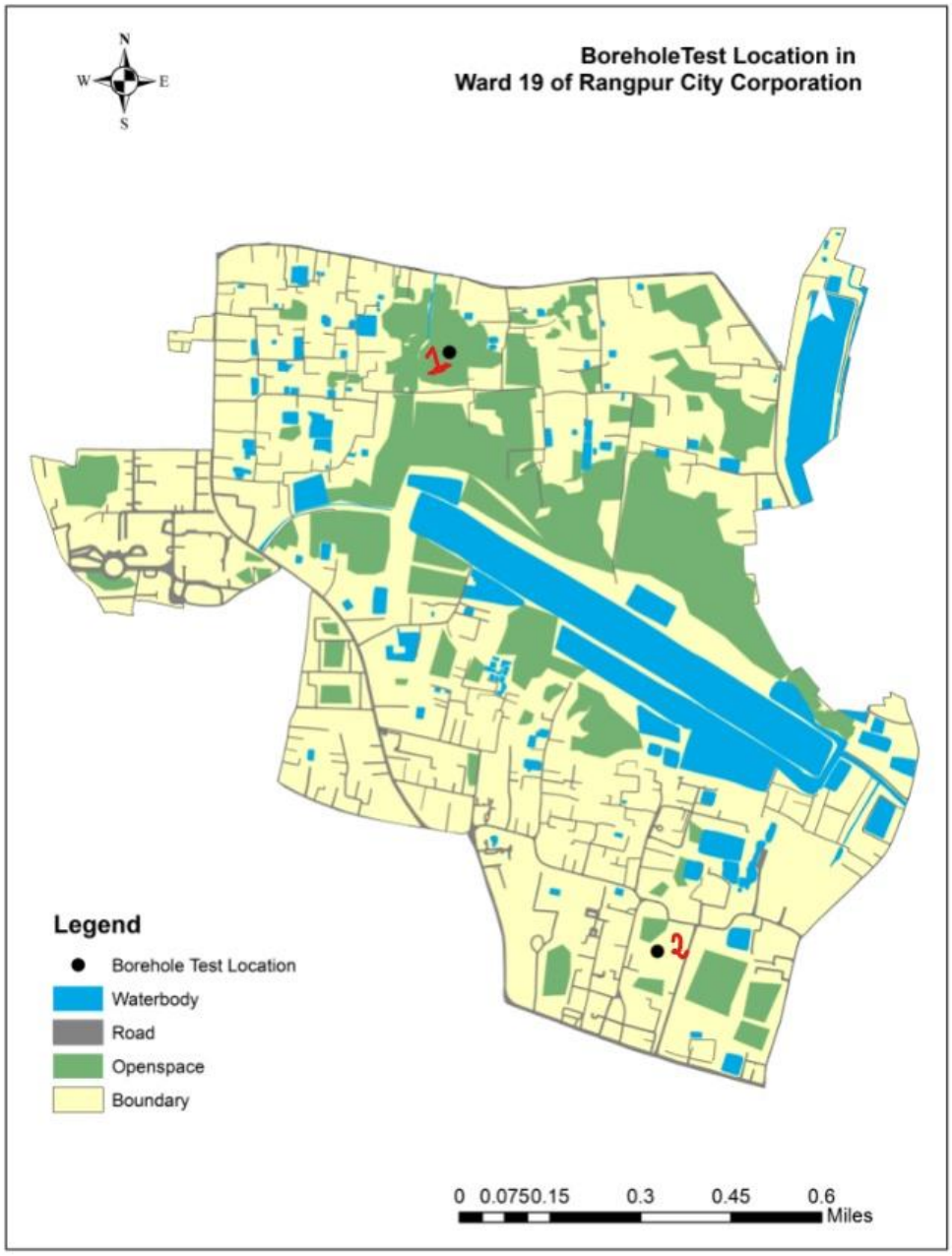


Figure 3.4: Location of boreholes in ward no. 19 of Rangpur City Corporation

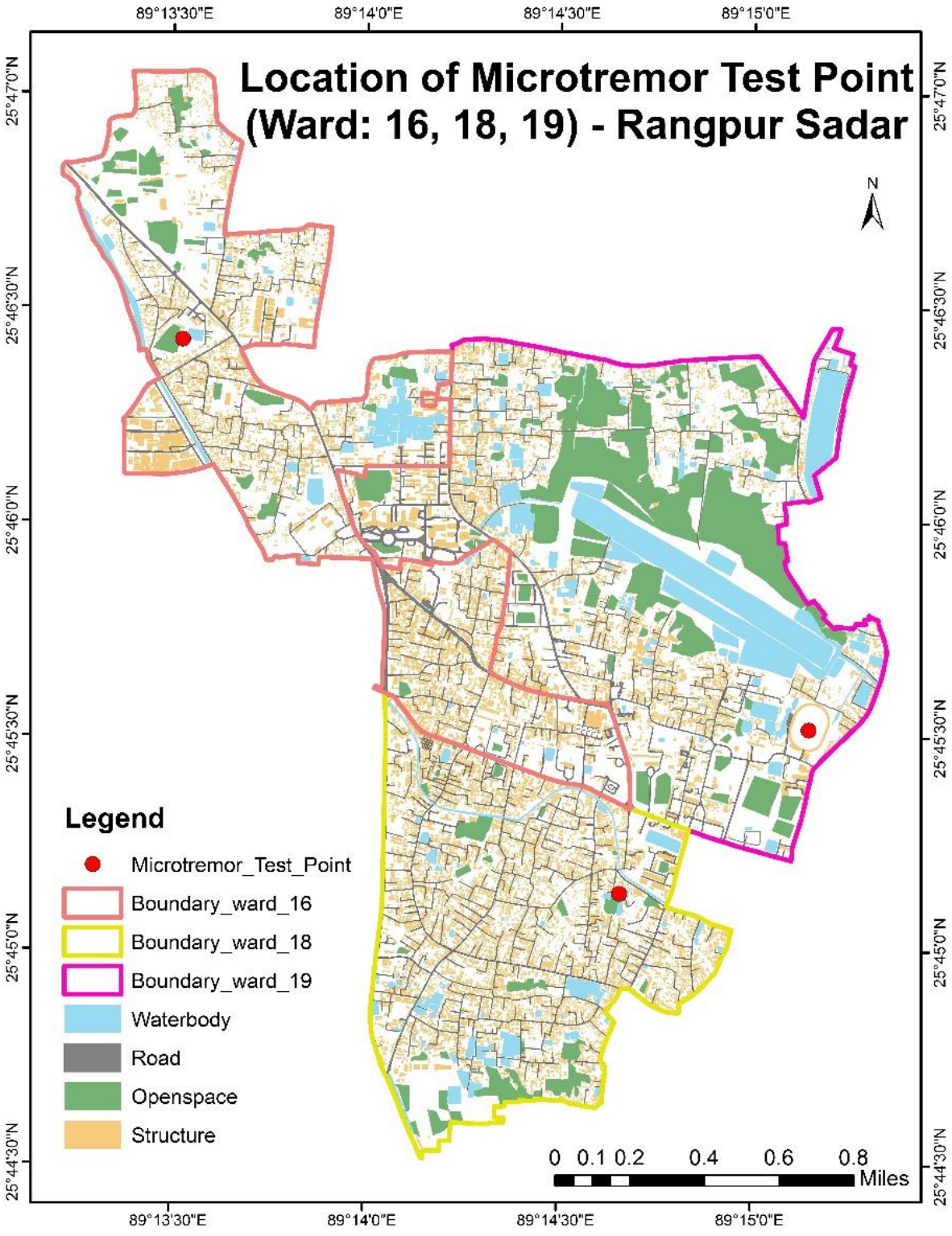


Figure 3.5: Microtremor test location at Ward no. 19 of Rangpur City Corporation

Table 3.2: Total number of buildings in Ward No. 19 of Rangpur City Corporation

Type of Structure	Ownership Status of Buildings				
Pacca	Private Buildings			Public Facilities Buildings*	
	1-3 Storey	4-6 Storey	6+ Storey	1-3 storey	3+ storey
	640	151	16	82	35

*All the government service office, hospitals, educational institutes were labeled as Public facilities buildings.

3.6.1 Preliminary Vulnerability Assessment of Buildings

To assess the buildings of the study area, two methodologies will be used: RVS (Rapid Visual Screening) suggested by FEMA (Federal Emergency Management Agency, USA, 2017 edition) for preliminary assessment and DEA (Detailed Engineering Assessment) for three (3) buildings. Already we have conducted the Rapid Visual Screening process of the buildings located in ward no. 19.

Rapid Visual Screening (RVS): FEMA 154 was developed by ATC (Applied Technology Council) under contract to FEMA. The purpose of FEMA P-154 was to provide a methodology to evaluate the seismic safety of a large inventory of buildings quickly and inexpensively, with minimum access to the buildings, and determine those buildings that require a more detailed examination (FEMA, 2017). It is a sidewalk survey process that enables to classify the surveyed buildings into two categories: those as to the risk to life and those that may be seismically hazardous and should be investigated in more details by a design professional experienced in seismic design.

3.6.2 Checklist Preparation for RVS

As already mentioned, preliminary assessment of the vulnerability of the buildings was done following the guideline provided by FEMA 2017 edition. According to this level 1 survey has been performed. In order to get a clear idea about the buildings subjected to visual screening FEMA has a recommended form. A digital checklist by keeping the features of the form suggested by FEMA were prepared using “Kobo Toolbox”. The checklist includes the building identification information, floor area, number of story as well as some pertinent data related to seismic performance e.g. vertical irregularity, seismic force resisting system, structural materials of the buildings, plan irregularity , pounding potential and the effect of surrounding structure, geological features of the site, non-structural hazards etc.

3.6.3 Sampling of Buildings

Stratified sampling method was used for selection of samples. At first the whole ward was divided into 24 clusters. Appendix B shows the designation of the zones. There were two sets in the sample, public facility buildings and private buildings. All the public facility buildings (e.g. government offices, educational facilities, religious facilities and health facilities) irrespective of their storey height were surveyed. There are 117 such buildings in ward no. 19. the rest of the surveyed buildings are private buildings. In choosing the private buildings, initially number of samples were proportionately distributed among the 24 clusters. Then all the pucca structures of 4-storeys and above were selected for RVS. In addition, the structures lower than 4 storied were selected maintaining their proportionate distribution. A total of 284 buildings such nature exists in the study area. Table 3.3 shows details of the number of samples. Table 3.4 shows the number of samples in each zone. However, in the field some one to three story private buildings were also surveyed in order to see their performance.

Table 3.3: Sampling of private and public facility buildings

Study Area	Private buildings (pucca)		Public Facility buildings (pucca)		**Total**
Rangpur	4-6 storey	6+ storey	1-3 storey	3+ storey	
Ward No. 19	**151**	**16**	**82**	**35**	**284**

Table 3.4: Number of samples in each zone

Zone No.	Sample Size		Zone No.	Sample Size
1	11		13	11
2	19		14	0
3	22		15	5
4	31		16	0
5	0		17	7
6	29		18	17
7	13		19	7
8	16		20	2
9	18		21	7
10	12		22	21
11	11		23	12
12	6		24	7

3.6.4 Training Program

Before starting the field work of rapid visual survey, a training session was arranged for the local volunteers who would conduct the survey. The training took place on February 27, 2020 at the Conference room of Rangpur City Corporation (Figure 3.6 a).

The training program consisted of two sessions. In the first session there was a formal inauguration. This was followed by a brief summary of the project and the objective of the work. There were 18 volunteers who conducted the RVS. After the summary they were divided into nine (9) groups. At first a brief description about the Rapid Visual Survey was presented. They were made familiar with the “Kobo Toolbox” and the check list. Each question was explicitly described, and its importance was also stated. They were provided with both soft copies and hard copies of the questionnaire along with supporting documents which carried details about specific questions. The session was interactive, and the surveyors were made familiar with the theoretical background of the process.

In the second part all the groups were deployed on the field and practical demonstration was conducted (Figure 3.6(b)). There were three (3) groups under which there were three (3) teams. The groups were led by an in-house technical official. They surveyed a building individually and filled up the checklist. After the survey all of them sat together and shared their findings.

Figure 3.6: Discussion during the training session (a) and Field demonstration (b)

3.6.5 Data Collection

Total 18 people volunteered for the purpose of data collection and they were students of Civil Engineering of local Polytechnic Institutes. The volunteers were divided into nine teams, each comprising of two members. A leader was directly supervising three teams (Figure 3.7). The team leaders were from BUET-JIDPUS. The teams worked in their designated zones and surveyed the buildings. The data collection stared from 27th February 2020 and was completed on 5th March, 2020.

Figure 3.7: Brief instruction by the team leader before data collection

3.7. Social Survey

3.7.1 Questionnaire Preparation

A questionnaire was prepared for the assessment of socio-economic vulnerability and the preparation of contingency plan. While preparing the questionnaire the following issues were taken into consideration: the General information of the respondent and household, Respondent's Awareness, knowledge and perception on earthquake, Respondent's Ideas about Earthquake Disaster Management, and Owner's Consent to Earthquake Risk Reduction. A tentative questionnaire has been developed to conduct the household survey for social vulnerability assessment. To check the consistency and identify the complexities or gaps of the questionnaire, piloting of the questionnaire was conducted and tested in the area. After the piloting, the questionnaire was finalized (Appendix A). The team members were trained to understand the questionnaire. Once the members of data collection team understand the questionnaire, they started the survey under the supervision of cluster leader. The findings from this piloting helped to develop the final questionnaire of social survey and to develop the mechanism of social surveying.

3.7.2 Sampling of Buildings for Household Survey

It Questionnaire surveys of 246 households were conducted in between 1st March, 2020 to 4th March, 2020. About 172 respondents were owner of the buildings (Table 3.5) and the rest were tenants.

According to the contract between DDM and BUET the total sample size for the study would be 2000. But considering the human error in data collection process, BUET team decided to collect data from 2200 households. However, as high rise buildings are more vulnerable to earthquake, all residential buildings which are four storied or higher were taken into consideration in the sample size; the total number of buildings falling in this category was 1290 for Rangpur City Corporation and the three pourashavas.. The remaining 810 residential buildings would be selected from katcha and semi pucca and one to three storied residential buildings following the theory of proportional sampling method. The proportion was considered as district level, then within a district as ward level, subsequently within a ward as cluster level. The ward was divided into 24 small clusters so that attributes (like: structure type, number of story) of every building can be shown in A4 size maps and that helped the surveyors to find out any specific building which was sampled/marked. Cluster map for Ward no 19 is shown in Appendix B.

Table 3.5: Sampling for household survey in Ward 19, Rangpur City Corporation (owner)

Cluster No.	1 to 3 Storied buildings	4 to 6 Storied buildings	6+ storied buildings	Katcha or Semi pucca	Total
Cluster 1	0	0	0	1	1
Cluster 2	0	1	1	1	3
Cluster 3	1	11	1	1	14
Cluster 4	1	6	1	0	8
Cluster 5	0	0	0	0	0
Cluster 6	1	13	4	1	19
Cluster 7	1	8	0	1	10
Cluster 8	1	2	1	1	5
Cluster 9	1	9	0	1	11
Cluster 10	1	4	0	2	7
Cluster 11	0	4	1	1	6
Cluster 12	1	4	0	4	9
Cluster 13	1	7	0	2	10
Cluster 14	1	1	0	2	4
Cluster 15	1	4	0	4	9
Cluster 16	0	0	0	0	0
Cluster 17	1	3	0	5	9
Cluster 18	1	6	0	3	10
Cluster 19	1	3	0	4	8
Cluster 20	1	1	0	2	4
Cluster 21	1	4	0	1	6
Cluster 22	1	7	0	1	9
Cluster 23	0	6	0	1	7
Cluster 24	1	1	0	1	3
Total	**18**	**105**	**9**	**40**	**172**

Table 3.6: Sampling for household survey in Ward 19, Rangpur City Corporation (tenant)

Cluster No.	1 to 3 Storied buildings	4 to 6 Storied buildings	6+ storied buildings	Katcha or Semi pucca	Total
Cluster 1	0	0	0	1	1
Cluster 2	0	1	0	0	1
Cluster 3	1	5	0	0	6
Cluster 4	0	2	0	0	2
Cluster 5	0	0	0	0	0
Cluster 6	0	5	2	1	8
Cluster 7	0	3	0	0	3
Cluster 8	0	1	0	0	1
Cluster 9	1	4	0	1	6
Cluster 10	0	2	0	1	3
Cluster 11	0	2	0	0	2
Cluster 12	1	2	0	2	5
Cluster 13	1	3	0	1	5
Cluster 14	0	0	0	1	1
Cluster 15	1	2	0	2	5
Cluster 16	0	0	0	0	0
Cluster 17	1	1	0	2	4
Cluster 18	0	3	0	1	4
Cluster 19	1	1	0	2	4
Cluster 20	0	1	0	1	2
Cluster 21	0	2	0	1	3
Cluster 22	0	3	0	0	3
Cluster 23	0	2	0	1	3
Cluster 24	0	1	0	1	2
Total	**7**	**46**	**2**	**19**	**74**

In the next phase of structural vulnerability assessment, sometimes retrofitting of vulnerable buildings would be proposed according to the consent of building owners. Paying attention to this very issue, seventy percent sample was considered from owner household of a residential building. While to get a comprehensive scenario, the remaining was taken from the tenant. This proportion was also maintained in each level i.e. district, ward, cluster mentioned earlier.

In ward-19 of Rangpur, it was found that 246 (172 owner and 74 tenant) household needed to be surveyed. Of these 162 households were taken from four storied or higher, 18 households one to three storied and 59 households are katcha and semi pucca residential buildings.

3.7.3 Training Program to Conduct Household survey

On 27th February, 2020, the training program was started at approximately 10:00 AM. at Rangpur City Corporation (Figure: 3.8). In this training program, there are two sessions. The activities under the first sessions were to render information, motivation and importance of the project to the volunteers so that they could own the project. In the second session, an interactive conversation was conducted to discuss and learn the contents of the questionnaire. The other activities in the second session was about how to interpret the maps and how to enter the information of HH at "KoBo Toolbox". On the same day, volunteers were trained in the field how to conduct the household survey by the faculties and research team of BUET.

Figure 3.8: Training program for household survey

3.7.4 Data Collection

Household questionnaire survey was conducted from 1st March, 2020 to 4th March, 2020 in the selected buildings according to the sampling in ward 19 of Rangpur City Corporation. The survey was conducted by total nine groups each consist of two members (One Female, One Male) in each group. One survey supervisor was assigned for every three groups to quality control.

Figure 3.9: Data Collection-Household Survey in Ward 19

3.8 Socio-Economic Vulnerability Assessment

Once the questionnaire survey is over, data was exported from KOBOToolbox as an excel spreadsheet. The socio-economic issues include issues like age, sex, educational level, occupation, household income, physically or mentally challenged people, house ownership etc. and the perception of the community regarding earthquake was included in the survey. Statistical analysis based on several variables has been performed to understand the socio-economic context of the study area and the rest of the analysis will also be performed very soon.

3.9 Contingency Planning for Earthquake

Based on building and socioeconomic vulnerability of the study area, an earthquake contingency plan is expected to be prepared for the study area. The contingency plan would include five components. They are:

• Ward Co-ordination Center planning at Ward level considering community based disaster risk management;

• Temporary Shelter Planning

• Emergency Health Facility Planning

• Evacuation Route Planning; and

• Household level preparedness planning at household level

3.9.1 Temporary Shelter Planning

After an earthquake, it is expected that good number of people homeless due to collapse of buildings. It would be an urgent need to provide them shelter. Temporary dwellings constitute a crucial step of recovery and reconstruction in the post-disaster aftermath. It plays

a vital role in order to provide protection to the affected people and provide a habitable environment while the outcomes of a disaster are being evaluated and then rectified (Donohue, 2012). Temporary shelter planning involve:

- Need Assessment
- Availability of Space Assessment
- Estimation of Ancillary Facilities for Temporary Shelter
- Allocation of Space to the needy

a) Need Assessment:

After a severe earthquake, occurrence of several aftershocks can be seen in the same area of main shock. Some structures that may sustain the main shock may not sustain the aftershocks (World Bank Institution, 2012). Additionally, as a result of aftershocks people may not prefer to return their buildings which are not damaged (World Bank Institution, 2012). In this context BUET team developed two scenarios in this research. The scenarios and their corresponding assumptions for estimating demand are:

Scenario 1: The residents of buildings which are damaged or collapsed would need shelter. So households living in these residents are considered for temporary shelter.

Scenario 2: All of the residents in the study area will require temporary shelter.

b) Available Space Assessment:

In Japan, large-park or open space, playground, religious and school buildings and spaces in public buildings are considered to provide shelter in after math of an earthquake (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012) while after 2015 tents in open spaces were used in Nepal as temporary shelter (Sheltercluster.org, 2018).So for temporary shelter, open space, playground, religious and school buildings and spaces in public building have been considered. Though, there are ample agricultural land in the ward (Figure 2.2) which are open in nature it was not considered for two reasons. Firstly, if the earthquake happened during harvesting season, it could not be used. Secondly, even if the earthquake occurs during non-harvesting season, presence of root of previous season's harvest or preparation for next season's harvest made this land unsuitable for setting up temporary shelter.

Initially, all the public building were considered as possible place for temporary shelter in addition to open space and playground. Then the buildings, which deemed to be structurally unsafe by RVS has been removed from calculation. It is expected that, in the upcoming workshop participants will verify these places of temporary shelters. Based on their feedback, final selection of the temporary shelters will be done. Once space for temporary shelter is identified, capacity of each of the shelter will be calculated.

c) Estimation of Facilities in Temporary Shelters:

Temporary shelters need to meet the need of the people staying in the shelters after an earthquake. So there is need for toilet, water and first aid treatment facility etc. This will also be estimated.

d) Allocation of Space to the homeless

The study would try to accommodate people of same cluster together. So cluster-wise need as well as space would be calculated. If there is shortage of space, then it would try to put people in closest shelter of the adjoining cluster of the ward. If there is shortage of space in the ward, then space from the nearest cluster of the nearest ward would be used.

3.9.2 Health Facility Planning

The collapse of structural buildings due to earthquake may result in death and severe injury to the people of the study area. Emergency health facilities will be required to minimize the sufferings of the injured people after an earthquake. Like temporary shelter planning it would follow a step process:

- Need Assessment
- Estimating availability of Space for providing medical support
- Estimation of support facilities to run medical support

a) Need Estimation:

There would be death and injury after an earthquake. According to CDMP (2009b) there would be four types of injury to people with different level of severity after an earthquake. They also estimated the probable ratio of injury of population at different severity level. From this, the need of emergency health facility will be estimated.

b) Estimating Availability of Space for providing medical support:

The Existing hospitals, clinics and diagnostic centers have been identified with their location and considered primarily for providing medical facility after earthquake in the study area. The facilities located in structurally safe building by RVS will be identified as possible health facility. After that, in the workshop participants will verify the health facilities. Based on their feedback, final selection of the health facilities will be done. It should be mention here that though Rangpur Medical College Hospital (RMCH) is located in Ward no 19 of Rangpur City Corporation, it was not considered. The BUET team felt that RMCH is a regional level facility and should be treated such.

c) Estimation of Support Facilities to run Medical Facilities:

As all the identified health facilities are now operating as health facility, so it is logical to assume that they have the necessary support infrastructure. However, in the aftermath of an earthquake these facilities have to support more than their designed p. So, this estimation also has to be done according to standards.

3.9.3 Evacuation Route Planning

Evacuation route is an escape designated to a facility (temporary shelter, hospital etc.) in an emergency situation, such as a fire or earthquake (CollinsDictionary.com, 2018). Evacuation route planning is a complex process consisting of several consecutive phases. After the detection of potential disaster, it is necessary to evaluate the potential threat for specific areas and then issue an evacuation order for these areas for the vulnerable area to a safe place to provide adequate protection to the residents and others. Evacuation planning is influenced by the condition of infrastructure of the affected area to ensure the accessibility to the safer place. Following steps will be followed to determine evacuation route:

(a) Identifying Vulnerable Building:

Buildings which have an RVS score 1.2 or less is considered as vulnerable for the study. It is assumed that debris from the collapsed building would partially or fully block the road considering different contexts.

(b) Determining Blockage in the Road:

It should be mentioned here that as data of all buildings were not collected some roads which the maps show unblocked may be blocked if the height of the building is greater than the road width. However, we do not expect such thing would happen as we collected data for all

buildings higher than three storied and most of the three storied building. And it is for two storied and lower there would higher probability of in situ collapse than collapsing on the road. So for identifying blockage, the height of each storey of building is considered 10 feet. Based on the width of the road in front of the building the road would not be blocked, partially blocked or fully blocked.

(c) Accessibility of the Open Roads:

Once the blocked roads are identified, the rest of the open roads will be considered based on their accessibility considering road width. The routes will be classified in some groups.

(d) Identifying Evacuation Route:

Based on road blockage and accessibility, the evacuation route map will be prepared. This route will be usable for the evacuees to move to the temporary shelters, to take the injured people to the health facilities and to connect the temporary shelters and the health facilities with the Ward Co-ordination Center.

3.9.4 Ward Co-ordination Center Planning

Ward Co-ordination Center is required during disaster in order to ensure proper mobilization and management of personnel, necessary equipment and supplies immediate after an earthquake. In identifying Ward Co-ordination Center following will be considered

- the facility should be in a government building,
- should be structurally safe and
- should be centrally located and easily accessible

3.9.5 Institutional Management Plan

An institutional arrangement is needed for proper functioning of temporary shelter, health facility and Ward Co-Ordination Center. So institutional management plan has been developed which will connect the temporary shelter, health facilities and Ward Co-Ordination Center to Rangpur City Corporation. Requirement of volunteers will also be estimated thereby for the management of the facilities. Criteria for selecting members have been fixed.

3.9.6 Household Preparedness Planning

To ensure proper preparedness for earthquake at household level, a plan would be developed guiding different preparedness activities. The household preparedness plan is based on Household Preparedness Plan prepared in Philippine but considered the local context.

3.10 Finalization of the plan at Local Workshop

It should be mentioned here that this is an initial contingency plan. It is expected that the plan would be revised once all data is process. It is expected that before finalization of the plan,, the draft plan is prepared it will be shared with local community. In the workshop, according to the suggestions from the community, some changes regarding temporary shelter, health facility and evacuation route which will be incorporated. The Ward Co-ordination Center can also be changed on their suggestion as happened in Mymensingh. Additionally, the participants may identify some road blocks to ensure proper evacuation after an earthquake. Based on their feedback, the evacuation route plan will be finalized and some recommendations will be developed to remove the identified road blockage. This local workshop will be participated by the Honorable mayor of Rangpur City Corporation, officials from Rangpur City Corporation, officials from UNDP, Ward Councilor of Ward no. 19, representatives of different groups of community of Ward no. 19, members of civil society, earthquake volunteers of Ward no. 19 and other representatives from Ward no. 19.

3.11 Final Report Preparation

Once the local workshop is concluded, the final report will be prepared. The report will be contained not only the result of the study with appropriate figures, maps and tables but also recommendation to reduce the vulnerability of the community.

CHAPTER 4 : SEISMIC EXPOSURE ASSESSMENT

4.1 Introduction

This chapter deals with the borehole location and results of microtremor analysis for Ward no. 19 of Rangpur City Corporation. It will help us to know the local soil condition and local seismic effect.

4.2 Borehole Data (SPT value and Description of Soil)

Figure 4.1 and Figure 4.2 represent the bore logs of the two bore holes of Ward 19 of Rangpur City Corporation. One boring (Bore Hole 1) was done at Zone 15 and another boring (Bore Hole 2) was done at Zone 1. Bore hole diameter, used in these tests was 100 mm. Both disturbed and undisturbed samples were collected from the borings. 20 readings of SPT-N value at 1.5m interval up to 30 m were taken. Point to be noted in this regard that, SPT value indicates the strength of soil.

The soil profile of bore hole 1 shows five different layers of soil. From the N value, it was observed that up to 7.5m, the readings were less than 10, which means upper layers of soil has lower strength compared to the bottom layers where the readings were approaching 50. The detailed description of the soil type has been shown in Figure 4.2.

On the other hand, the soil profile of bore hole 2 shows six layers of soil. It was observed that up to 4.5m, the N values were less than 10 and the bottom readings were approaching 50. So, the depth of soil layer with less strength is smaller here than compared to that of bore hole 1.

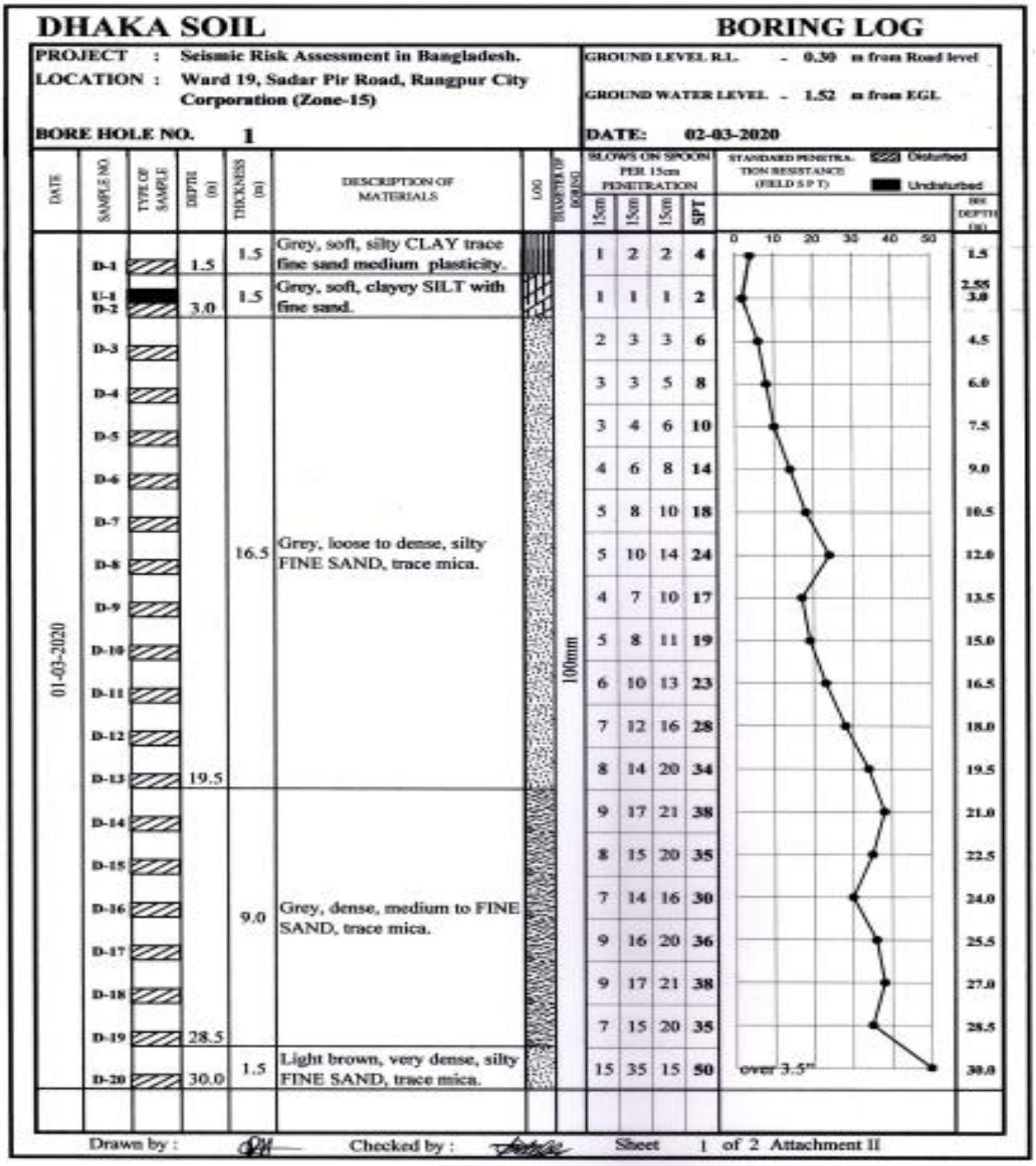
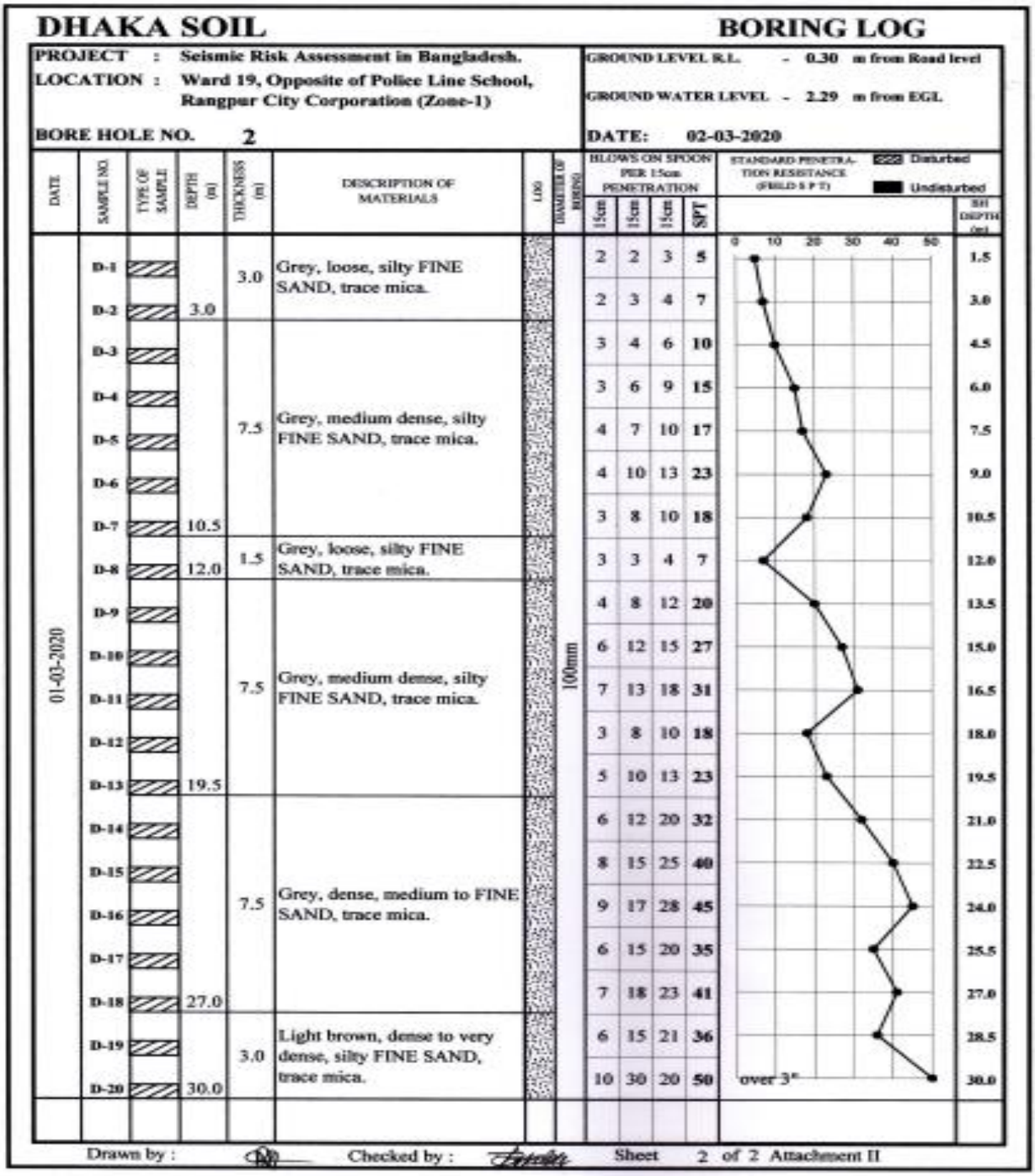


Figure 4.1: SPT data of Bore Hole 1



DHAKA SOIL — **BORING LOG**

PROJECT : Seismic Risk Assessment in Bangladesh.
LOCATION : Ward 19, Opposite of Police Line School, Rangpur City Corporation (Zone-1)
BORE HOLE NO. 2

GROUND LEVEL R.L. - 0.30 m from Road level
GROUND WATER LEVEL - 2.29 m from EGL
DATE: 02-03-2020

DATE	SAMPLE NO.	TYPE OF SAMPLE	DEPTH (m)	THICKNESS (m)	DESCRIPTION OF MATERIALS	BLOWS ON SPOON PER 15cm PENETRATION 15cm	15cm	15cm	SPT	MID DEPTH (m)
01-03-2020	D-1			3.0	Grey, loose, silty FINE SAND, trace mica.	2	2	3	5	1.5
	D-2		3.0			2	3	4	7	3.0
	D-3			7.5	Grey, medium dense, silty FINE SAND, trace mica.	3	4	6	10	4.5
	D-4					3	6	9	15	6.0
	D-5					4	7	10	17	7.5
	D-6					4	10	13	23	9.0
	D-7		10.5			3	8	10	18	10.5
	D-8		12.0	1.5	Grey, loose, silty FINE SAND, trace mica.	3	3	4	7	12.0
	D-9			7.5	Grey, medium dense, silty FINE SAND, trace mica.	4	8	12	20	13.5
	D-10					6	12	15	27	15.0
	D-11					7	13	18	31	16.5
	D-12					3	8	10	18	18.0
	D-13		19.5			5	10	13	23	19.5
	D-14			7.5	Grey, dense, medium to FINE SAND, trace mica.	6	12	20	32	21.0
	D-15					8	15	25	40	22.5
	D-16					9	17	28	45	24.0
	D-17					6	15	20	35	25.5
	D-18		27.0			7	18	23	41	27.0
	D-19			3.0	Light brown, dense to very dense, silty FINE SAND, trace mica.	6	15	21	36	28.5
	D-20		30.0			10	30	20	50	30.0

100mm

STANDARD PENETRATION RESISTANCE (FIELD S P T) — Disturbed / Undisturbed

0 10 20 30 40 50

over 3"

Drawn by : Checked by : Sheet 2 of 2 Attachment II

Figure 4.2: SPT data of Bore Hole 2

4.3 Microtremor Test

Microtremor test was conducted at one location of ward no. 19 of Rangpur City Corporation. The methodology has been stated in article 3.5 of Chapter 3.

Microtremor Analysis of Ward no. 19 of Rangpur City Corporation

Figure 4.4 shows the Amplitude vs Frequency graph for Ward 19 of Rangpur City Corporation. From the graph we can observe that the amplitude is maximum at around 1.2 Hz. So, the predominant frequency is around 1.2 Hz. Using empirical equation, the shear wave velocity of the 30 meter 1-D soil column was found to be around 144 m/s.

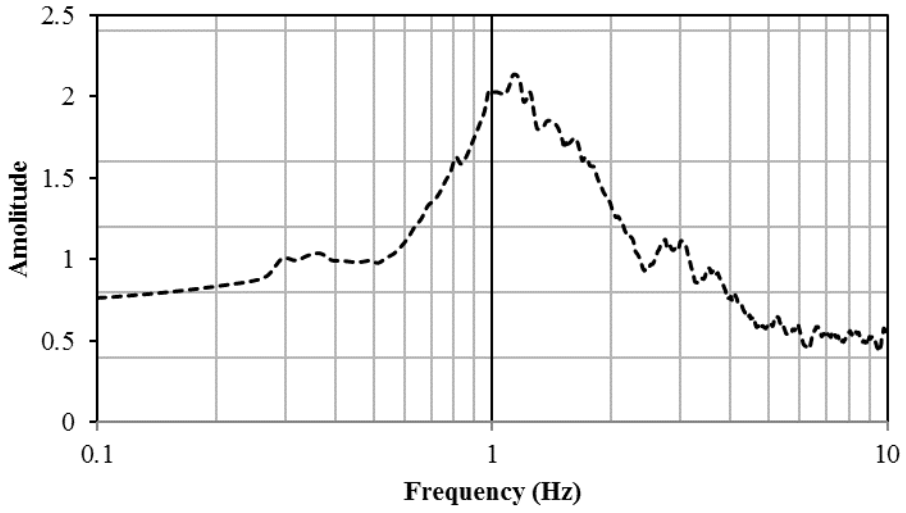


Figure 4.3: Amplitude vs Frequency graph of Ward no. 19 of Rangpur City Corporation

CHAPTER 5 : BUILDING VULNERABILITY ASSESSMENT

5.1 Introduction

In this chapter, the seismic vulnerability of the buildings of Ward No. 19 of Rangpur City Corporation has been discussed on the basis of Rapid Visual Screening of 284 buildings.

5.2 Preliminary Assessment using Rapid Visual Screening

The seismic vulnerability assessment of structures in the selected area has been done by RVS (Rapid Visual Screening) method formulated in FEMA P-154. In this method, the main focus was on earthquake issues such as identifying building type, plot size and shape, clear distances from surrounding structures, road width and basic information of the building: year of construction, number of storey, overhang, vertical irregularity, plan irregularity etc. Digital photographs of each building from at least two directions were taken.

5.3 Results and Discussion of Preliminary Vulnerability Assessment

In this section, results of the analysis are presented focusing on the main concerning point of the structure.

Table 5.1 shows the number of the total surveyed buildings of all 24 zones of Ward no 19 of Rangpur City Corporation. It has been observed that the final score of 84.5% of the total surveyed buildings were below cutoff (1.2) and thus these are vulnerable. Zone 8 has the lowest percentage of vulnerable buildings. Total eight zones (2, 3, 13, 15, 17, 19, 21 & 24) of twenty four zones show that all the buildings in these zones are vulnerable.

It was found that among the 284 surveyed buildings, 235 buildings are Concrete frame with unreinforced masonry infill walls (C3). 40 of the buildings are Unreinforced masonry building (URM) and only 9 of them are Concrete shear wall buildings (C2). Figure 5.1 shows the percentages of the different building types.

Table 5.1: Percentage of vulnerable buildings in different zones

Zone	Number of Building Surveyed	Number of Vulnerable Buildings	Percentage of Vulnerable Buildings
1	11	9	82%
2	19	19	100%
3	22	22	100%
4	31	24	77%
6	29	28	97%
7	13	9	69%
8	16	6	38%
9	18	16	89%
10	12	9	75%
11	11	8	73%
12	6	5	83%
13	11	11	100%
15	5	5	100%
17	7	7	100%
18	17	15	88%
19	7	7	100%
20	2	1	50%
21	7	7	100%
22	21	15	71%
23	12	10	83%
24	7	7	100%

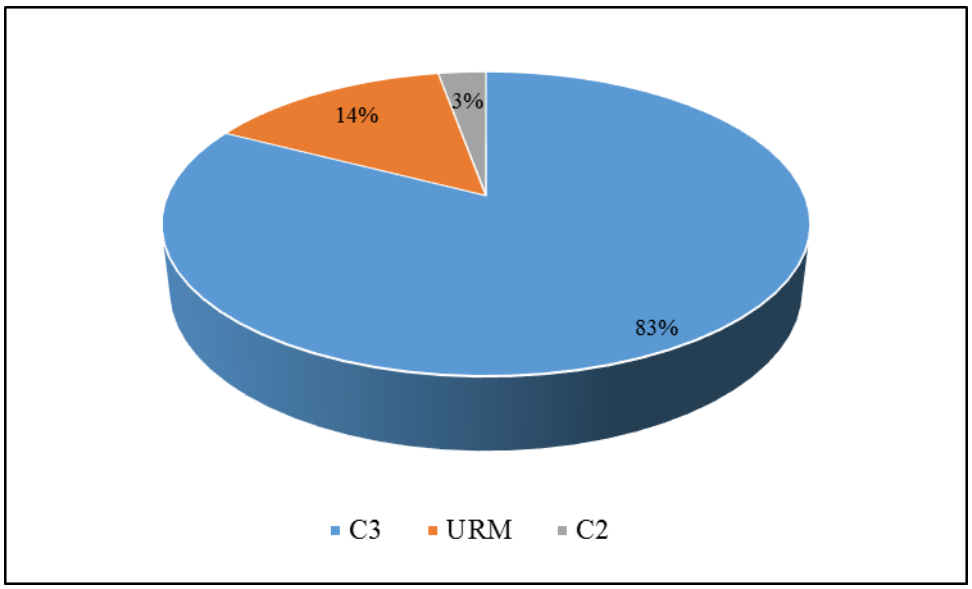


Figure 5.1: Building Classification percentage

Figure 5.2 represents relation between number of buildings and severe vertical irregularity which included any or all of the stated: short column, soft story/weak story and out of plane setback. It has been observed that 82% of the buildings which were surveyed had severe vertical irregularity. Figure 5.3 represents relation between number of buildings and moderate vertical irregularity (e.g. in plane setback, sloping site, split level). We saw that only 5% of the buildings had moderate vertical irregularity.

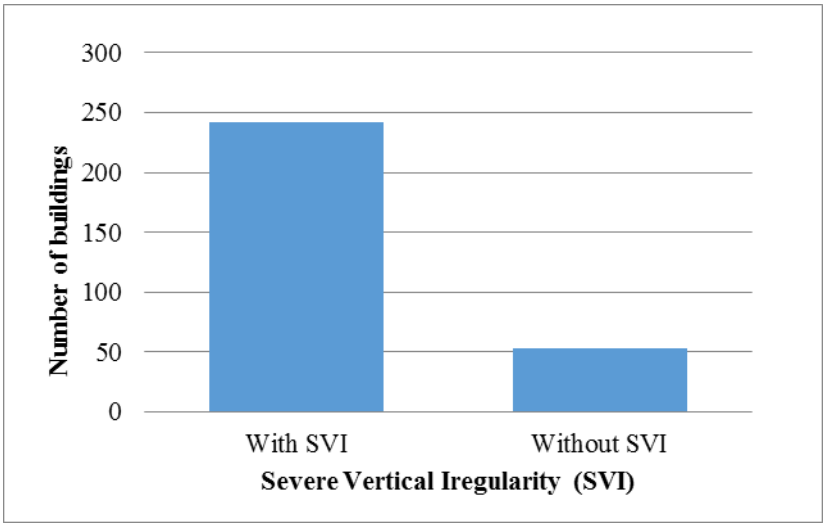


Figure 5.2: Relations between Number of buildings and Severe Vertical Irregularity

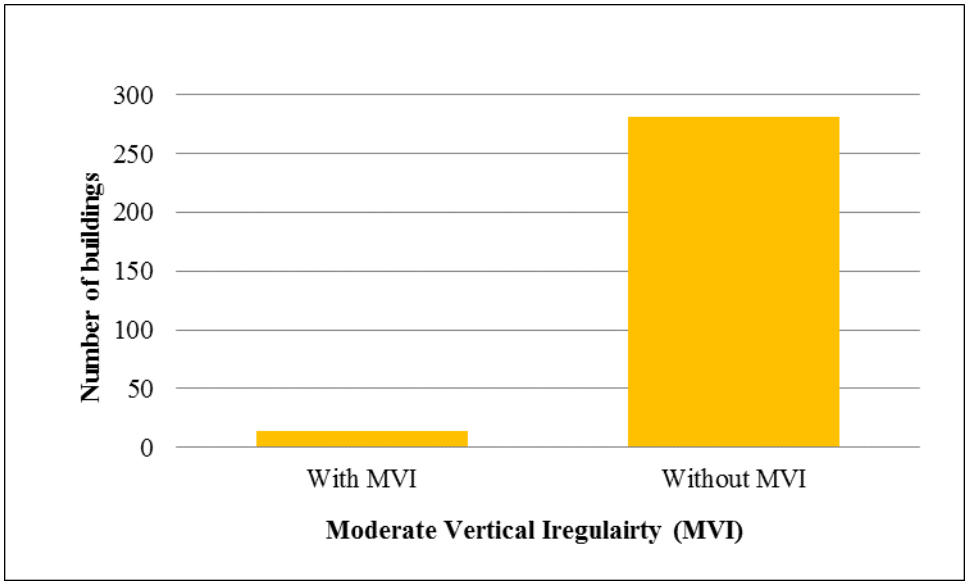


Figure 5.3: Relations between Number of buildings and Moderate Vertical Irregularity

Figure 5.4 represents relation between number of buildings and plan irregularity (e.g. torsional irregularity, non-parallel system, reentrant corner, diaphragm opening, out of plane offset) Only 3% of the buildings had shown plan irregularity.

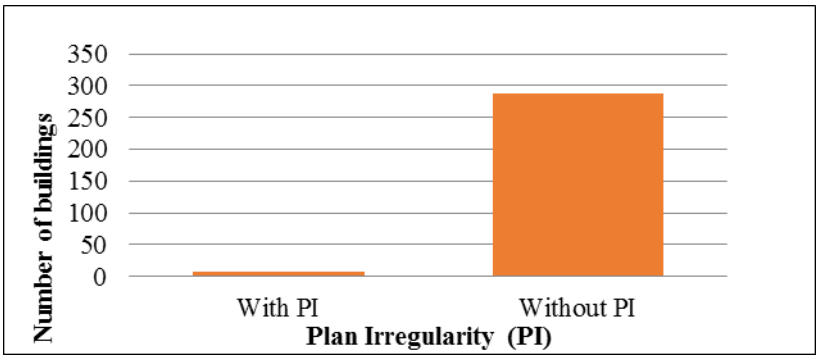


Figure 5.4: Relations between Number of buildings and Plane Irregularity

Figure 5.5 represents relations between number of buildings and the RVS score. This figure indicates that 38% of the buildings has a score less than or equal 0.3, 41% of the buildings has a score between 0.4 to 0.6, 2% of the buildings score in between 0.7 to 0.9, 9% of the buildings has score in between 1 to 1.2 and finally 6% of the buildings has score greater than 1.2.

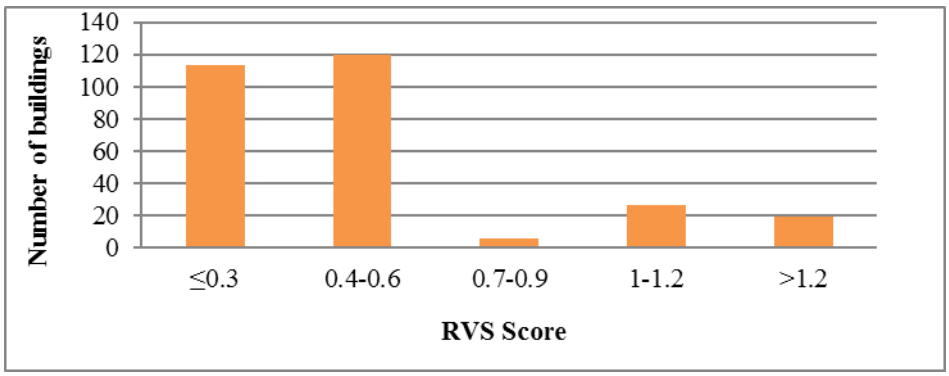


Figure 5.5: Relations between Number of buildings and RVS Score

Figure 5.6 shows the relation between numbers of buildings and number of storey. From this figure, it is clear that 4 storied building are predominant in the surveyed area and it is about 31% of the total sample size of ward no. 19. The second dominant type are the buildings with 3 stories and they are 24%. Percentage of 5 storey buildings is 11%. Only 12% of the surveyed buildings fall within the storey range of 6 to 12.

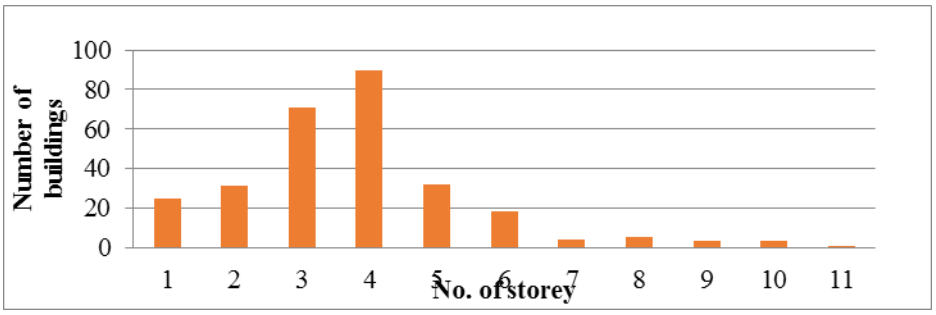


Figure 5.6: Relations between the number of buildings and no. of storey

CHAPTER 6 : SOCIO-ECONOMIC VULNERABILITY ASSESSMENT

6.1 Introduction

Socio-economic vulnerability of a community is defined as the condition of a community which have unequal participation in decision making process, weak or no community organizations; discriminative economic standard, social norms and values, political accountability, variation of income and production etc. (Mnestudies.com, 2018). It examines social and economic factors for better understanding of the how the combination of both influences an area of interest or study (Brouwer, 2018). A disaster like earthquake does not only damage or destroy buildings and infrastructures, but cause damage and destruction of centers of economic, cultural and social activities. By causing massive destruction to individual buildings, critical facilities, or economic and cultural centers, earthquake disturbs or destroys the existing inter-relationship and interaction between or among the different groups and activities of a society or a nation (ADPC, n.d.). Socio-economic vulnerability is greatest among the poorest people in developing countries due to lack of information and resources with in order to take the appropriate measures. Within this group, children, women and the elderly are considered to be the most vulnerable. To reduce such vulnerability, it is necessary to identify the knowledge and understanding of the local residents (Mnestudies.com, 2018). This chapter focuses on the analysis of socio-economic vulnerability of Ward No. 19 of Rangpur City Corporation. The socio-economic issues considered here include general profile of the respondents and their family members (age, sex, educational qualification, occupation, house ownership, earthquake training, data of physically challenged people etc.), perception regarding earthquake risk, perception about earthquake preparedness and their eagerness to get involve with these type of volunteering works etc. The analysis has been done on the basis of household questionnaire survey of 254 households which includes total 949 members.

6.2 General Socio-economic profile of surveyed population

To understand socio-economic profile of the study area, gender and age composition, occupation, education level and physical disability status of total 949 members of 254 households were analyzed. Additionally, monthly household income of 949 households were also analyzed.

Data of 949 individuals of 254 surveyed households who live in Ward 19 of Rangpur City Corporation was collected for the study through the method described in Chapter Three. It has been observed that distribution of male and female is very close and almost equal. So, there is no scope to exclude any gender group rather, special needs and requirements of both groups must be incorporated in different disaster management activities so that they can response in the case of any disaster.

Table 6.1 shows the distribution of the residents of Ward 19 according to their age group. For the convenience of analysis, the surveyed population has been divided into five age groups. They are children (<10 years), young (11-20 years), young adults (21-30 years), middle aged (31-60 years), and elderly (>60 years). It can be viewed from the table that, highest percentage (42%) of individuals among the surveyed household belong to age group 21-60. It is also necessary to note that a significant share of the population are children (12%) and elderly people (8%), who may require assistance after an earthquake.

Table 6.1: Distribution of respondents according to their age group

Age Group	**Number of residents**
Less than 10 years	31
11 to 20 years	43
21 to 30 years	53
31 to 60 years	107
More than 60 years	20
Total	**254**

Source: Field Survey, 2020

6.2.2 Occupation

Figure 6.1 shows the distribution of 949 members of the surveyed household according to their occupation. It is visible that, one third of the inhabitants of the area are students. So there is a wide scope to engage this group in disaster management activities through awareness building and proper training.

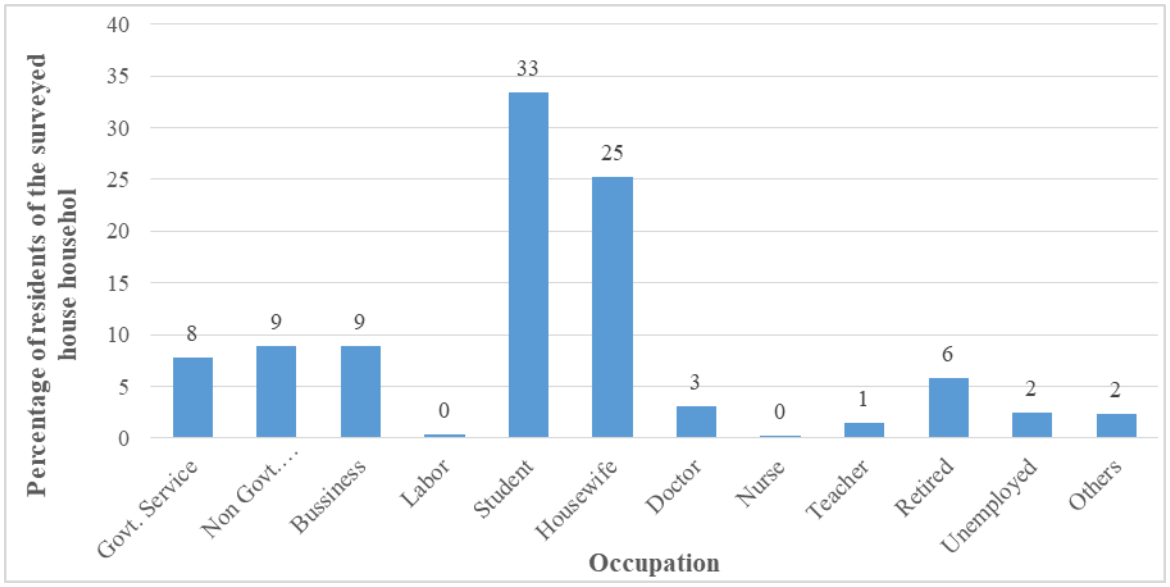


Figure 6.1: Distribution of household members according to their occupation (Source: Field Survey, 2020)

6.2.3 Educational Qualification

Figure 6.2 shows the distribution of educational qualification of 949 members of 255 households of the ward. The highest percentage of the people of this area is graduate (25%) followed by who studied up to secondary level (23%). Only 4% of the inhabitants of the surveyed households are illiterate where the national illiteracy rate in Bangladesh is almost 40% (UNESCO, 2008).

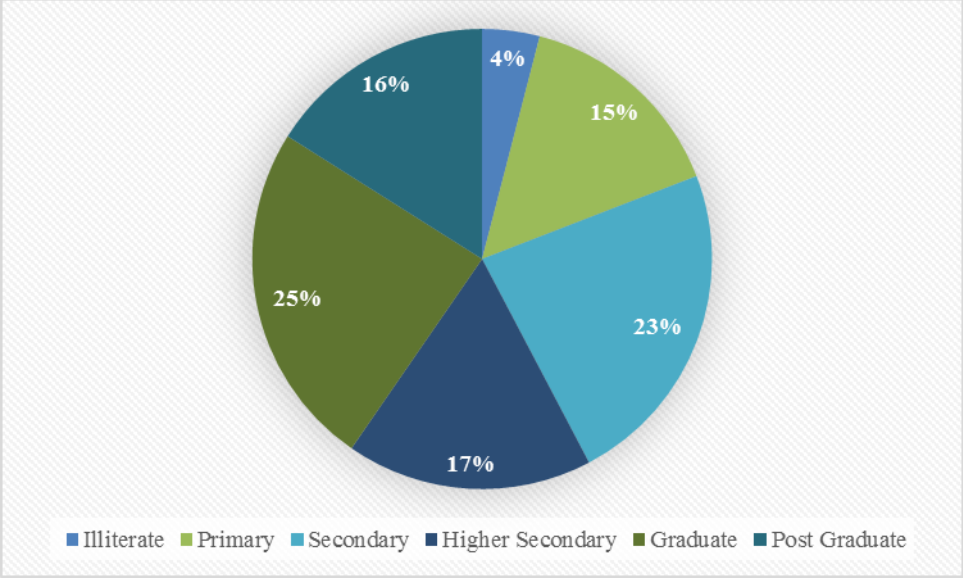


Figure 6.2: Distribution of household members according to educational qualification (Source: Field Survey, 2020)

6.2.4 Physically Challenged Population

People who are physically challenged or have special needs would require special care and attention after an earthquake. It has been found from the survey that only two persons among 949 people of the surveyed household are physically disabled. Though the percentage is very low, still it is important to consider them to ensure proper earthquake response. But it is understood that RCC should have data on all physically challenged people with the information on the address of the household they live.

6.2.5 People Having Earthquake Training

Among 949 people of surveyed 254 households, only 16 residents have some sort of training on earthquake. They were trained by Fire Service and Civil Defense, Red Crescent, Scouting and school level earthquake drill.

6.2.6 Household Monthly Income

Monthly income of majority portion of the households' surveyed (254 households) is less than 40,000 BDT (Figure 6.3). 17% household has monthly income of less than 20,000 BDT. More than 50,000 BDT per month is earned by 26% of the surveyed households.

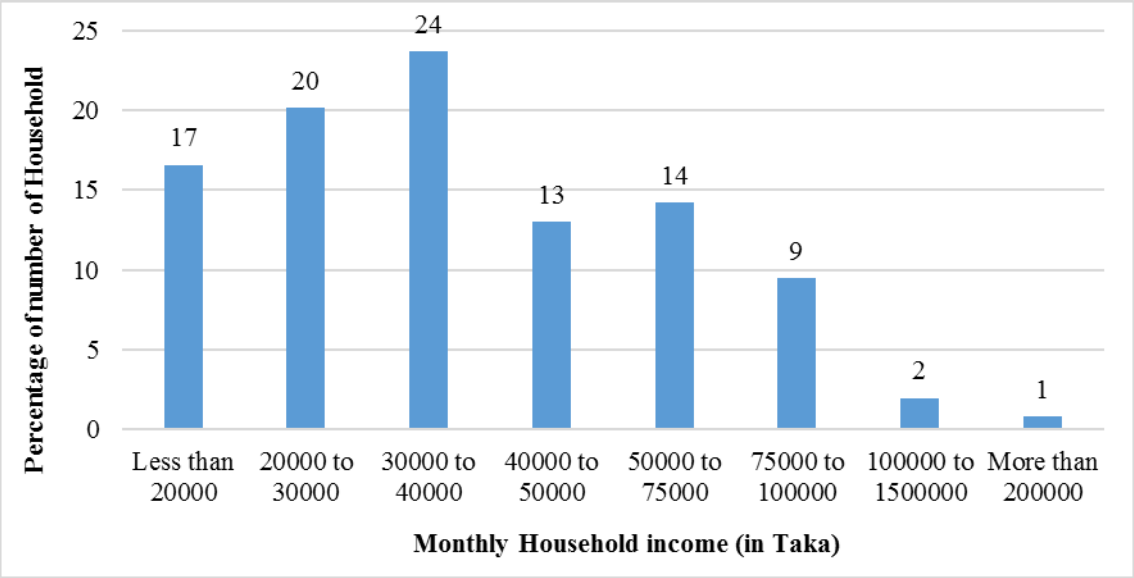


Figure 6.3: Distribution of monthly household income of the surveyed household (Source: Field Survey, 2020)

6.3 Peoples' Perception about Earthquake Vulnerability of the Area

The respondents were asked if they are aware of the earthquake vulnerability of their district. Though Rangpur is vulnerable to earthquake, only 39% (99 out of 254) responded that they are aware of this, which infers to the harsh truth that, majority of the respondents don't even

know about the earthquake risk they are facing. The finding states 61% (155 out of 254) of the respondents do not have any idea about the earthquake vulnerability of the area. They don't know the actual reasons and are not aware of the precautions that should be taken for earthquake resiliency.

6.4 Peoples' Perception about Earthquake Vulnerability of their Building

From previous discussion it is found that, 99 out of 254 (39%) respondents know about earthquake vulnerability of the area. But when respondents were asked whether they know about the earthquake vulnerability of their own buildings, only 11% (27 out of 254) of the respondents thought that they consider their buildings to be vulnerable to earthquake. As all data are not processed yet we could not verify that whether the buildings responded think are vulnerable is really vulnerable or not and vice versa.

6.5 People's Eagerness to Participate in Disaster Management Activities

Participation of community people in any disaster related activities is necessary for effective disaster management plan. Community level participation helps integrating with national and international level complement which is very important to ensure proper management after earthquake. Only 8% of the 254 respondents showed eagerness to get involved with the activities disaster management committee of their ward. It is expected that when all the data are processed BUET team could provide the detail breakdown of the nature and type of involvement.

CHAPTER 7 : CONTINGENCY PLAN FOR EARTHQUAKE IN THE STUDY AREA

7.1 Introduction

In this chapter, the preliminary earthquake contingency plan prepared to reduce the seismic vulnerability of Ward No. 19 of Rangpur City Corporation has been discussed. The aspects which were intended to consider are:

- Contingency Plan Area
- Temporary shelter: A place for peoples' temporary displacement caused by a disaster (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012).
- Emergency health facility: Formal health services (hospital, clinic etc.) to treat the moderate and severely injured people after an earthquake (CDMP, 2009b).
- Ward Co-ordination Center: Central command and control facility responsible for carrying out the principles of emergency preparedness and emergency management or disaster management functions at a strategic level during an emergency, and ensuring the continuity of operation at Ward level.
- Evacuation route: Safe routes in an area for immediate transfer of victims to safer places and shelters, take the injured to health facilities and to transfer relief to the temporary shelters and emergency health facilities after an earthquake (Argyroudis, Pitilakis & Anastasiadis, 2005).

As mentioned earlier, this is an ongoing project and preparation of final contingency plan will be done at the later phase of the project after analysis of necessary data and in consultation with local officials, residents and other stakeholders. As a consequence, this report presents the preliminary contingency plan which could not address all the components of the contingency plan at this phase of the project. The following aspects of contingency plan have been recapitulated in following sections:

- Temporary shelter
- Emergency health facility
- Ward co-ordination center

The other aspects will be covered in the final phase of the contingency plan.

7.2 Temporary Shelter

Temporary shelter planning for earthquake in the study area Ward No. 19 of Rangpur City Corporation has been done following three steps. They are: firstly, estimation of demand for temporary shelter; secondly planning temporary shelter supply to meet the estimated demand, and thirdly, planning for temporary shelter management including estimation of facilities to meet the need of the evacuees (i.e. water, toilet, first aid treatment, volunteer with first aid treatment training, first aid box) and institutional setup for management. These findings are discussed in the following sections.

7.2.1 Demand for Temporary Shelter

After the main shock of a severe earthquake, several aftershocks may take place in the same area. Experience in Nepal shows that people prefer not to return to their buildings irrespective of the building condition after the earthquake (Burke and Rauniyar, 2015). Moreover, some people may become homeless due to collapse/ severe damage to their buildings. Considering such contexts, two demand scenarios were considered in this study as mentioned in Chapter 3 (Section 3.11.1).

Demand Scenario 1: All residents of buildings which will be damaged or collapsed would need shelter.

Demand Scenario 2: All of the residents in the study area will require temporary shelter.

The population data of Ward 19 was collected from the Rangpur City Corporation office. The study area was divided into 24 clusters to collect the data and to prepare the community level plan, (Appendix B). The population of each clusters was calculated to estimate cluster wise demand for temporary shelter. For this purpose, it was assumed that, population is related to building density. So the total population of the Ward was distributed among the clusters according to the proportion of buildings in each cluster accordingly.

For Scenario 1, it is assumed that, the residents of the buildings which have been identified as unsafe according to the result of structural vulnerability assessment (RVS score) will require temporary shelter. Based on this assumption, it is estimated that around 8,819 people would need shelter in Demand Scenario 1. However, in Demand Scenario 2, all of the residents in the study area, around 11,468 people would require temporary shelter. According to Sphere Project (2011) per person space requirement for temporary shelter was considered 1.8 square

meters. Table 7.1 shows cluster-wise population and space requirement for shelter for both demand scenarios. Clusters of the study area have been illustrated in Appendix B.

Table 7.1: Space Requirement for temporary shelter considering Scenario-1 and Scenario-2

Cluster	Scenario 1		Scenario 2	
	Population requiring shelter	**Space requirement (in m^2) ***	**Population Requiring Shelter**	**Space requirement (in m^2)***
1	245	442	300	540
2	300	540	300	540
3	566	1019	566	1019
4	271	488	336	605
6	490	883	508	914
7	190	343	275	495
8	114	206	305	549
9	447	805	503	905
10	340	612	453	815
11	184	331	253	455
12	650	1170	780	1404
13	639	1150	639	1150
14	0	0	522	940
15	672	1210	672	1210
16	0	0	947	1705
17	955	1719	955	1719
18	524	942	589	1060
19	894	1609	894	1609
20	199	357	397	715
21	389	700	389	700
22	220	396	308	554
23	236	425	283	509

Cluster	Scenario 1		Scenario 2	
	Population requiring shelter	**Space requirement (in m^2) ***	**Population Requiring Shelter**	**Space requirement (in m^2)***
24	294	529	294	529
Total	**8819**	**15875**	**11468**	**20642**

* 1.8 m^2 in shelter is required per person according to Sphere Project (2011)

7.2.2 Possible Available Space for Temporary Shelter

It is evident from prevailing literature that large-park, playground and open space, and religious, educational and public buildings are used as temporary shelter (Xu, Okada, Hatayama, & He, 2006; World Bank Institution, 2012). From household questionnaire survey, it was also found that residents of this area prefer open space, playfield, government buildings, educational facilities, socio-cultural and urban service-related community facilities as temporary shelter. Thus, the open spaces and public buildings (i.e. religious, educational institutions, socio-cultural and urban service-related community facilities, government administrative buildings) have been considered to be used as temporary shelter in the study area. Primarily all the existing possible spaces for temporary shelters have been illustrated in Figure 7.1. Cluster-wise number and area of institutions and open spaces are showed in Table 7.2. Clusters of the ward has been shown in Appendix B.

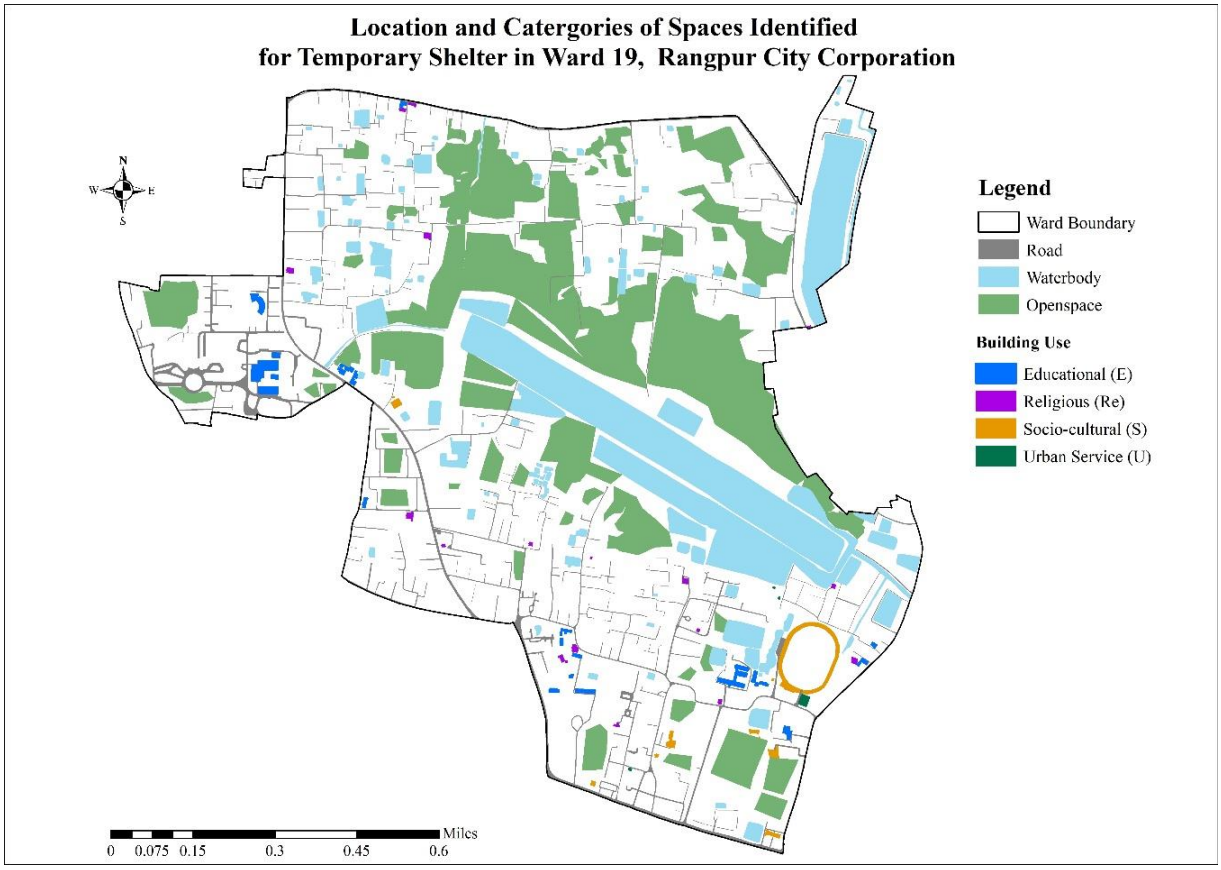


Figure 7.1: Map showing location of possible temporary shelter in Ward 19, Rangpur City Corporation (Source: Field Survey, 2020)

Table 7.2: Cluster wise Possible Spaces Identified for Temporary Shelter in Ward 19 of Rangpur City Corporation

Cluster	Educational Institution		Religious Institution		Community Facility		Area of Open Space (sq.m)
	Number	Area (sq.m)	Number	Area (sq.m)	Number	Area (sq.m)	
1	1	2823.32	0	0.00	2	675.63	36350
2	2	3584.91	2	785.77	2	482.02	8129
3	1	311.91	1	218.27	0	0	8678
4	1	19806.33	0	0.00	0	0	24649
6	0	0.00	1	1459.47	0	0	0
7	1	449.21	0	0.00	1	607.73	4877
8	0	0.00	1	94.17	0	0	2247
9	0	0.00	0	0.00	0	0	29187
10	0	0.00	0	0.00	0	0.	0
11	0	0.00	0	0.00	0	0	527
12	1	385.45	0	0.00	0	0	10592
13	0	0.00	1	607.46	0	0	3783
14	0	0.00	0	0.00	0	0	24819

Cluster	Educational Institution		Religious Institution		Community Facility		Area of Open Space (sq.m)
	Number	Area (sq.m)	Number	Area (sq.m)	Number	Area (sq.m)	
15	0	0.00	1	280.44	0	0	55670
16	0	0.00	0	0.00	0	0	47431
17	1	652.71	1	352.73	0	0	5449
18	0	0.00	0	0.00	0	0	54
19	0	0.00	1	111.80	0	0	11183
20	0	0.00	1	32.47	0	0	11016
21	0	0.00	0	0.00	0	0	0
22	1	6699.48	2	224.33	0	0	8182
23	1	559.28	1	548.69	1	7545.06	0
24	0	0.00	1	469.22	1	40.61	0
Total	**10**	**35272.61**	**14**	**5184.81**	**7**	**9351.05**	**292823**

Source: Field Survey, 2020

To get an overall view of the demand-supply scenario of Ward no 19, category wise total area of the temporary shelters from Table 7.2 has been calculated considering number of stories of the buildings and building footprint. It is evident from Table 7.1, under Demand Scenario 1 and Demand Scenario 2 at least 8,819 to 11,468 people will need shelter respectively. Table 7.3 shows an approximate idea on how much people can be accommodated in the existing and primarily selected temporary shelters. According the Table 7.3 about two lakhs people can be accommodated in the existing possible temporary shelters which is far above the requirement.

It needs to be noted that final selection of temporary shelters will depend on willingness of the owner of the building, floor plan of the structure, difficulty of converting the building to temporary shelter during need etc. In case of open space, weather condition (dry and wet seasons) is another important criterion. Moreover, due to road blockage, some of the identified temporary shelter may remain inaccessible at the event of an emergency. These issues will be discussed with the stakeholders during consultation workshops to finalize the list for temporary shelters.

Table 7.3: Population that can be served by primarily selected temporary shelters

Categories of Possible Temporary Shelters	Total Area (in square meter)	Population that can be Served by this Area*
Educational Institution	35272.61	19,596
Religious Institution	5184.81	2,880

Categories of Possible Temporary Shelters	Total Area (in square meter)	Population that can be Served by this Area*
Community Facility	9351.05	5,195
Open Space	292823	1,62,679
Total	**342631.47**	**1,90,351**

Source: Field Survey, 2020 (* 1.8 sq. m area per person)

7.2.3 Temporary Shelter Management

Temporary Shelter Management Committee (TSMC) is responsible to conduct different tasks like food preparation, primary medical care etc. Figure 7.2 shows the structure of Temporary Shelter Management Committee (TSMC) and their activity at different phases of earthquake management. Total 31 temporary shelters have been identified in the area, 10 of them are educational institutions, 14 are religious places and seven of them are community facilities. About 72 acres open spaces and playgrounds have also been identified. A team of total twelve members headed by a manager and one assistant manager needs to be constituted for one TSMC. Again, one TSMC is proposed for temporary shelter which would accommodate more than 100 persons. The shelters which accommodate less than 100 people would form a group so that the combined inhabitants of the shelters are more than 100.

The manager and assistant manager of this committee would act as leaders to manage the temporary shelter. They would not only co-ordinate tasks among the members of the team but would regularly maintain contact with Ward Co-ordination Center in the aftermath of the earthquake. The manager of TSMC would preferably be a member of Ward Disaster Management Committee (WDMC) (Figure 7.2). All other members of the committee must be residents of Ward No. 19 of Rangpur City Corporation. The members should be educated and well-informed about the vulnerability of the area. Each member should be familiar with the building or space to be used as temporary shelter: its size, facilities, and day-to-day level of supplies.

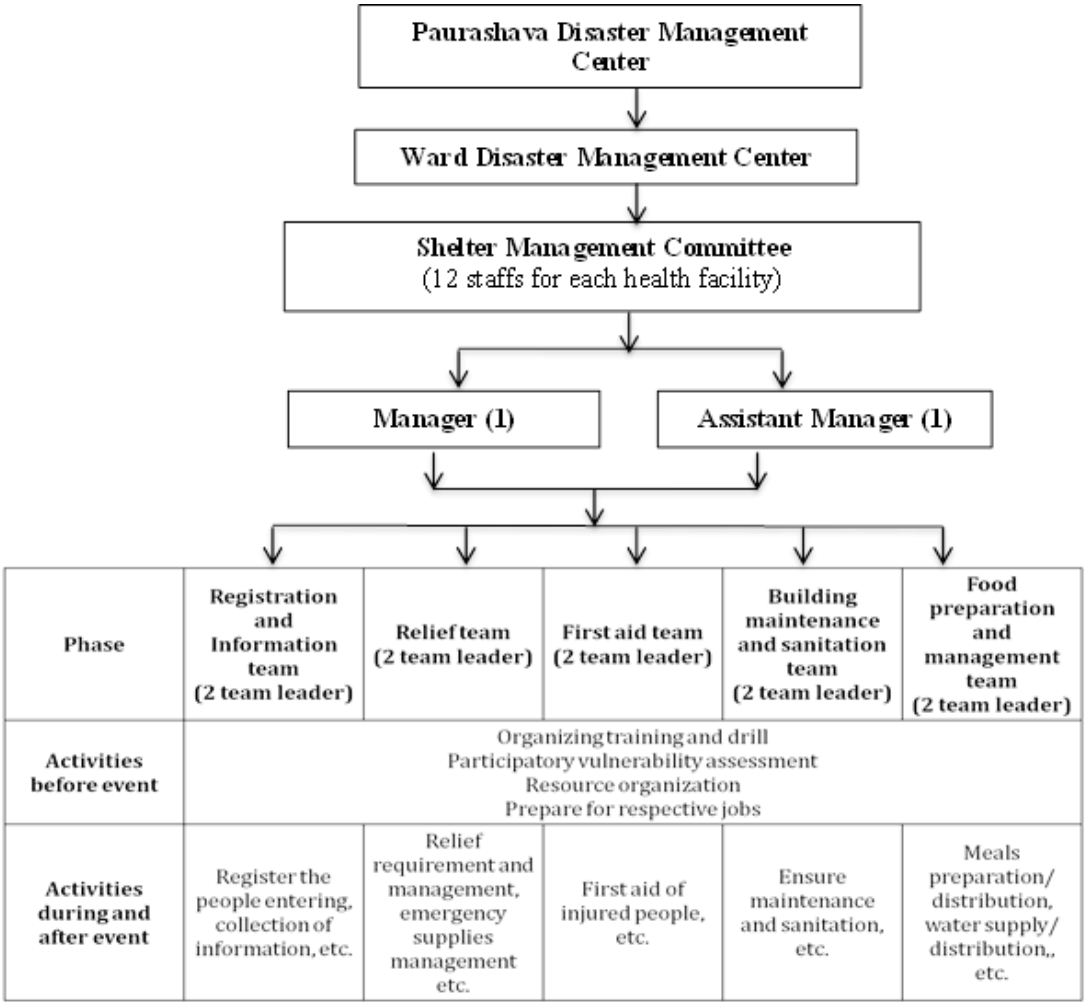


Figure 7.2: Structure of Temporary Shelter Management Committee (TSMC) and their activity at different phases of an earthquake (Source: Adapted from Barua, Tasneem, and Azad, (2014))

For an educational institution, the principal (or Head Master) and vice principal (Assistant Head Master) or others designated by them may be the manager or assistant manager of the temporary shelter. The regular staff working in the building such as office and maintenance staff can also be involved in management committee, as they have the complete knowledge of the facility and can best safeguard against damage and misuse. If necessary, volunteers can be engaged to serve the purpose.

The members and others involved in the committee should be properly trained and their activities and responsibilities at different phases of disaster should be assigned. Regular monitoring and maintenance should be done. The assigned members should also keep contact with the Ward Co-ordination Center and other agencies and institutions if necessary. All the members of the team should regularly meet (at least once in three months) to keep updated about the responsibilities.

7.3 Emergency Health Facility

Emergency health facility planning for earthquake in the study area Ward No. 19 of Rangpur City Corporation is intended to be done following three steps.

- estimation of demand for emergency health facility;
- planning emergency health facility supply to meet the estimated demand,
- planning for emergency health facility management.

At this stage of research, supply estimation and planning for management of emergency health facility have been done. Rest of the planning would be incorporated in further analysis. The findings so far are discussed in the following sections.

7.3.1 Possible Available Space for Emergency Health Facility

Emergency health facilities were identified as per the requirement mentioned in Chapter 3 (Section 3.11.2). Figure 7.3 shows the existing health facilities of Ward 19 and clusters of the ward has been shown in Appendix B. Table 7.4 shows cluster-wise number and area of existing health facilities in the study area which are primarily being considered as possible emergency health facility. It is observed that, in most of the clusters health facilities are absent, these facilities actually are grouped in certain locations.

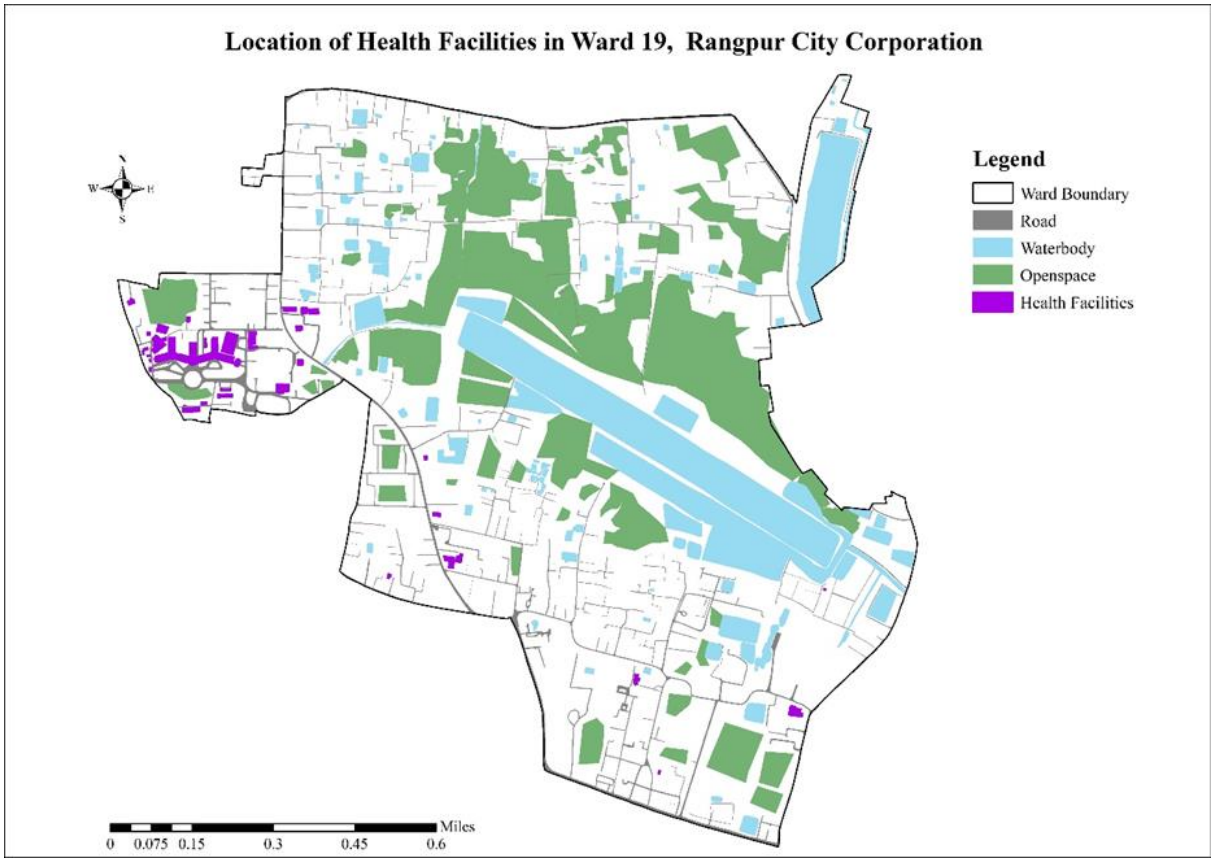


Figure 7.3: Map showing location of health facilities in Ward 19, Rangpur City Corporation

Table 7.4: Cluster wise Health Facilities in Ward 19 of Rangpur City Corporation

Cluster No	Number of Health Institution	Area of Health Institution (in sq. m)
1	1	2760.13
2	1	342.04
3	1	296.03
4	3	64516.90
5	0	0
6	2	10559.10
7	0	0.00
8	1	4214.61
9	0	0.00
10	0	0.00
11	2	677.77
12	0	0.00
13	0	0.00
14	0	0.00
15	0	0.00
16	0	0.00
17	0	0.00
18	0	0.00
19	0	0.00
20	0	0.00
21	0	0.00
22	0	0.00
23	0	0.00
24	0	0.00
Total	**11**	**83366.57**

Source: Field Survey, 2020

Table 7.4 shows that, cluster no. 4 has the highest amount of spaces for health facilities because Rangpur Medical College Hospital falls in this cluster. Though, in the preliminary stage of making contingency plan it is considered in the existing facilities, but in the later stages of plan making Rangpur Medical College Hospital will not be considered as emergency health facility for earthquake for the study area considering its regional importance and large service area. Additionally, it must be remembered that final selection of emergency health facility will depend on the structural vulnerability of the facility buildings considered to be used for emergency health facility. Moreover, due to road blockage, some of the identified emergency health facility may remain inaccessible at the event of an emergency. These conditions will lead to exclusion of some possible emergency health facility. Emergency health facilities will be finalized later incorporating all these issues.

7.3.2 Emergency Health Facility Management

Figure 7.3 shows the structure of Emergency Health Facility Management Committee (EHFMC) and their activities at different phases of earthquake management. In the study area 24 buildings are identified as possible location for emergency health facilities (Figure 7.3). A team of total 12 members headed by a manager and one assistant manager needs to be constituted to form one EHFMC.

As commercial facilities, the health facilities of the study area already have management committee of their own. So to avoid conflict, the management of the existing facilities should be incorporated in the EHFMC. The manager and assistant manager of this committee would act as leaders to manage the emergency health facility. They would not only co-ordinate tasks among the members of the team but would regularly maintain contact with Ward Co-ordination Center in the aftermath of the earthquake. The manager of EHFMC would preferably be a member of Ward Disaster Management Committee (WDMC). All the members of the team should regularly meet (at least once in three months) to keep updated about the responsibilities.

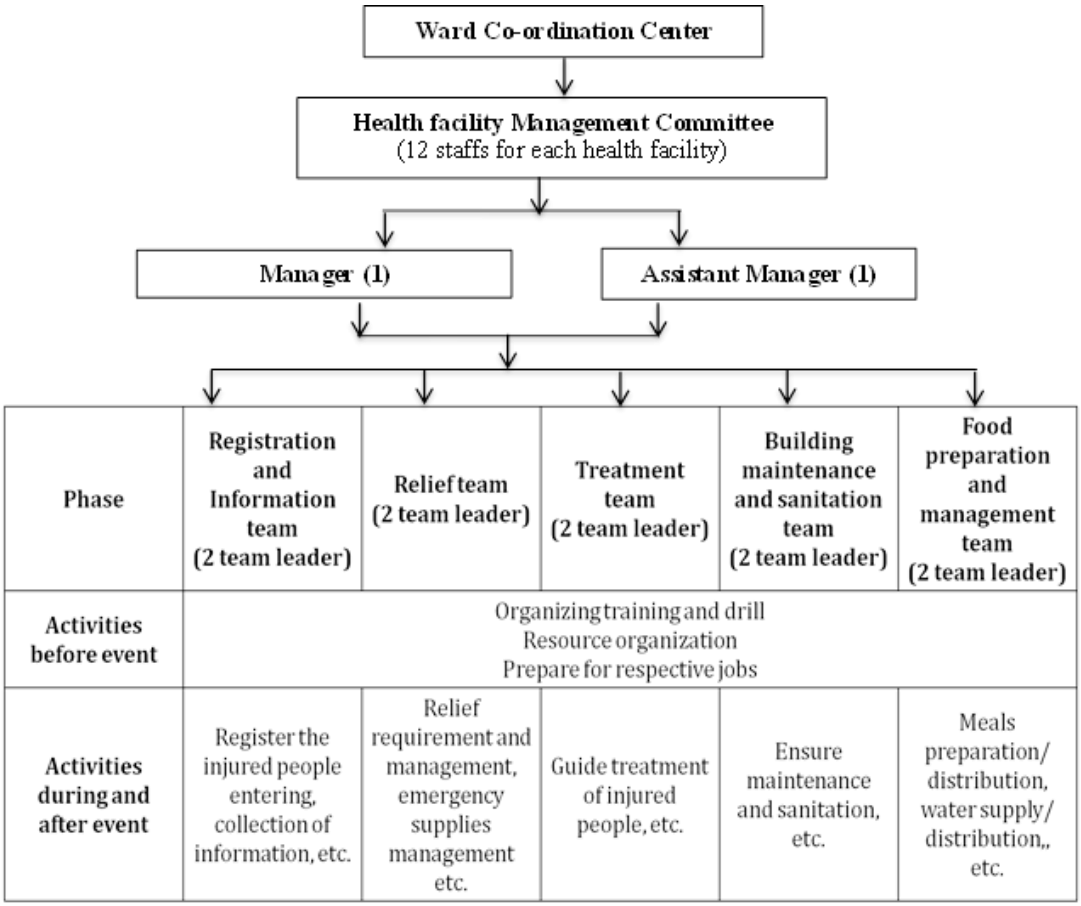


Figure 7.4: Structure of Emergency Health Facility Management Committee (EHFMC) and their activity at different phases of an earthquake (Source: Adapted from Barua, Tasneem, and Azad, 2014)

7.4 Ward Co-ordination Center

One of the important tasks during and after any disaster is to coordinate the different activities of management. Tasks performed by different government agencies, private organizations, volunteers, and individuals are needed to be coordinated to get the maximum benefit. In addition, WDMC needed a place to coordinate the works. For this co-ordination, Ward Co-ordination Center (WCC) is proposed to be formed in the study area. In the following sections, proposed location and institutional setup for Ward Co-ordination Center are described. Among the identified 11 safe public buildings, one will be used as Ward Co-ordination Center. As mentioned earlier, the research team is still working on building vulnerability data as well as to identify the exact location of Co-ordination center the discussion with local people and stakeholders are necessary, so selection of the building to be used for WCC is under process. Moreover, final vetting of the contingency plan will be done in consultation with local people.

7.4.1 Institutional Setup and Management Activities

Figure 7.5 shows the structure of Ward Co-ordination Center Committee. Each team should contain two team leaders, but to manage the process properly each team will require more team members.

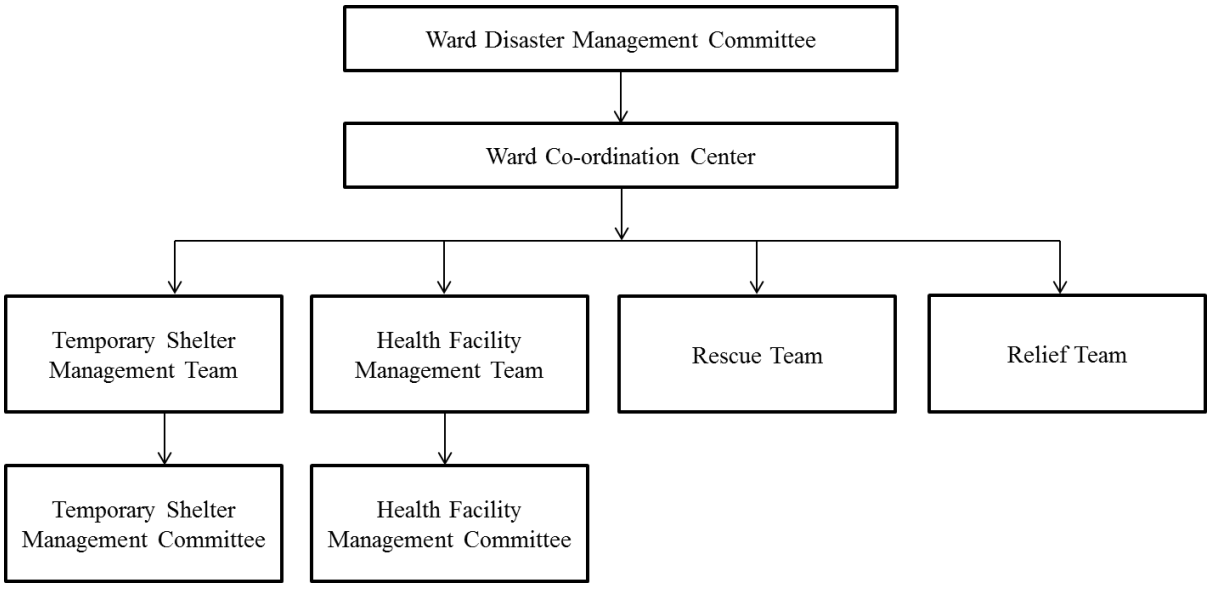


Figure 7.5: Structure of Ward Co-ordination Center Committee

All the members of the committee should meet once in three months to keep update about the responsibilities and should keep a link with the WDMC, TSMC, and EHFMC.

The committee consists of the following teams.

Temporary Shelter Management Team: Co-ordinate with all the TSMC.

Health Facility Management Team: Co-ordinate with all the EHFMC.

Rescue team: To take part in the rescue operation

Relief team: To collect, manage and distribute reliefs in temporary shelters and emergency health facilities

7.4.2 Criteria for Selecting Members

All the members of the committee should be residents of the area i.e. Ward No 19 and representatives from all the clusters should be ensured. Each member should be familiar with the area. A representative from the bureaucracy of Rangpur City Corporation should also be the member of the committee. This will increase credibility and effectiveness of the committee. It is also desirable that at least one member of the owners of these private medical facilities should be co-opted in the health facility management team under this committee. The BUET team suggests there should be at least three members from the private medical facilities representing hospitals, clinics, and diagnostic centers accordingly. The members and others involved in the committee should be properly trained and their activities and responsibilities at different phases of disaster will be assigned. The assigned members should keep contact with TSMC and EHFMC, other agencies and institutions

7.4.3 Activities of Ward Co-ordination Center Committee at Different Phases of an Earthquake

To be prepared, the committees have to regularly meet and perform task before the disaster. Similarly, they have some task during and after the disaster. The following provide a tentative list of tasks the committees would perform.

a) Activities before Disaster

- A systematic program for the inspection, maintenance, and repair of buildings identified as temporary shelters and emergency health facilities at regular interval at the community level by building maintenance and rehabilitation team
- Storage of equipment and emergency supplies
- Proper dissemination of the prepared plans at the community level by victim registration and information team
- The training program at community level at a regular interval
- The arrangement of community awareness program at a regular interval such as disaster drills, emergency training, community meetings etc.

- Preparation of volunteer list at the community level and updated it at regular interval
- Distribution of activities of volunteers
- Training of volunteers based on their activities

b) Activities within 72 Hours of an Earthquake Event

- Evacuation of the people to the predefined evacuation space.
- The arrangement of necessary reliefs by the relief management team.
- Search and rescue of people by the search and rescue team.
- Disaster victim registration and segmentation of the victims according to their need for health facility and shelter requirement.
- Assessment of the suitability of the pre-identified temporary shelters and emergency health services by building maintenance and rehabilitation team. If any of the pre-identified temporary shelters and emergency health services are proved to be unsuitable, then initiative should be taken to identify alternative places to provide temporary shelter and emergency health facility.
- Assessment of the pre-identified evacuation routes (to reach the shelters and health services) to find out whether they are open or not. If required, new evacuation routes should be identified or adjustments should be done. The routes that must be opened to support health, shelter and relief operation should be given priority while clearing debris.
- The arrangement of the identified shelters with designated TSMC according to the plan for receiving people.
- Preparation of the designated emergency health facilities with designated EHFMC along with all the doctors and nurses to serve the injured people.
- The arrangement of inventory and equipment supply at Ward Co-ordination Center.

c) Activities from 72 Hours to 14 Days of an Earthquake Event

- Continue search and rescue operation
- Continue disaster victim registration
- Initiation of temporary shelter operation. The victims should be brought from the evacuation space and directly from the rescue spot to a temporary shelter. Necessary first aid should be provided to the injured people. The designated shelter management team should manage the shelter along with the help of the evacuees. Need for supplies and equipment should be estimated properly.

- Provide treatment to the injured people accordingly in the designated emergency health facilities.
- Collection of reliefs assigned to the community by the relief team from government agencies, NGOs, international organizations etc. From the center, reliefs should be distributed to the temporary shelters and the emergency health facilities according to the requirement. In the center, there should be food preparation facility. Here food for the victims should be prepared, where food preparation standards should be observed. The prepared food should be disseminated in nearby shelters and health facilities as required.
- Establishment of necessary extra emergency setups
- It will not be possible to construct permanent houses immediately. So, initiatives to construct transition shelters should be taken.

d) Activities from 14 Days to 60 Days of an Earthquake Event

- Full shelter capability should be maintained.
- The facilities of emergency health facilities should be continued.
- Relief management should be continued
- Construction of transition shelter should be initiated and completed
- Transfer of victims from temporary shelter to transition shelters or the repaired residential houses should be initiated**.**

e) Activities from 60 Days to One Year of an Earthquake Event

- The transfer of victims from temporary shelter to transition shelters or the repaired residential houses should be completed.
- The temporary shelters should be closed and the regular activities should be started.
- The construction work of permanent shelters should be started. The shelters should be allocated on land where the beneficiaries lived before the earthquake, promoting the return of displaced people to their places of origin.

The transition of families to permanent housing should be initiated (Xu, Okada, Hatayama, & He, 2006).

7.5 Preparedness at Household Level

It should be bear in mind that the basic foundation of any earthquake contingency plan starts from household level. The countries who experience earthquake frequently (for example

Japan) has developed plans to be carried out by the households if an earthquake strike. They ensured that the households are prepared by continuously running mock drill. The following should be done to prepare the households for an earthquake. Some of these should be done by households themselves, some are by WCC.

- Households in the study area should attend earthquake awareness programs arranged by the Ward Co-ordination Center
- Different workshops and training should be organized to train them about how to respond during and immediately after an earthquake, e.g.
    - If inside home, turn off electricity, gas and water line.
    - Drop down; take cover under a desk or table and hold on.
    - Secure from heavy objects, windows, hanging objects etc.
    - Avoid stairs until shaking stops
    - If outside home; get into the open, away from buildings, power lines, and trees.
    - Be alert for debris that could be loosened by the earthquake.
- Households should identify the objects in the house that can fall down and can cause a loss in an earthquake. Then plan to address the hazards, e.g. fix items to sturdy walls or grounds.
- All members of the family should be prepared to respond appropriately in the event of an earthquake. If a disaster takes place and the family members are in a different place of the area they must be prepared to reunite in a fixed location. A family emergency plan should be developed and practiced regularly. Keep contact with family members living in a distant place and let them informed about the plan.
- After an earthquake, there will be disruption of the regular supply system of drinking water, food, electricity etc. In this situation, each family needs to survive before external help arrives. Having sufficient amount of own food, water, and other supplies may reduce the vulnerability. An emergency kit is a collection of basic items that member of the household may require during a disaster like an earthquake. To prevent food and water from going tale the bag is needed to be refurbished in every 4 months. It may contain-
    1. Water
    2. Non-perishable food (peanuts, dry fruits, energy drinks: Glucose, Instant coffee and tea bags, sugar, salt, pepper)
    3. If a family member has a special need (a child, ill or elderly people) then store for the persons need

4. Helmet
5. Portable radio, flashlight, and extra batteries
6. Screwdriver, pliers, hammer, adjustable wrench
7. Pocket knife, whistle
8. Cash
9. First aid box (Roller bandages of different sizes, a pack of cotton, Small scissors, Antiseptic solution, Antiseptic cream, Oral re-hydration solution, Gauze pieces- small and large, Pain-killer tablets, prescribed medicines, Sterilized dressing: Small and large splints made up of wood or bamboo sticks)
10. Copies of valuable documents

CHAPTER 8 : CONCLUSION

It should be bear in mind that contingency plan is neither a stand-alone document nor a static document. It should be an ongoing process integrated and coordinated with activities suggested by other documents. It is well understood that earthquake would cause damaged at regional scale. So contingency plan at regional scale should be prepared. But the issue which bear the highest importance is to count the effect of an earthquake on spatial dimension at local level. Though CDMP (2014) prepared a contingency plan for Rangpur City which gave importance on institutional activities and less focus on local level panning. Though the work on this ward is not completed yet, involvement of local level planning and community participation will be ensured in the next stages. However, for successful implementation of the contingency plan, this kind of plan needed to be prepared for the other wards of the city corporation.

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APPENDIX A

Questionnaire for Social Survey

রংপুর সিটি কর্পোরেশন এর এলাকা ভিত্তিক ভূমিকম্প ঝুঁকি নিরসন এবং ব্যবস্থাপনা

প্রশ্নপত্র নম্বর _____ তারিখ _____

বিল্ডিং আইডি _____ ওয়ার্ড নং _____

প্রশ্নকারীর গ্রুপ_____ ক্লাস্টার নং _____

হোল্ডিং নং _____

১। উত্তরদাতার সাধারণ তথ্য

১.১ উত্তরদাতার নাম _____

১.২ আবাসিক ভবনের মালিকানা (√চিহ্ন দিন)

- সরকারী
- বেসরকারী (ব্যক্তিগত)
- বেসরকারী (যৌথ মালিকানাধীন)

১.৩ ভবনটি নির্মাণ এর সাল _____

২। পরিবারের তথ্য (আবাসিক ভবনের ক্ষেত্রে)

২.১ পরিবারে সদস্য সংখ্যা _____

২.২ পরিবারের সদস্যদের বিস্তারিত বিবরন

সদস্য ক্রম	বয়স	লিংগ	শিক্ষাগত যোগ্যতা	পেশা	প্রতিবন্ধী আছে কি ? (হ্যাঁ/ না) প্রতিবন্ধকতার ধরন	ভূমিকম্প নিয়ে কোন সদস্যের প্রশিক্ষন আছে?(হ্যাঁ/ না)
১*						
২						
৩						
৪						
৫						
৬						
৭						
৮						

* উত্তরদাতা নিজে ১ম সদস্য হিসেবে বিবেচিত হবেন

বয়স	লিংগ	শিক্ষাগত যোগ্যতা	পেশা		প্রতিবন্ধকতার ধরন
১০ বছরের কম = ১ ১১ – ২০ বছর = ২ ২১ – ৩০ বছর = ৩ ৩১ – ৬০ বছর = ৪ ৬০ বছরের বেশী = ৫	পুরুষ = ১ মহিলা = ২ অন্যান্য = ৩	নিরক্ষর = ১ প্রাথমিক = ২ মাধ্যমিক = ৩ উচ্চ মাধ্যমিক = ৪ স্নাতক = ৫ স্নাতকোত্তর = ৬	সরকারি চাকুরি = ১ বেসরকারী চাকুরি = ২ ব্যবসা = ৩ শ্রমিক = ৪ ছাত্র = ৫ গৃহিণী = ৬	ডাক্তার = ৭ নার্স = ৮ শিক্ষক = ৯ অবসরপ্রাপ্ত = ১০ বেকার = ১১ অন্যান্য = ১২	মানসিক প্রতিবন্ধী = ১ শারীরিক প্রতিবন্ধী = ২ বাক প্রতিবন্ধী = ৩ দৃষ্টি প্রতিবন্ধী = ৪ অন্যান্য = ৫

২.৩ যদি কোন সদস্য ভূমিকম্প বিষয়ক প্রশিক্ষণ নিয়ে থাকেন তবে তার সাথে যোগাযোগ স্থাপনের জন্য মোবাইল নং _____

২.৪ উত্তরদাতার ভবনে মালিকানার তথ্য

- বাড়িওয়ালা
- ভাড়াটিয়া
- অন্যান্য

২.৫ এই পৌরসভা/ সিটি কর্পোরেশনে কত বছর যাবত আছেন ? _____

২.৬ পরিবারের মোট মাসিক আয় (টাকায়)

- ২০,০০০ এর কম
- ২০,০০০ – ৩০,০০০
- ৩০,০০০- ৪০,০০০
- ৪০,০০০- ৫০,০০০
- ৫০,০০০-৭৫,০০০
- ৭৫,০০০- ১,০০,০০০
- ১,০০,০০০-১,৫০,০০০
- ১,৫০,০০০-২,০০,০০০
- ২,০০,০০০ এর বেশি

৩ উত্তরদাতার ভূমিকম্প বিষয়ক সচেতনতা, জ্ঞান এবং ধারনা

৩.১ আপনি কি ভূমিকম্প সম্পর্কে জানেন?

- হ্যাঁ
- না

৩.১.১ হ্যাঁ হলে, ভূমিকম্প বিষয়ে আপনি কি জানেন? (খোলা প্রশ্ন** এবং একাধিক উত্তর গ্রহণযোগ্য)

- এটি একটি প্রাকৃতিক দুর্যোগ
- পৃথিবীর স্থলভাগ যে প্লেট দিয়ে নির্মিত তার নড়াচড়ার কারনে এটি হয়
- ভূমিকম্পে বাড়িঘর কাপতে থাকে
- অবকাঠামোগত ক্ষতি হয়
- ভূমিকম্পে মৃত্যুঝুকি রয়েছে
- কোনটি নয়
- অন্যান্য (উল্লেখ করুন) _____

৩.২ ভূমিকম্প হলে কি করতে হয়/ করবেন? (খোলা প্রশ্ন** এবং একাধিক উত্তর গ্রহণযোগ্য)

- কাঠের কিছুর নিচে লুকাবো
- দেয়াল/শক্ত পিলারের পাশে দাড়াবো
- মাথায় বালিশ/ কম্বল ইত্যাদি রাখবো
- দ্রুত ভবন থেকে নেমে যাবো
- ছাদে চলে যাবো
- ইলেক্ট্রিসিটি/গ্যাসের লাইন বন্ধ করবো
- খুব ভয় পেয়ে যাবো
- কিছুই করবো না
- অন্যান্য (উল্লেখ করুন) _____

**খোলা প্রশ্নসমূহে উত্তরদাতাকে কোন বিকল্প (option) দেওয়া হবে না

৩.৩ আপনি কিভাবে ভূমিকম্প সম্পর্কে এসব জানতে পেরেছেন (নিম্নোক্ত বিকল্প গুলোর মধ্যে নির্বাচন করুন এবং একাধিক উত্তর গ্রহণযোগ্য)

- গণমাধ্যম (টিভি / রেডিও ইত্যাদি)
- সংবাদপত্র/ লিফলেট
- স্কুল কলেজের বইপত্র
- স্কুল-কলেজ বা কোন প্রতিষ্ঠানের ভূমিকম্প বিষয়ক ড্রিল
- পরিবারের সদস্যদের সাথে কথা বলে
- এলাকার লোকজন/ প্রতিবেশীর সাথে কথা বলে
- ভূমিকম্প বিষয়ক অনুষ্ঠান/ কর্মশালার মাধ্যমে
- নিজে থেকেই জেনেছি
- সামাজিক যোগাযোগের মাধ্যম থেকে
- অন্যান্য (উল্লেখ করুন) _____

৩.৪ ভূমিকম্পের ঝুঁকি নিরসনে সক্ষমতা এবং সচেতনতা বৃদ্ধির জন্য নিম্নোলিখিত মাধ্যমগুলির মধ্যে কোন তিনটিকে সবচেয়ে বেশি পছন্দ করেন ক্রম উল্লেখপূর্বক প্রকাশ করুন

মাধ্যমের তালিকা	**ক্রম**
গণমাধ্যম ((টিভি / রেডিও ইত্যাদি)	
সংবাদপত্র/ লিফলেট	
বিভিন্ন সাংস্কৃতিক পরিবেশনা (নাটক / গান)	
ভূমিকম্প বিষয়ক এলাকা/ পাড়া ভিত্তিক সভা/ কর্মশালা	
ভূমিকম্প বিষয়ক ড্রিল/ ট্রেনিং	
অন্যান্য (উল্লেখ করুন) _____	

৩.৫ আপনি কি আপনার এলাকার ভূমিকম্প ঝুঁকি সম্পর্কে জানেন?

- হ্যাঁ
- না

৩.৫.১ হ্যাঁ হলে, আপনার এলাকাকে ভূমিকম্পের জন্য ঝুঁকিপূর্ণ মনে করার জন্য নিম্নের যে কারণ গুলি প্রযোজ্য সেগুলিতে টিক দিন এবং প্রযোজ্য কারণ গুলোর মধ্যে সবচেয়ে গুরুত্বপূর্ণ তিনটি কারন চিহ্নিত করে তাদের ক্রম উল্লেখ করুন

সম্ভাব্য কারণ সমূহ	**প্রযোজ্য হলে টিক দিন**	**ক্রম**
ভৌগলিক অবস্থান এবং অবস্থা		
এলাকার মাটির ধরন ও প্রকৃতি (ভূতাত্ত্বিক অবস্থা)		
এলাকায় অনেক পুরানো ভবন রয়েছে		
অপরিকল্পিত স্থাপনা		
এলাকার ভবন এবং স্থাপনা সমূহ খুবই ঘনবসতি পূর্ণ		
খোলা জায়গার অভাব		
সরু রাস্তা		
এলাকায় অনেক জলাভূমি রয়েছে		
ভূমিকম্পের কারনে ভুমিধস হবার সম্ভবনা		
বৈদ্যুতিক দুর্ঘটনার কারণে আগুনের সম্ভাবনা		
অন্যান্য (উল্লেখ করুন)		

৩.৫.২ আপনার এলাকার ভূমিকম্প ঝুঁকি হ্রাস করার জন্য কি করা যেতে পারে বলে আপনি মনে করেন?

_____-

৩.৬ আপনি যে ভবনে বাস করেন সেটি কি ভূমিকম্পের জন্য ঝুঁকিপূর্ণ বলে আপনি মনে করেন?

- হ্যাঁ
- না

৩.৬.১ হ্যাঁ হলে, আপনার এরুপ ধারনার পেছনে নিম্নের যে কারণ গুলি প্রযোজ্য সেগুলিতে টিক দিন এবং প্রযোজ্য কারণ গুলোর মধ্যে সবচেয়ে গুরুত্বপূর্ণ তিনটি কারন চিহ্নিত করে তাদের ক্রম উল্লেখ করুন

সম্ভাব্য কারণ সমূহ	**প্রযোজ্য হলে টিক দিন**	**ক্রম**
নিম্নমানের নির্মাণ সামগ্রী এবং নির্মাণ কৌশল		
অনেক পুরানো ভবন		
ভবনের দৃশ্যমান ফাটল		
জরুরি নির্গমন পথের অপর্যাপ্ততা এবং অব্যবস্থাপনা		
ভবনের নিচের মাটির ধরন		
ভবনের সাথে পার্শ্ববর্তী ভবনের স্বল্প ব্যবধান		
জলাভূমি ভরাট করে বানানো ভবন		
অন্যান্য (উল্লেখ করুন) _____		

৩.৭ আপনার কি ভূমিকম্পের অভিজ্ঞতা আছে?

- হ্যাঁ
- না

৩.৭.১ হ্যাঁ হলে, শেষ কত সালে ভূমিকম্প অনুভব করে ছিলেন ? _____

৩.৭.২ আপনি তাৎক্ষণিকভাবে কি করেছিলেন? (খোলা প্রশ্ন** এবং একাধিক উত্তর গ্রহণযোগ্য)

- কাঠের কিছুর নিচে লুকিয়েছিলাম
- দেয়ালের/ শক্ত পিলারের পাশে দাঁড়িয়ে ছিলাম
- মাথায় বালিশ, কম্বল ইত্যাদি নিয়েছিলাম
- পরিবারের সাথে ভবন থেকে নেমে রাস্তায় চলে গিয়েছিলাম
- ছাদে চলে গিয়েছিলাম
- ইলেক্ট্রিসিটি/গ্যাসের লাইন বন্ধ করেছিলাম
- ভয় পেয়ে গিয়েছিলাম
- কিছুই করিনি
- অন্যান্য (উল্লেখ করুন)_____

৪। উত্তরদাতার ভূমিকম্প দুর্যোগ ব্যবস্থপনা বিষয়ক ধারনা

৪.১ আপনি কি ভূমিকম্প বিষয়ে পারিবারিকভাবে প্রস্তুতি নিয়েছেন ?

- হ্যাঁ
- না

৪.১.১ হ্যাঁ হলে, নিম্নোক্ত প্রস্তুতিগুলির মধ্যে কোনটি আপনারা গ্রহন করেছেন (একাধিক উত্তর গ্রহণযোগ্য)

- তাৎক্ষণিকভাবে ব্যবহার এবং সাথে রাখার জন্য প্রয়োজনীয় সরঞ্জাম একত্রিত করেছি
- ভূমিকম্প চলাকালীন অবস্থান করার জন্য বাড়ির ভিতরে অপেক্ষাকৃত নিরাপদ একটি জায়গা নির্ধারন করেছি
- পরিবারের সদস্যদের সাথে ভূমিকম্প হলে করণীয় বিষয় নিয়ে আলোচনা করেছি
- প্রতিবেশি এবং ভবনের অন্যান্যদের সাথে আলোচনা করেছি
- অন্যান্য (উল্লেখ করুন) _____

৪.১.১ (ক) প্রথম বিবৃতিটির উত্তর হ্যাঁ হলে, ব্যবহার এবং সাথে রাখার জন্য নিম্নোক্ত কোন কোন প্রয়োজনীয় সরঞ্জাম একত্রিত করেছেন? (একাধিক উত্তর গ্রহণযোগ্য)

- ফার্স্ট এইড বক্স
- শুকনা খাবার
- পানি
- টর্চ লাইট
- টাকা
- হুইসেল
- অন্যান্য (উল্লেখ করুন) _____

৪.১.১ (খ) দ্বিতীয় বিবৃতিটির উত্তর হ্যাঁ হলে, নিম্নের কোন স্থানটি/গুলোকে নিরাপদ হিসাবে বিবেচনা করেছেন?

- দরজার ফ্রেমের নিচে
- বীমের নিচে
- পিলারের পাশে
- দেয়ালের পাশে
- টেবিল/খাটের নিচে
- ছাদে
- সিঁড়িতে
- অন্যান্য (উল্লেখ করুন) _____

৪.২ আপনি কি ভূমিকম্পের পর প্রয়োজন সাপেক্ষে আশ্রয়কেন্দ্রে যাবেন?

- হ্যাঁ
- না

৪.২.১ যদি হ্যাঁ হয় তবে আশ্রয়কেন্দ্র হিসেবে নিচের যে জায়গাগুলো আপনি পছন্দ করেন সেগুলোর পাশে টিক দিন। কোনটি পছন্দ না হলে টিক এর পরিবর্তে পছন্দ না করার কারনটি লিখুন। পরবর্তীতে নিম্নোলিখিত জায়গাগুলির মধ্যে কোন তিনটিকে সবচেয়ে বেশি পছন্দ করেন ক্রম উল্লেখপূর্বক প্রকাশ করুন

জায়গার নাম	**পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন**	**শুধুমাত্র পছন্দের জায়গা গুলোর ক্রম**
খোলা জায়গা		
খেলার মাঠ		
শিক্ষা প্রতিষ্ঠান		
ধর্মীয় প্রতিষ্ঠান		
সরকারি প্রতিষ্ঠান		
অন্যান্য (উল্লেখ করুন) _____		

৪.২.২ যদি না হয়, তবে কেন যেতে চান না ? _____

৪.৩ ভূমিকম্পের পর আপনি/ আপনার পরিবারের কোন সদস্য কি স্বেচ্ছাসেবক হিসেবে কাজ করতে ইচ্ছুক?

- হ্যাঁ
- না

৪.৩.১ যদি হ্যাঁ হয় তবে স্বেচ্ছাসেবক হিসাবে আপনি/ আপনারা নিম্নলিখিত কাজগুলোর মধ্যে কোনগুলো করতে চাইবেন সেগুলোতে টিক দিন, যেগুলো করতে চাইবেন না সেগুলোতে টিকের পরিবর্তে কারণটি লিখুন। পরবর্তীতে টিক দেয়া কাজ গুলোর মধ্যে কোন তিনটি বেশি পপছন্দ করবেন ক্রম উল্লেখপুর্বক প্রকাশ করুন। (এক্ষেত্রে ছক ২.২ এর সদস্যক্রম অনুসরণ করতে হবে)

স্বেচ্ছাসেবী কাজের তালিকা	১ম সদস্য		২য় সদস্য		৩য় সদস্য		৪র্থ সদস্য	
	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম
নিবন্ধন ও তথ্য সংক্রান্ত								
উদ্ধার কার্য								
ত্রাণ ব্যবস্থাপনা								
প্রাথমিক চিকিৎসা/ মানসিক পরিচর্যা								
আশ্রয়কেন্দ্র/ চিকিৎসাকেন্দ্র ব্যবস্থাপনা								
খাদ্য প্রস্তুতি ও ব্যবস্থাপনা								
অন্যান্য								

স্বেচ্ছাসেবী কাজের তালিকা	৫ম সদস্য		৬ ষ্ঠ সদস্য		৭ম সদস্য		৮ম সদস্য	
	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম	পছন্দ হলে টিক দিন / পছন্দ না করার কারণটি সংক্ষেপে লিখুন	পছন্দের কাজ গুলোর ক্রম
নিবন্ধন ও তথ্য সংক্রান্ত								
উদ্ধার কার্য								
ত্রাণ ব্যবস্থাপনা								
প্রাথমিক চিকিৎসা/ মানসিক পরিচর্যা								
আশ্রয়কেন্দ্র/ চিকিৎসাকেন্দ্র ব্যবস্থাপনা								
খাদ্য প্রস্তুতি ও ব্যবস্থাপনা								
অন্যান্য								

৪.৪ আপনি কি আপনার ওয়ার্ডের ডিজাস্টার ম্যানেজমেন্ট কমিটির কাজের সাথে সম্পৃক্ত হতে চান?

- হ্যাঁ
- না

৪.৫ আপনি কি বর্তমানে আপনার ওয়ার্ডের আর কোন কমিটি/ সামাজিক কার্যক্রমের সাথে জড়িত আছেন ?

- হ্যাঁ
- না

৪.৫.১ যদি হ্যাঁ হয়, তাহলে সেটি কি উল্লেখ করুন _____

৫। ভূমিকম্পে ঝুকি নিরসনে বাড়িওয়ালার সম্মতি (বাড়িওয়ালার জন্য)

৫.১ যদি আপনার ভবন ঝুকিপূর্ণ হিসেবে চিহ্নিত হয় তবে আপনি ভবন ঝুকিমুক্ত করনে/ শক্ত করতে রাজি আছেন? (ধারনা করুন, ভবন শক্ত করনের জন্য ঝুকির উপর নির্ভর করে বর্তমান নির্মান খরচের ৫% থেকে ৩৫% পর্যন্ত খরচ হতে পারে)

- হ্যাঁ
- না

৫.১.১ যদি হ্যাঁ হয় তবে আপনার কোন ধরনের সহায়তার প্রয়োজন আছে ?

- আর্থিক সহায়তা
- কারিগরী সহায়তা
- অন্যান্য

৫.২ যদি প্রয়োজন হয় তবে রাস্তা প্রশস্ত করনের জন্য আপনি কি আপনার ভুমির অংশ দেবেন ?

- হ্যাঁ
- না

APPENDIX B

Clusters of Ward 19, Rangpur City Corporation

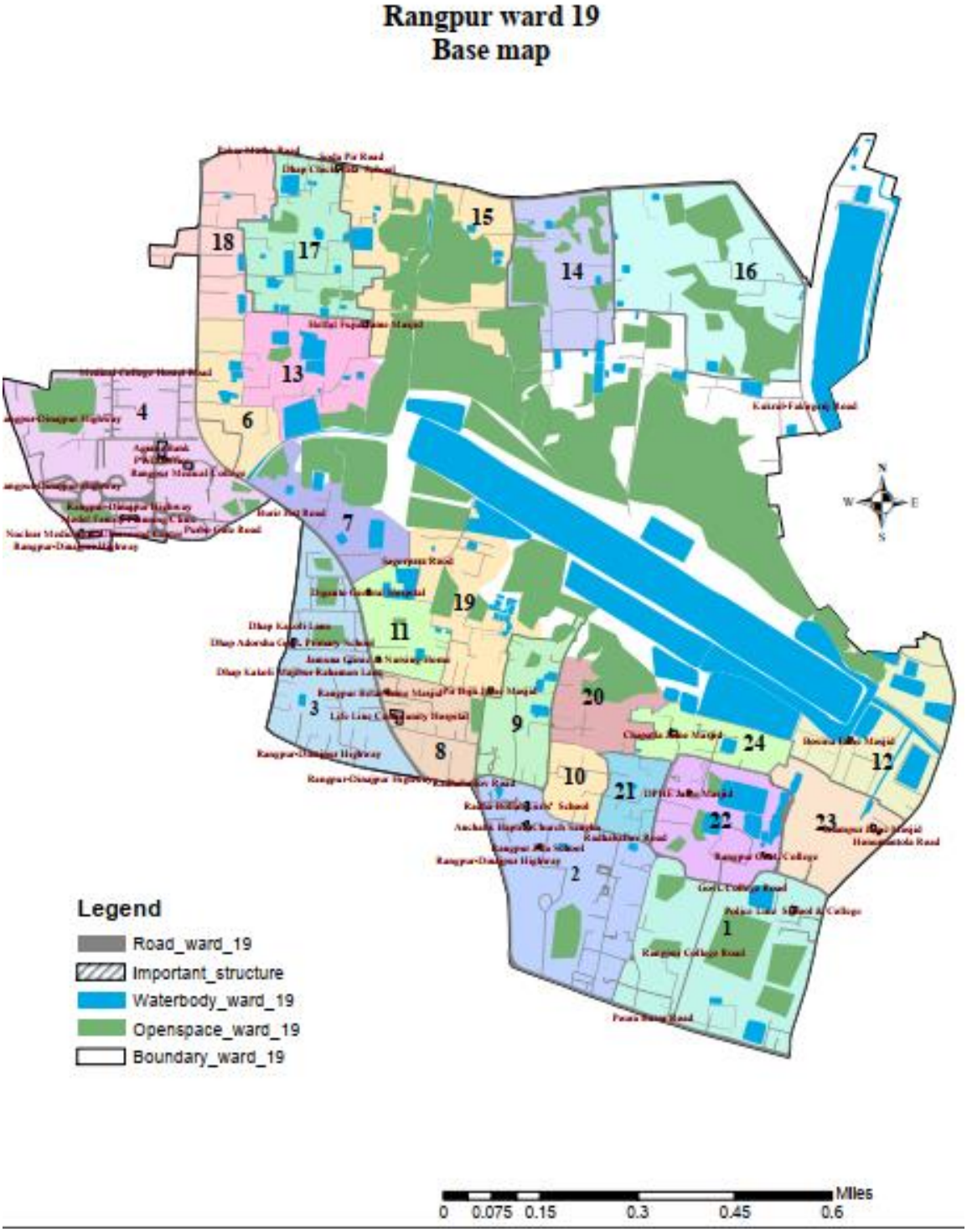

Figure: Map showing clusters of Ward 19, Rangpur City Corporation

APPENDIX C

Checklist for Data Updating

Checklist for Data Updating

1. Ward No

2. Building ID

3. Holding No

4. Type of the structure

    1. Pucca 2. Semi-pucca 3. Katcha

5. Number of storey

6. Building use

    1. Residential 2. Commercial 3. Industrial 4. Educational

    5. Community facilities 6. Health 7. Administrative 6. Religious

    7. Others

    If "Educational", please specify the type _____

    If "Health", please specify the type _____

    If "Religious", please specify the type _____

    If "administrative", please specify the type _____

    If "community facilities", please specify the type _____

7. Width of adjacent road (in feet)