CHAPTER VII

FLOOD HAZARD VULNERABILITY OF KAMRUP METROPOLITAN DISTRICT

European Union (EU) flood directives has defined flood as a temporary covering by water of land not normally covered by water. It may result from the volume of water within a body of water like river, lake, which overflow or break levees, with the result that some of the water escapes its usual boundary. Principal flood types are riverine, estuarine, coastal, catastrophic, human induced, muddy and others (Yadav and Rajbir, 2013).

Flooding, which already affects large areas of the poorest parts of India including Bihar and North-East India has yet to be effectively addressed. Large dams and embankments are the standard response as the solution to the problem. India is only now starting to explore the combinations of ‘hard interventions’ (to protect high-value infrastructure) and ‘soft interventions’. Soft interventions refers to ‘smart adaptation’ to living with floods, including changing land-use patterns, cropping patterns and construction of emergency shelters for people and animals, which are globally accepted best practices of countries as diverse as United States and Bangladesh (Briscoe and Malik, 2006).

Hazard can be defined or viewed as a naturally occurring or human induced process or event with a potential to create loss. It is a rare or extreme event in the natural or human made environment that adversely affect human life, property or
activity to the extent of causing a disaster. Whether a hazard would culminate into a disaster depend on two factors namely: physical exposure, which can be expressed in terms of statistical variation as per location and human vulnerability, reflecting the socio-economic tolerance to the hazard at the same location (Rao, 2010).

The term vulnerability is very loosely defined, in a sense that it has lot of relative connotation. In case of hazard vulnerability, even same type and intensity of hazard may have different impact depending on social, demographic, economic and other issues of the population under scanner. At-least four (4) categories of vulnerability can be identified like: living vulnerability (who live in poor physical environment), economic vulnerability (one who live with low wage in hazardous condition), social vulnerability (who face lack of proper education, health etc), and finally personal vulnerability (one who is prone to vulnerability like, child, women etc.) (Singh and Kaish, 2010).

To evaluate flood vulnerable areas two approaches are used: Bolean approach and weighted linear combination approach. In Bolean approach vulnerable areas are produced by numerically overlaying a map. In weighted linear combination ranking and pair-wise comparison methods are taken-up. In ranking method every criteria under consideration is ranked in the order of the respondent’s preferences. The inverse ranking is normally applied where 1 is the least important and 10 is the most important, in a 10-point scale (Yalcin and Akyurek 2002).

Vulnerability denotes the inadequate means or ability to protect oneself against the adverse impact of natural events and, on the other hand, to recover quickly from their effects. It can be measured at various levels from family to village to country. Various factors in combination works behind vulnerability of a system
such as: politico-institutional lapse like weak legislation and related regulations, inadequate finance, ill-defined role, working of vested interest group, low people's participation etc., economic factors like lack of finance, people's poverty that compels them to settle in endangered areas etc. and socio-cultural factors like poor education, traditional out-dated practices etc. (Rao, 2010).

In urban hazard management evacuation planning is an important component of emergency preparedness. Number and location of rescue facilities is an important aspect of the planning. Secondary route of evacuation is an important thrust area need to be identified. A model of urban hazard emergency planning related to effective evacuation can be incorporated into a Geographic Information System, which planners can access to via internet during the time of crisis (Almeida L. et. al., 2009).

Water logging is manifestation of lowland conditions, which is an important issue of man-environment study. It is a problem observed throughout the world including China, India, Pakistan, and Bangladesh. It is therefore a global phenomenon, a condition generated by blockage of water on land surface, especially in low-lying areas. Water logging is a result of multiple causes, including geology, topography, drainage and amount of water supplied to the place concerned from various sources. Normally water logging increases with contributing drainage and decreases with increasing local slope angle (Sahu. A, 2014).

In context of Guwahati the issue of water logging is a result of multiple causes including its low-lying character, where natural water logged zones are converted to built-up zone, rushing of water from the Meghalaya plateau, inability of the urban drainage to carry the flood water towards the mighty Brahmaputra etc.
Rather there instances of backflow during the full flow stage of the mighty Brahmaputra at its upstream near the confluence of Kolong, that inundated many parts of villages under Chandrapur circle, mid-stream section near the confluence of Bharalu, that causes flooding in the city core and towards the downstream section, that causes flood water to inundate parts of Azara circle. During the field visit dilapidated condition of the urban drainage affected by pollution, garbage dump sites were observed in many occasion. The poor and improper maintenance of the drainage system is also an issue of the haphazardly developed city of Guwahati, as revealed by the respondents during the household survey.

In the context of flood vulnerability of Kamrup Metropolitan district, it’s related land-use, land-cover character and change analysis plays a vital role, which is already analysed in detail in chapter 4, as a newly created district. A study on land-use in relation to population growth in the fringe area of Guwahati city (inner and outer fringe) based on district census (1971-2001) and ARSAC has revealed explosive growth of population in the fringe zone with natural growth and migration and corresponding decline in agricultural land and forest. Consequently there is a rise in built up zone, which is almost doubling from 14.83 to 25.5% in both inner and outer fringe combined, at the expense of non built-up area. Sharp fall in waste land from 10.08 to 4.84% of total share, combining both inner and outer fringe is observed. In outer zone agriculture land is added with slow transformation of land from forest and wasteland to agriculture. The spatial variation of land-use pattern has been more in the outer fringe zone (Begum and Kar, 2013).

A study of hurricane risk of US Gulf coast in between 1950-2005 has tried to investigate the damage in terms of population structure and specific socioeconomic
components. Variables selected for the analysis within population structure includes age, race, and state of poverty. The result shows that white, non-poor and young shifted over time. On the other hand elderly, poor and African-Americans moved in opposite direction (Logan and Xu, 2015).

A similar study on natural hazards and vulnerability in Himachal Pradesh has tried to unearth the vulnerable zones of the state as a whole in district level. The study was based on secondary information of Himachal Pradesh development report, Himachal Pradesh State Disaster Management Plan and City Disaster Management Plan Shimla. The state is among the first five states in respect of natural hazards such as earthquake, flash flood, landslide, snow avalanche, drought and forest fire. Based on the recorded data districts are categorised under very high, high, medium disaster risks vulnerability (Sharma and Sharma, 2014).

In most of the western countries there is a general shift from flood defence to risk management, engaging the local affected people in the process. The need of the affected people needs to be incorporated. Here lies the necessity of examining perception of the people who live with the crisis. Convergence of management strategy with that of the perception made or possess by the people can eventually help to make a trust between the affected people and the strategy makers for an effective hazard management plan (Vavra., et. al, 2015).

In Assam parts of Nogaon and Morigaon are two chronically affected flood zones. A study of flood hazard of the region tries to demarcate the affected parts, its responsible factors, trend of occurrence to formulate a flood management plan. The study also tested the structural and non structural flood control measures. In addition
identification of local and traditional flood control measures are incorporated as a part of the management strategy (Kar, M., 1995)

Some of those factors leading to flood vulnerability in the study area and their status of interrelation are tried to be observed in the following discussion. In this context respondent’s household level understanding of various situations related to hazard identity and vulnerability is interpreted with necessary figures.

7.1 A Brief History of Natural Hazards of the District

Kamrup Metropolitan District, situated on the western part of Assam has always been at the centre stage of natural calamities like floods, cyclones, earthquake, landslide, epidemics etc. Keeping in mind these very probable calamities in the district that brings major setbacks to lives, livelihoods and property (both movable and immovable), the district administration felt the urgency of the need of preparing an emergency response plan. The plan is chocked out with certain objectives like: hazard preparedness (district and ward level), providing need based support services, skill building of line departments, timely information dissemination, immediate and long-term support to the vulnerable section of people, awareness building, building up of a response system, ensure active participation of all concerned stakeholders including government organizations, Non-government organizations, various community based organizations and even self help groups at grassroots (Guwahati City Disaster Management and Response Plan).

Based on history, Kamrup Metropolitan district is seen to be affected by multiple hazards including: earthquake, flood, soil erosion, fire and cyclones. As per
the latest seismic zoning map of India, the district falls under High Risk Zone-V, where a maximum intensity of 9.0 magnitudes earthquake can be expected. Severe earthquake of 1897 and 1950 is a testimony of that, with massive damage impact, all throughout the state, including present Kamrup. Based on the periodicity, a mega quake is already an impending strike in the state. The general reason of occurrence of flood in Kamrup Metropolitan district is due to overflow of river Brahmaputra and its tributaries, mainly Bharalu, Kolong and Digaru. The soil erosion is another major threat to many places in Kamrup Metropolitan district including the Azara and Chandrapur Revenue Circle.

From the realization that people’s vulnerability is a key factor determining the impact of disasters on them, ‘vulnerability’ emerged as the key theme and more and more emphasis was laid on using ‘vulnerability analyses’ as a tool in disaster. Like all other low-lying belts of Assam, low-lying parts of Kamrup Metropolitan district is also been affected by flood during the monsoon period. In addition to that landslide is a crucial hazard of the region, mainly aggravated due to human occupancy of the virgin hills, cutting of forest and other form of human interferences. During last couple of decades urban flash flood is also growing in terms of frequency, volume and spread, exposing the unplanned growth of this lone metropolitan district of the North-East India. In addition to all these, another natural hazard that is looming large over the city dwellers is its earthquake vulnerability.

The flood scenario of the district of Kamrup Metropolitan can be visualised in two different types as: flood of rural peripherals and the flash flood issue of the wards under Guwahati Municipal Area (GMA). The low-lying areas of kamrup metropolitan district, specifically the area falling under Chandrapur, Sonapur and
Azara are the three (3) frequently inundated revenue circles of the district. The problem arises in the monsoon phase from the month of May to August. The issue of flash flood and water logging problem on the other hand is an acute problem for the citizens of Guwahati. The problem has arisen due to the fact that the topography of Guwahati city is bowl shaped with areas like Anil Nagar, Nabin Nagar, Lachit Nagar etc. being at the lowest points of the bowl which leads to automatic stagnation of water pursuant to heavy rainfall over a short periods during the monsoon season. This problem is greatly compounded by flood water coming from the hill area of Meghalaya State right from Jorabat to Garbhanga Reserve Forest. The entire water passes through the Guwahati city through the river Bahini and Bharalu and falls into Brahmaputra. In the following observations, the situation of rural seasonal flood and urban flash flood are tried to be analysed in terms of their demographic vulnerability pattern at village and ward level of the affected circles and municipal area respectively. The following table (table No. 7.1) has indicated the strength of vulnerable villages of the three most vulnerable circles of the district.

**Table 7.1 Circle-wise flood vulnerable villages of Kamrup Metropolitan district**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the circle</th>
<th>Total Villages</th>
<th>Total Flood Vulnerable villages</th>
<th>% of Flood Vulnerable villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chandrapur</td>
<td>43</td>
<td>29</td>
<td>67.4%</td>
</tr>
<tr>
<td>2</td>
<td>Sonapur</td>
<td>142</td>
<td>46</td>
<td>32.4%</td>
</tr>
<tr>
<td>3</td>
<td>Azara</td>
<td>21</td>
<td>10</td>
<td>47.6%</td>
</tr>
</tbody>
</table>

Source: i) Total village, District Census Handbook, Kamrup Metropolitan, 2011  
ii) % value is calculated by researcher based on report, Flood Management Plan 2009, Kamrup Metropolitan, District, Govt. of Assam
7.2 Circle-wise Population Density Based Flood Vulnerability Pattern

Based on village population density each vulnerable village is identified in terms of vulnerability weight. The method of calculation of village population density and assigning of weight is already added in chapter: 5. Based on assigned weight all the vulnerable villages are ranged into low, moderate and high vulnerable category. On the other hand at ward level locations are identified in terms vulnerable and non-vulnerable category from the exiting data. Finally maps have been prepared on GIS platform using ArcGIS version 9.3.

7.2.1 Flood vulnerability pattern of Chandrapur revenue circle

Chandrapur revenue circle has forty three (43) villages, spreading in an area of 8278.98 hectares under Beltola, Panbari and Mayang mouzas. Out of 43 villages, 29 are identified as vulnerable to flood (67.4%). The flood vulnerable villages are falling along either the mighty Brahmaputra or in-between the low lying areas of river Kalang and Digaru. Two (2) vulnerable villages are taken for field survey, one from vulnerable category named Tatimara and the other from very vulnerable category named Rajabari, highlighted in the respective table.

Based on the weight index assigned on the basis of population density value, a circle level village vulnerability weight index map is prepared. The original circle map with village boundary is taken from Kamrup District Census Report, 1991, which is restructured on GIS platform using ArcGIS.

The weight assigned on the basis of population density is finally ranged into some categories to identify the demographic vulnerability status of that particular
village. Village vulnerability weight index map is prepared on the basis of that weight range on GIS platform. The range is indicated in the following table:

**Table: 7.2 Vulnerability weight range**

<table>
<thead>
<tr>
<th>Vulnerability status</th>
<th>Weight range (Based on population density)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4-6</td>
</tr>
<tr>
<td>Moderate</td>
<td>7-9</td>
</tr>
<tr>
<td>High</td>
<td>10-12</td>
</tr>
</tbody>
</table>

**FLOOD VULNERABLE LOCATIONS, CHANDRAPUR CIRCLE**

KAMRUP METROPOLITAN DISTRICT, ASSAM

![Map of flood vulnerable locations](image)

**Figure: 7.1** Location of flood vulnerable villages, Chandrapur circle, Kamrup Metro
The red shaded part falls under flood vulnerability, which is located either by the side of the mighty Brahmaputra or the confluence of Digaru and Kolong river near the Brahmaputra. Some part of the villages (under Burhachapori) is already worn down by erosion. However original boundary from 1991 district census is kept superimposed on the present district boundary.

On the basis of calculated weight index data of vulnerable villages from population density a circle level weight index map is separately prepared as shown in Figure: 7.2

Figure: 7.2 Vulnerability weight index map, Chandrapur circle, Kamrup Metro
Out of 29 total vulnerable villages of the circle two (2) are under high vulnerability category namely Rajabari and Bonda2, based on population density and two are moderately vulnerable namely Panikhaiti and Tatimara. These villages are experiencing increasing population density during last 40 years (1971-2011 censuses). Accordingly two villages of Rajabari and Tatimara are taken up as sample survey villages, from high and moderate vulnerability zone respectively. The rest of the villages are low vulnerable with density below 500person/ sq. km.

7.2.2 Flood vulnerability pattern of Sonapur revenue circle

Sonapur revenue circle have highest numbers of 46 flood vulnerable villages within the district. However percentage wise it is half of Chandrapur. Out of total 142 villages 32.4% are recognised as vulnerable to flood. Based on the vulnerability status and its corresponding weight index value, a circle level village vulnerability location map and vulnerability weight index map is prepared for Sonapur revenue circle shown in Figure 7.3 and 7.4 respectively. Figure 7.3 have indicated that all the vulnerable villages (red shaded) are located along the downstream section of Digaru and Kolong river, extended down to its zone of confluence.
Figure: 7.3 Location of flood vulnerable villages, Sonapur revenue circle
Figure: 7.4 Vulnerability weight index map, Sonapur circle, Kamrup Metro

Based on weight index value assigned against population density, two villages are identified as highly vulnerable (10-12 weight), four as moderately vulnerable (7-9), while rest are categorised as low vulnerable as shown in Figure 7.4.

7.2.3 Flood vulnerability pattern of Azara revenue circle

Among the three most flood vulnerable circle of Kamrup Metropolitan district the last is the western most Azara circle, which shares its district boundary with Polasbari circle under Kamrup rural district. The circle is descending from the Meghalaya side in south till the river valley of mighty Brahmaputra. Based on the similar method of assigning weight against population density between 1971-2011 censuses, a circle level village vulnerability location map and corresponding weight index map is prepared for Azara revenue circle as shown in Figure 7.5 and 7.6.
respectively. Flood vulnerable location of Azara circle, indicated by red shaded part in Figure 7.5 are all confined towards the valley part of the mighty Brahmaputra.

**Figure: 7.5** Location of flood vulnerable villages, Azara revenue circle

In Azara, the western most circle of flood vulnerable location under Kamrup Metropolitan district, it become clear that the red shaded part represented by the flood vulnerability is mostly confined towards the river side, whereas the southern part is covered by the highland descending from the plateau side of Meghalaya. There are ten (10) flood vulnerable villages out of which two each are shared by low and moderate vulnerability, based on population density weight between 1971-2011 censuses. Of the rest six villages, five are falling under high vulnerability, and one namely Mikirpara Chakordoi is left out of the range due to non availability of census data.
population data. The circle has a total of 21 villages, of which 47.6% are falling under flood vulnerability. The weight index map of the circle is shown in Figure 7.6.

![Flood Vulnerable Villages of Azara Circle](image)

**Figure: 7.6 Vulnerability weight index map, Azara circle, Kamrup Metro**

### 7.3 Urban Flood Vulnerability

Urban flood is different from rural flood in terms of loss mainly due to its overcrowding population and centre of economic activities. In 2001 Indian urban population was 286 million (27.8%), which is expected to grow up-to 433 million by 2021. Indian cities and towns have witnessed growing population in low lying areas, over the drainage by encroaching land and on hill slope that causes flooding. The problem is aggravated by improper sewerage and expanded impervious area. Identification of the chronic flooding area which is mostly low lying is a priority action (NDMA). On the line of National Disaster Management Authority (NDMA)
observations, flood problem of city of Guwahati has mostly affected its low-lying areas, especially the wetlands, which are fast disappearing and transformed into urban built-up zone. The overall change in last twenty years in land-use and land-cover (1991-2011) has revealed many aspects related to the ultimate cause of urban flood in the region, lucidly explained in the land-use part in chapter: 4.

Flash flood is sudden occurring with little lead time, usually violent with severe damage to property, infrastructure. They occur in often unexpected place generally at a small local scale. They are of short duration. To tackle such event certain measures need to be adopted like risk identification, vulnerability identification and develop certain designs to avoid vulnerability (Grunfest and Handmer, 1999).

Flash flood is a rapid flooding of geomorphic low-lying areas. It is distinguished from the regular flood by a timescale less than six (6) hours (Dutta R., 2011). The places facing urban flash flood in Kamrup Metropolitan district traditionally included: RG Baruah Road, Nabin Nagar, Anil Nagar, Tarun Nagar and Lachit Nagar area. However with shrinking wetlands and increasing population pressure, flash flood problem and water logging is expanded to fresh areas. Many wards under Guwahati Municipal Corporation Area (GMCA) are increasingly facing the seasonal water logging and flash flood issue. In addition to the traditional areas, the problem is spreading out to fresh areas like: Geetanagar, Hatigaon Char Ali up-to Narengi, Maligaon, Guwahati College area, Ambikagiri nagar, Sundarpur, by-lanes of Rajgarh, Rukmini gaon, Mathura Nagar, Fatasil Ambari, Lamb Road and parts of A.T. Road (CDP, Guwahati, 2006).
The GMCA itself has undergone many structural changes over the years. In 1970s there were only 14 wards, which have gone up to 34 in 1990s and subsequently to 60 wards in later period. However further rearrangement still continued. Under the Nagar Raj Bill, GMCA is restructuring with 31 wards and 90 area sabhas. The idea is to ensure greater participation of people through area sabhas. According to the new rule minimum population of each ward should be around twenty thousand (20,000). Each ward will have at-least two area sabhas to ensure more power to people to voice their grievances.

At national level urban flood management actions like preparedness and mitigation, early warning, response, awareness generation and community capacity building are the area given priority. In urban context ward level assessment of vulnerability and risk is to be carried out, involving the community. But other stakeholders also have to play their role like municipal authority, river and water related agencies, various scientific and data generating agencies, private players and NGOs (NDMA Guidelines, 2010).

Vulnerability is a dynamic entity which may rise and fall with time and circumstances. Various non-structural measures can be adopted to fight with the urban flood vulnerability like: preparedness, emergency response, evacuation, financing, legal framework, flood insurance, rehabilitation, people’s participation, awareness building, education and training, land-use regulation etc. (IHP, UNESCO, 2001).
7.3.1 Ward-level flood vulnerability pattern of the district

Most part of Guwahati Municipal area, structured and restructured into various wards over time, is subjected to urban flood. The problem is aggravated by rushing of runoff, south of Meghalaya on the hill sides, which directly enters the city through three crisscrossing river networks of Bahini, Basistha and Bharalu. In addition, the flow of these three rivers towards the mighty Brahmaputra, which flows along the city, is obstructed time and again by construction activities, encroachment, garbage dump etc. Reduced carrying capacity of the concerned channel eventually leads to urban flooding during heavy rainfall. Some parts of the city, which is bowl shaped and low-lying, are thus facing an extended period of urban flood inundation (GMDA). The old city ward structure (60), its included area, flood area and sample study locations are shown in table: 7.3.

During recent past development activities near the Jorabat hill side along Meghalaya-Assam border in the form National Highway expansion has affected the entire region in form hill-cutting, deforestation etc. As a result the entire region is facing the problem of landslide. Water coming down in full flow towards the city has further multiplied the problem especially towards the national highway by-pass. With shrinking waterlogged area and haphazard expansion of the built-up zone (including residential and commercial), most part of the low-lying settlements are going to add to the problem in coming future. With scope of further expansion of the city towards its fringe zone, a stringent policy level exercise for an effective, futuristic and scientific land-use planning become the need of the hour.
<table>
<thead>
<tr>
<th>Ward No. (old)</th>
<th>Included Areas</th>
<th>Vulnerability Status</th>
<th>Sample Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Garigaon, Bazpara, Sodilapur, Jalukbari (w)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Mazjalukbari, part of University campus</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Ferryghat, Pandu colony</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Kamakhya, Pandunath Railway colony</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Maligaon (part)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Adabari, Garpandu, Maligaon (part)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Baripara, Pandunath, Kamakhya</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Gotanagar (part), Maligaon Railway colony</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Gotanagar (part), Maligaon Railway colony</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Baripara, Gotanagar (part), Tetelia</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Gotanagar (part), Durgasarobar, Santipur (Hill)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Gotanagar (part), Durgasarobar, Kumarpura</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Boragaon (w), Fatasil (part), Dhirenpara</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Fatasil (part), ganeshpara</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Udalbakra, Jyotikoshi (part)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>Udalbakra (part), Kahilipara (part), Durgabari</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>Bhetapara, Lokhara, Barsajai</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Part of Kumarpura, Athgaon, Santipur</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>Part of Kumarpura, Athgaon</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>No.</td>
<td>Location Details</td>
<td>Vulnerability</td>
<td>Notes</td>
</tr>
<tr>
<td>-----</td>
<td>------------------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>20</td>
<td>Birubari (part), Rupnagar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>Birubari (part), Sankarpur, Bimalanagar (part)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>Udalbakra (part), Kahilipara (part)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>Birubari (part), Medical college area</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>Ganeshguri (part), Kachari basti, Udayachal</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>Rehabari (part), Birubari (part), Ulubari</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>Pub &amp; South Sarania, Lachit Nagar</td>
<td>Vulnerable</td>
<td>Pub-Sarania</td>
</tr>
<tr>
<td>27</td>
<td>Part of Rehabari and Ulubari</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Part of Chatribari and Tokoubari</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>Fancy Bajar (central)</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>Fancy Bajar, Pan Bajar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>31</td>
<td>Fancy Bajar, Pan Bajar, Paltan Bajar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>32</td>
<td>Rehabari (part), Monipuri Basti, Solapur</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>33</td>
<td>Jorpukhuri, Lotasil, Ambari</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>34</td>
<td>Dighalipukhuri (E), Ambari, Jahazghat</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>Chenikuthi, Hedayatpur</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>36</td>
<td>Chandmari colony,Gandhibasti, South Sarania</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>37</td>
<td>Kharghuli, Nabagraha, Nisorapara</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>38</td>
<td>Chandmari colony (part), Milanpur</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>39</td>
<td>Pub-Sarania, Rajgarh(part),Chandmari colony</td>
<td>Vulnerable</td>
<td>Rajgarh</td>
</tr>
<tr>
<td>40</td>
<td>Chandmari, New-Guwahati, Bhaskar Nagar</td>
<td>Vulnerable</td>
<td>Bhaskar Nagar</td>
</tr>
<tr>
<td>41</td>
<td>Zoo Road Tin-Ali, Narikal Basti, Zoo-Narengi Road, Geeta-Nagar</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>42</td>
<td>Zoo Road Tin-Ali (part), Bhaskar</td>
<td>Vulnerable</td>
<td>Zoo</td>
</tr>
<tr>
<td>No.</td>
<td>Location</td>
<td>Vulnerability</td>
<td>Details</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------------------------------</td>
<td>---------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>43</td>
<td>Tarun Nagar, Bhangagarih, Christian-basti, Ganeshguri</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>44</td>
<td>Part Tarun Nagar, Ambikagiri Nagar, Krishna Nagar</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>45</td>
<td>New Guwahati, Bamuni Maidam, Jyotinagar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>46</td>
<td>Bijoy Nagar, Noonmati, Bamuni Maidam.</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>47</td>
<td>Noonmati, Anand Nagar, Ganesh Nagar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>48</td>
<td>Noonmati, Bamuni Maidam, Pub-Jyoti Nagar</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>49</td>
<td>Narikal basti, Madgharia, Bathou Nagar</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>Hengrabari, Sarumotoria, Barbari</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>51</td>
<td>Hengrabari, Dwarka Nagar, Mathura Nagar</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>52</td>
<td>Part of Birkuchi, Madgharia, Satgaon</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>53</td>
<td>Dwarka Nagar, New Sachal, Punjabari</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>54</td>
<td>Baghbari, Punjabari, Bataighuli</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>55</td>
<td>Bormotoria, Capital complex, Beltola Tinali</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>56</td>
<td>South Basistha, Lotakota, Patharkuchi</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>57</td>
<td>Rukminigaoi, Bormotoria, Survey, Basistha</td>
<td>Vulnerable</td>
<td>-</td>
</tr>
<tr>
<td>58</td>
<td>Survey-Beltola part, Borsojai, Ajanta Nagar</td>
<td>NV</td>
<td>-</td>
</tr>
</tbody>
</table>
Based on the above Guwahati Metropolitan Development Authority data a flood vulnerability location map of the municipal wards within Kamrup Metropolitan district is prepared on GIS platform. The map has represented the entire ward location into two categories as vulnerable and non-vulnerable, with the red shaded zones as the wards where flood vulnerable places are concentrated. However in many cases the part of a ward or parts amalgamated into many wards become the actual location of vulnerability, because of their frequent affect of flash flood, inundation, water logging etc. In addition to that, a separate map has been prepared to represent the vulnerability status within the old 60 ward structure of the Guwahati municipal ward. Figure 7.7 have represented the flood vulnerable location map of the municipal zone within the district, whereas Figure 7.8 have further illustrated the vulnerability pattern within the old 60 ward municipal area.

The red shaded part, identified as flood vulnerable are traditionally belongs to flooding. The ward zone has two prominent pattern of flood vulnerability (ward-wise). One is the linear zone that goes along the National Highway bypass, while the other is a compact zone inside the city, that traditionally belong to the bowl shaped low-lying part of the city including, Nabin Nagar, Anil Nagar, Lachit Nagar, Pub-Sarania, Part of Rajgarh, Zoo Road etc.

The linear zone along the National Highway bypass mostly includes the new built-up area of settlement and other commercial activities, which originally belongs to low-lying area including agricultural field. The water that rushing from Meghalaya

<table>
<thead>
<tr>
<th></th>
<th>Ward Location</th>
<th>NV</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>Jotia, Kahilipara, Hatigaon, Ganeshguri part</td>
<td>NV</td>
<td>-</td>
</tr>
<tr>
<td>60</td>
<td>Hatigaon, Bhetapara, Borsajai part</td>
<td>NV</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Guwahati Metropolitan Development Authority (GMDA), NV=Non-vulnerable
side through Basistha is drained towards Deepor bil and finally towards the Brahmaputra, which is coming under the clutches of encroachment. In addition, with growing built-up area this part of Kamrup Metro is increasingly become vulnerable to flood, artificial inundation and other related issues.

**Figure: 7.7 Location of flood vulnerable wards, Guwahati Municipal Area**

The flood vulnerable zones that running along the National highway by-pass comprised of ward 13 and 17. This part of the district was earlier covered by low-lying belt including crop field. But over a short duration the low-lying zone are transformed into built up zone, with intensification of flood inundation and related problems. The rushing of water from the Meghalaya side and inability of Basistha channel to carry the entire water volume towards deepor bil has aggravated the problem, which is further intensified by depleted wetland and fast expanded built-up zone in this region. The other part of flood vulnerable location is distributed within
13 wards of old 60 ward map, comprising of ward nos.26, 39, 40, 41, 42, 43, 44, 49, 50, 51, 53, 55 and 57. This belt is traditionally falls within a low-lying zone, where shrinking wetland and expanded built-up zone has ultimately resulted in the problem of artificial water logging and inundation during the summer monsoon period.

The map of the municipal ward (old) and its ward locations frequently inundated by flood water is represented by Figure: 7.8

Figure: 7.8 Municipal wards having maximum flood vulnerable locations (old), Kamrup Metro
7.4 Hazard Identification of the Sample Village and Ward Locations

The second part of the structured questionnaire deals with identification of hazard type and its vulnerability status. To identify types of hazard, their causes and effects and other related responses a household simple random sampling is conducted in ten (10) vulnerable villages and seven (7) ward locations. The data base is enclosed in form of annexure with appendix VII and VIII. Some of the observations are enclosed in the following discussion.

7.4.1 Comparative longevity of residing in the place of residence

Looking at the Figure 7.9 it can be assessed that rural residence are comparatively older habitant than their urban counterpart. Average 78.11% rural respondent are living in the place of their residence for more than 10 years, while its urban counterpart stand at 62.6. Contrary to that newly settled people with 0-5 and 5-10 years living experience are more in urban places than rural. In rural places 0-5 year's settlers are a meagre 7.13% at an average, while urban stood at 10.7%.

On the other hand family residing with 5-10 years living experience in rural places is an average 14.76% of respondent, which gets almost double in case of urban with an average of 26.6% of the total respondents as shown in the same Figure (7.9%).

The observation is a general indication of the fact that rural people with their greater experience of living in their place of residence have more scope of co-existence with the places and its related events. While urban dwellers having lesser experience in terms of age of residing in the place, always have the scope of learning new things with new places and events. It become evident in practical too that in
most part of the world urban dwellers has to fight hard during hazard incidence like flood and others, due to their lesser experience with the events. Despite all the technological and other advantages, urban people feel panicky during crisis, whereas rural residence easily tackles the situation with their vast experience and exposure to such events.

**Figure: 7.9** Comparative longevity of residing in the place of residence

### 7.4.2 Type of hazard

Out of 10 surveyed villages entire 100% of respondents of 7 villages have indicated flood as a type of hazard. On the other hand respondents of two villages from Tatimara and Majirgaon have shown erosion as a second hazard event with 26.2 and 27.3% of the respondents. In both the cases erosion by the mighty Brahmaputra is a serious threat. In case of Majirgaon, field visit has revealed continuous breach of the existing Dharapur-Majirgaon embankment along the downstream section of Azara circle that have compelled people to fled the vicinity to neighbouring safe places (Figure: 7.10).
Contrary to rural, in 5 out of 7 location of urban survey, people are mostly responding towards inundation as a result of urban flood. However under 10% of respondents in Jonali and Zoo road in each, have responded towards experiencing landslide, which is evident from the landslide during the rainy season from the bordering Japorigog hill side (Figure:7.11).

**Figure 7.10:** Hazard type in rural areas (in %)
Figure 7.11: Hazard type in urban areas (in %)

During the period of household survey, urban respondents were asked to give their experience regarding the highest and lowest flood water level that they have experienced from their visual observation. In some cases, water level was also judged by either informal interviewing of shops and vendors or measuring the existing marks of water on walls and buildings of the localities by the researcher. The individual household responses are added to get a total and average value of the highest and lowest flood water level of the concerned locality. It has been observed that the highest water level was responded by people of Anil and Nabin Nagar area, which is incidentally the most severely and regularly affected zone of urban flood inundation during the monsoon. Installations of pump sets have been observed in both Jonali and Anil Nagar-Nabin Nagar area to drain out the additional flood water during the rainy season. However, local people have claimed that such an activity is not
sufficient to drain-out the flood water, since river Bharalu can’t carry forward the additional water towards the mighty Brahmaputra during the peak of monsoon. Rather there is possibility of backflow at Bharalumukh during rainy days. The community response towards flood water level is indicated by Figure 7.12.

Figure: 7.12 Flood water levels of sample urban locations (in feet)

7.4.3 Causes of hazard

Comparative analysis of rural-urban causes of hazard has reflected various types of causes from the respondents of household. While in case of rural household they are mostly confined to low-lying and river side location as causes of hazard, urban people have identified multiple causes, which are mostly related to affect of urban expansion. The graphical analysis in Figure 7.13 has explained the fact that out of total rural respondents 60.26% has claimed the causes as their close proximity to riverside, followed by low-lying areas (39.74%). During field visit in many parts of Chandrapur submergence of area which were later converted to wetland were
observed with remnants of tree roots, which are locally known as ‘bils’. Elderly people of the locality also have revealed the existence of vast area of wetland in Chandrapur area such as Khankar, Khamrenga bil, Ghagua, Borbila etc. Under such conditions villages of the low-lying area become more vulnerable towards flooding during the rainy season.

Contrary to that urban people have sighted multiple causes, which are interestingly dominated by drainage blockage and poorly maintained drainage system, which are apparently the vital issues in haphazardly grown cities like Guwahati, as shown in Figure 7.14. Out of the total respondents 38.8% have sighted the drainage blockage as the main cause of flood hazard, followed by 21.8% average respondents identifying the cause as poorly maintained drainage system. The remaining causes being identified by the urban people are also issues related to drainage like low-lying area (21.7%), poor outgoing channel (16.6%), while 1.1 identified it as others.

Identification of the problem and their causes by the people themselves can definitely help towards a more effective and scientific participatory planning for management of such vital natural issues. However in this context the main concern is whether there is a mechanism for incorporating the views of the people in such policy making to address the problem that faced by the people. The following Figures (7.13 and 7.14) have graphically identified the causes of hazard in form of percentage of respondents for both rural and urban respectively.
**CAUSES OF URBAN HAZARD (IN %)**
KAMRUP METRO DISTRICT

- Majorgaon: 14.5% Poor Outgoing Channel, 85.5% River side
- Sonapurpathar: 16.7% Poor Outgoing Channel, 83.3% River side
- Amarapathar: 35% Poor Outgoing Channel, 65% River side
- Murkata: 100% River side
- Durung: 24.1% Poor Outgoing Channel, 75.9% River side
- Kasutali: 32.4% Poor Outgoing Channel, 67.6% River side
- Digarupara NC: 28.6% Poor Outgoing Channel, 71.4% River side
- Uttar Dimoria: 100% River side
- Tatimara: 16.9% Poor Outgoing Channel, 83.1% River side
- Rajabari: 29.2% Poor Outgoing Channel, 70.8% River side

**Figure: 7.13** Causes of rural hazards (x-axis indicates % of respondents)

**CAUSES OF URBAN HAZARD (IN %)**
KAMRUP METRO DISTRICT

- Sundarpur: 20.5% Poor Outgoing Channel, 43.2% Low-lying area, 18.2% Other
- Pub-Sarania: 19% Poor Outgoing Channel, 37.9% Low-lying area, 27.6% Other
- Bhaskar N: 15.9% Poor Outgoing Channel, 31.8% Low-lying area, 32.7% Other
- Jonali: 16.7% Poor Outgoing Channel, 44.4% Low-lying area, 13.9% Other
- Zoo Rd: 14.6% Poor Outgoing Channel, 35.4% Low-lying area, 37.1% Other
- Rajgarh: 19.2% Poor Outgoing Channel, 42.3% Low-lying area, 23.1% Other
- Anil & Nabin N: 18% Poor Outgoing Channel, 36.7% Low-lying area, 20% Other

**Figure: 7.14** Causes of urban hazards (x-axis indicates % of respondents)

190
7.4.4 Frequency of hazard per year

Both rural and urban respondents are asked to put their observations regarding frequency of hazards that they face in three categories as once, twice and more than twice. A contrasting picture was reflected by both the cases. 72.6% of rural people feel the hazard frequency as once and subsequently marginalized to just only 5.7% respondents with hazard frequency of more than twice in a year.

Contrary to that only 29.2% urban respondent feel the frequency as once in a year. Whereas urban respondents who feel the hazard frequency as twice in a year is almost double than rural (average 21.6% rural and 41% urban). Most interestingly almost 6 times larger urban respondents than rural have observed the frequency as more than twice in a year (average 5.7% rural and 29.8% urban respondents). Such contrasting situation may be either due to people’s higher adaptability in rural scenario with hazardous events like flood or, because of greater sensitivity of urban people towards such events. In any case both are reflective of opposite character of experiencing such hazard events, that reflects on the perceptional variation of people towards natural events. Figure 7.15 and 7.16 has indicated the actual situation.
<table>
<thead>
<tr>
<th>Location</th>
<th>Once</th>
<th>Twice</th>
<th>More than twice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majirgaon</td>
<td>69.1</td>
<td>21.8</td>
<td>9.1</td>
</tr>
<tr>
<td>Sonapurpathar</td>
<td>73.2</td>
<td>20.8</td>
<td>6.0</td>
</tr>
<tr>
<td>Amarapathar</td>
<td>90.0</td>
<td>10.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Murkata</td>
<td>92.9</td>
<td>7.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Durung</td>
<td>74.1</td>
<td>18.5</td>
<td>7.4</td>
</tr>
<tr>
<td>Kasutali</td>
<td>58.6</td>
<td>23.5</td>
<td>17.7</td>
</tr>
<tr>
<td>Digarupara NC</td>
<td>71.4</td>
<td>21.4</td>
<td>7.2</td>
</tr>
<tr>
<td>Uttar Dimoria</td>
<td>90.9</td>
<td>21.4</td>
<td>7.2</td>
</tr>
<tr>
<td>Tatimara</td>
<td>70.8</td>
<td>21.5</td>
<td>7.7</td>
</tr>
<tr>
<td>Rajabari</td>
<td>29.2</td>
<td>62.5</td>
<td>8.3</td>
</tr>
</tbody>
</table>

**Figure: 7.15** Hazard frequency/year in rural areas (x-axis indicates % of respondents)

<table>
<thead>
<tr>
<th>Location</th>
<th>Once</th>
<th>Twice</th>
<th>More than twice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundarpur</td>
<td>38.6</td>
<td>34.1</td>
<td>27.3</td>
</tr>
<tr>
<td>Pub-Sarania</td>
<td>22.4</td>
<td>56.9</td>
<td>20.7</td>
</tr>
<tr>
<td>Bhaskar N</td>
<td>22.7</td>
<td>59.1</td>
<td>18.2</td>
</tr>
<tr>
<td>Jonali</td>
<td>44.4</td>
<td>22.2</td>
<td>33.3</td>
</tr>
<tr>
<td>Zoo Rd</td>
<td>25.0</td>
<td>33.3</td>
<td>41.7</td>
</tr>
<tr>
<td>Rajgarh</td>
<td>34.6</td>
<td>50.0</td>
<td>15.4</td>
</tr>
<tr>
<td>Anil &amp; Nabin N</td>
<td>16.7</td>
<td>31.7</td>
<td>51.7</td>
</tr>
</tbody>
</table>

**Figure: 7.16** Hazard frequency/year in urban areas (x-axis indicates % of respondents)
7.4.5 Hazard calendar

Preparation of a hazard calendar based on community response has revealed some identical rural-urban characteristics. It has been observed that in both the cases respondents have opted for the month of July as the month of maximum hazard events in a calendar year, followed by the month of June. On an average 56.8% rural hazards occur in the month of July, distantly followed by June with 23.6% of hazards. Similarly in case of urban respondents too July have the highest average occurrence with 42.9% of average events, followed by June with 27.2%. Incidentally, the rainfall statistics of IMD, Borjhar have also revealed the same situation of maximum rainfall during the month of July in a calendar year, as analyzed in chapter 2 and 3. It has logically established the fact that month of monsoon specially the month of July have the maximum occurrence of hazard events, which is strongly a result of higher rainfall during the period. It has also reflected on people’s awareness towards the timing of incidence, which ultimately help them for necessary preparedness measures. Figure 7.17 and 7.18 has indicated the rural and urban hazard calendar.
Figure: 7.17 % of respondents to hazard calendar in rural areas (y-axis indicates % of respondents)

Figure: 7.18 % of respondents to hazard calendar in urban areas (y-axis indicates % of respondents)
7.4.6 Hazard duration

Both rural and urban household respondents were asked to put their views on duration of hazard in their locality. Accordingly four categories of durations were identified as one week, two week, one month and more than a month’s time. In both the cases identical situation were observed: However there are differences of response among vulnerable villages and ward location as can be visualized from the fluctuation in comparative trend line analysis of hazard duration in Figure 7.19. On an average it has been observed that in both rural and urban; maximum of respondents opted for one weeks of duration of hazard, with average 69.6% from rural and 62.1% form urban response. However in case of hazard with two weeks duration; urban people are little ahead with average 27.3% respondents (1.6% ahead of rural).

Like in case of hazard frequency where six (6) times larger urban respondents than rural have observed the frequency as more than twice in a year; hazard duration by the urban people also have been identified more than double the average rural duration (4.6% rural and 10.1% urban with hazard duration as a month). However in the last category duration above one months have shown a very marginal response in both the case.
7.4.7 Damage impact of hazard

A vast majority of natural disaster occur in emerging economics (medium human development) and developing countries (low human development). The loss of life is higher in emerging and developing countries. But material damage is greater in industrialized countries (high human development). (Rao, 2010). This becomes visible even at grassroots level between rural and urban economy.

Damage assessment is one of the very important focus areas not only to formulate an overall plan of recovery but also to prepare for the long term policy initiatives towards a better disaster risk reduction strategy. A household level damage analysis of ten (10) vulnerable villages and seven (7) flood affected municipal ward locations is presented here with special reference to settlement, economy and loss or injury of life, to identify the nature and extent of damage under this two different type of socio-economic set-up. The data has revealed the fact that while rural...
damages are mostly confined to inundation of settlement, crop field and loss of livestock. Urban damages are more widespread in terms of nature of damage and economic loss.

In the rural scenario maximum average damage is confronted by the crop field affecting the rural economy with an average 41.1% household responded towards it. It is closely followed by house inundation (39.9% of average respondent). Loss of livestock is a major concern, which again affects the rural economy, including their production sector with 16.36% of respondents admitted the damage. Another average 2.61% respondent feel that death and injury is last but not the least of the field of damage in their locality.

Contrary to rural, nature of urban damage is more widespread related to various sub-areas from within settlement and economy. Within settlement, the urban respondents have identified an average 27.9% with household inundation, 17.2% as loss of their gates and boundary wall, 9.6% for loss of building materials that they used to pile up for construction activities etc., while a meagre 1.9% responded none of the damage. Similarly from the field of economy related damage, highest response was given to vehicular damage (17.3%), followed by average 12.5% for loss of household goods, 7.4% as for loss of furniture and average 6.2% for business establishment. Interestingly none in case of urban response was given to death or injury related incidence. Figure 7.20-to-7.22 has reflected on the nature of rural and urban damages during flood events.
Figure: 7.20 Nature of rural household damage (y-axis indicates % of respondents)

Figure: 7.21 Nature of urban settlement related damage (y-axis indicates % of respondents)
7.4.8 Hazard affect

Both rural and urban respondents were asked to give their response towards affect of hazard that they face in their locality. Differences in nature of response were observed depending on the experience and background of the respondents.

In case of the rural survey majority response was towards traditional hazard affects like: loss of property which lead the response (average 56% respondents), followed by road damage (38.2%). Other affects like communication failure, price rise of services etc. was responded very poorly by fewer than 5% respondents.

While rural response towards affects like: communication failure, price rise of services etc. was fewer than 5%, it has sharply increased in case of urban respondents to average 28.5% for communication related affect and 21.1% of respondents for price rise of services. As urban people become increasingly dependent on technology including mobile, internet etc. for their day-today affairs, flood affect have immediately influenced their function by disrupting the communication system at time. Similarly price rise of services of essential
commodities also have badly affected the urban life. During field visit abrupt rise of fare of rickshaw puller, running in water logged area, uncontrolled price rise of essential commodities were observed as an offshoot of flood affect. Traditional hazard affect like road damage and loss of property also have shown healthy urban response with 24.1% and 16.1% of average respondent. In addition to all these a unique type has been identified by the urban respondents as pollution affect of hazard. About 10.1% of average respondent have identified the pollution affect of hazard as indicated by the short light blue line in Figure 7.23.

**Figure: 7.23** Comparative rural-urban hazard effect (in%)
7.4.9 Pre-hazard awareness

It is recognized that awareness is a key issue in changing attitudes and converting knowledge into desirable action. The initiatives under the state water policy would have this mandate of statewide scientifically organized awareness campaign through booklet, posters, video-audio programme, street plays etc. (State Water Policy, Assam, 2007). Awareness building at household level is important as it helps towards building a sense of preparedness. Special effort is to be taken to reach out to women, children and differently able section of the society (NDMA guideline). Public awareness, education, professional training, early warning etc. are the foundation of culture of disaster prevention. The targets at global level include reducing mortality, economic loss and damage to housing, education and health to a given percentage by 2025 (UNDRR Conference, 2014).

The household level pre-hazard awareness of the study area was tried to be assessed in terms respondent's yes and no type of reply, where contrasting rural urban situation was observed. There are differences from village to village and even within ward locations in terms of response towards pre-hazard awareness. Some of the fundamental pre-hazard awareness related observations are:

i) The average picture have shown some contrasting rural-urban situation, with only 33.8% of the urban respondents have indicated to have pre-hazard awareness, which is just double in case of rural with average 65%.

ii) Among the rural, Rajabari and Tatimara have the highest response with pre-hazard awareness, which may be due to their close proximity to river and frequent flood affect.
iii) Among the urban, where average 66.2% respondents feel to live without pre-hazard awareness, location like Anil Nagar and Nabin Nagar area have maximum of respondent without pre-hazard awareness, which is incidentally the most flood affected location within the ward of Guwahati Municipality.

Under the circumstance it can be summarised that, rural respondents have greater pre-hazard awareness due to frequency of the events, whereas urban respondents are less aware due to its sudden occurrence. Pre-hazard awareness gives the respondents the required time to prepare and mitigate with such type of hazard events.

**Figure: 7.24** Rural-urban pre-hazard awareness
7.4.10 Awareness-information received

Both rural and urban dwellers have given identical responses towards receiving of awareness and information from government and other sources, regarding tackling of flood related crisis. However comparative statistics have shown that average respondents who feel that they have not received any awareness and information is much higher in rural cases with 78.25% responded negative. Another striking observation is that, while rural people are pointed in terms of responding either with yes or no, a huge urban percent of average 30.8 are responding to the situation as ‘no idea’. Based on the response it can be summarized that, regarding flood events, while the rural people are more intelligent in terms of showing their grievances to the authority concern, urban people are more ignorant to the issue. The overall situation can be explained with the help of a graphical comparison as represented by Figure 7.25.

Figure: 7.25 Awareness-information received by rural-urban respondents (in %)
7.4.11 Satisfaction with government interventions

Being a citizen of a democratic country, every person has their right to express their grievances as well as satisfaction with all kind of government activities. During the survey it was asked to the people to respond to the level of satisfaction that they have in the government interventions, in tackling the issue of flood hazard. It has been observed that a huge percent of average 92.63 of rural respondents are dissatisfied with the kind of government interventions that they have experienced. The issue of breaching of Dharapur-Majirgaon embankment, sensitivity of Tatimara embankment etc. and its repeated plea for permanent solution by the people to the authority seems to fall in deaf ear.

Contrary to the rural situation, urban people seems to be relatively satisfied with average 22.8% respondent turns positive to the interventions made by the government, which is 3 times higher than the rural response. But still considerably high percent of urban respondents turns negative to the interventions (average 77.2%). At individual urban location level an interesting observation is that, Anil Nagar and Nabin Nagar have the highest 88.3% respondents that turns negative to the government’s interventions, which is incidentally the most flood vulnerable location within the municipal ward zone of Guwahati. The overall trend of response towards satisfaction by the respondents is represented by Figure 7.26.
7.4.12 Suggestion to address the issue

Resident of both the rural and urban samples was asked to give their response towards suggestion if any to tackle the problem of flood in their locality. While rural respondents were mostly confined to yes or no type of response, without going into the detail of nature of suggestion, urban people have given their views to address the issue of urban flood in their own way. The response given by rural and urban habitants are separately presented in Figure 7.27 and 7.28 respectively. It has been observed that more than half of the average rural respondents (57.8%) have to say no suggestions at all towards the issue of flood in their locality. It may be interpret as their indifferences towards the issue, distrust with government interventions or, in the positive side their ability to cope with the crisis by themselves.
Contrary to rural situation, urban people have shown greater sensitivity to the issue of flood and accordingly added a wider range of suggestions from traditional to technological. With more than 60% average urban respondents have thrown weight on drainage related issue like blockage, poor maintenance etc. as major causes of urban flood, almost equal average respondents (58.2%) have suggested drainage related measures to eradicate it. Statistics shows highest 33.4% average respondents have advocated for regular cleaning of drainage. However during the field visit some gloomy situation was also unfurled, like road side dumping of the debris from the drainage, especially in the bye-lanes and sub-lanes. Such practices ultimately mess up the whole effort and intensify the problem during the rainy season.

Average 24.8% of the urban respondents have supported the idea of an additional drainage, an idea which was also floated by the authority, under Guwahati Municipal Development Authority initiative. The concept behind the idea is to divert the water rushing down from the Meghalaya side towards Bonda and Deepor bil in either direction, before entering the main city. Rushing of water from the Meghalaya side during the rainy season towards the city is shown in the photograph section that in itself indicates one of the root causes of the urban flood of the region.

In addition to drainage, maintenance of road (18.2%), technological support (12.0%) and public sensitization (11.6%) are also identified as some of the suggestive measures to address the issue of urban flood. Public sensitization can definitely go a long way in addressing some civic issues like garbage dump, creation of different kind of pollution, use of plastics etc. which all have their otherwise cumulative effect in creating and aggravating the issues like urban flood. In ever expanding cities like Guwahati, which have continuously bear the brunt of population
and related pressures, authority can't solve any problem in themselves, unless supported by the residing people of the affected localities. Figure 7.27 and 7.28 have not only identified the problems and their suggestions, but also indirectly reflected on the level of consciousness of the people of the concerned localities, who are actually living with the problem. As mentioned earlier, mechanism to incorporate the views of the affected people will also help to deal with the issues from multiple directions. Such a mechanism will automatically build-up a culture of participatory approach towards addressing the problems of the society and the people at large.

![RURAL RESPONDENTS' SUGGESTION LEVEL (IN%)](chart)

**Figure: 7.27 Rural respondents’ suggestion level (in%)**
7.4.13 Role of Non-government organization

Recent trend in management of natural disaster have highlighted the role of Non Government Organization (NGO) as a vital stakeholder in the relief and response effects especially with respect to facilitating communication and coordination between the administration and affected communities. NGOs have strong grassroots presence with strong linkage to community, who can easily respond to the need of the community.

Disaster Management Act, 2005 has emphasized the need of NGOs and therefore mandates the state executives committees with the responsibilities to advice, assist and coordinate the activities of NGOs engaged in disaster management. The National Policy on Disaster Management, 2009 spells out the role of NGOs as potential partner for disaster management. Various sectors NGOs are associated with...
includes: education, health, shelter, livelihood, water and sanitation, protection of vulnerable groups, environmental management, work with disabilities, supply and relief etc. (NDMA guideline, NGO role, 2015).

Considering the importance of presence of NGOs, both rural and urban respondents were asked to put their views regarding presence of NGOs in their locality in form of yes and no. It has been observed that among the rural only 10.4% average respondent acknowledged the presence of NGOs in their locality, with a huge average of 89.6% turned it down. Contrary to that among the urban respondents average 31% have acknowledged the presence of NGO. However in this context mere presence of non-governmental organizations can hardly do any better, unless and until their roles are closely monitored by the local people concerned. In this context an effective public-private partnership can be floated under the scanner of NDMA guidelines for an effective hazard management strategy. With growing of technical supports like geographic information system and other operations related to rescue and rehabilitation and simultaneous skill building of all concerned stakeholders, a more effective disaster risk reduction strategy can be expected in future.
7.4.14 Various adaptation practices

Rural and urban people have taken up various adaptation measures to fight and cope with their flood and related issues. It primarily depends upon nature and volume of the problem and the avenues that they normally possess. A comparative data analysis in the surveyed locality have shown that rural people are mostly depending on change of location in terms of moving to safer place during the flood period. However urban resident have to tackle the issue of short term inundation, which they need to tackle in a day-to-day basis. The findings of the respondents view are presented here as a location specific observation by using pie diagram technique.
It may help us to analysis how under different location people use to adapt to different methods to cope with the impending problem.

Most rural resident have opted for adaptation measures like: moving to safer location, preferably a highland unaffected by flood water (36.51% average respondents). Arrangement of makeshift boat for to-and-fro movement in their locality during flood is also responded as a part of adaptation by 28.86% average respondents. In addition adequate sheltering (22.11%) and move to houses of their relatives (12.52) are reflected as alternative options. Figure 7.30(a)-to-7.30(j) has reflected on the location specific adaptation practices.

Figure: 7.30(a) Adaptation practices, Rajabari
Figure: 7.30(b) Adaptation practices, Tatimara

Figure: 7.30(c) Adaptation practices, Uttar Dimoria
Figure: 7.30(d) Adaptation practices, Digarupara NC

ADAPTATION PRACTICES BY THE RESPONDENTS
KASUTAU KAMRUP METRO DISTRICT

Move to relative's place 19%
Prepare makeshift boat 28%
Adequate sheltering 31%
Move to safe location 22%

Figure: 7.30(e) Adaptation practices, Kasutali

ADAPTATION PRACTICES BY THE RESPONDENTS
DURUNG, KAMRUP METRO DISTRICT

Prepare makeshift boat 43%
Move to relative's place 9%
Adequate sheltering 13%
Move to safe location 35%

Figure: 7.30(f) Adaptation practices, Durung

ADAPTATION PRACTICES BY THE RESPONDENTS
MURKATA, KAMRUP METRO DISTRICT

Prepare makeshift boat 4%
Move to relative's place 29%
Adequate sheltering 30%
Move to safe location 37%

Figure: 7.30(g) Adaptation practices, Murkata
ADAPTATION PRACTICES BY THE RESPONDENTS
AMARAPATHAR, KAMRUP METRO DISTRICT

Figure: 7.30(h) Adaptation practices, Amarapathar

ADAPTATION PRACTICES BY THE RESPONDENTS
SONAPURPATHAR, KAMRUP METRO DISTRICT

Figure: 7.30(i) Adaptation practices, Sonapurpathar

ADAPTATION PRACTICES BY THE RESPONDENTS
MAJIRGAON, KAMRUP METRO DISTRICT

Figure: 7.30(j) Adaptation practices, Majirgaon

214
Contrary to rural scenario, urban dwellers have given their opinion towards certain adaptation practices that suited their problem and living condition. As majority urban respondents are vocal in terms of their prime problem of blockage and poorly maintained drainage system, more than 1/3rd of the respondents (average 69%) have advocated for cleaning of drainage at a regular basis. In addition plantation (average 12.66%), water conservation (11.8%) and soil conservation (5.6%) are also identified as long term initiatives, as a part of urban flood adaptation practices. Location specific responses are shown by pie in Figure 7.31(a)-to-7.31(g).

**Figure:7.31 (a)** Adaptation practices, Anil & Nabin Nagar

**Figure:7.31 (b)** Adaptation practices, Rajgarh
ADAPTATION PRACTICES BY THE URBAN RESPONDENTS
ZOO ROAD, KAMRUP METRO DISTRICT

- Water conservation: 19%
- Plantation: 15%
- Soil conservation: 10%
- Drainage clean: 50%

**Figure:7.31 (c) Adaptation practices, Zoo Road**

ADAPTATION PRACTICES BY THE URBAN RESPONDENTS
JONALI, KAMRUP METRO DISTRICT

- Water conservation: 14%
- Plantation: 8%
- Soil conservation: 8%
- Drainage clean: 70%

**Figure:7.31 (d) Adaptation practices, Jonali**

ADAPTATION PRACTICES BY THE URBAN RESPONDENTS
BHASKAR NAGAR, KAMRUP METRO DISTRICT

- Soil conservation: 4%
- Water conservation: 18%
- Plantation: 14%
- Drainage clean: 64%

**Figure:7.31 (e) Adaptation practices, Bhaskar Nagar**
Various factors like type, frequency of hazard, economic conditions of the people, living environment, available resource base etc. all have their combined affect on practising of various kinds of adaptation methods. However as indicated by the respondents of villages and urban locations there are clear differences in adaptation practices of rural and urban dwellers. As most villagers are used to flood events, they normally adapt by shifting place of residence to safer zone, which urban dwellers can hardly entertain. Secondly with make-shift boat like bamboo raft or regular wooden boat, mobility of the rural flood affected people are rarely disturbed
during the flood events. Rather with flood water, navigation and fishing, give an additional source of living to a section of people.

Contrary to rural, urban people have to fight in terms of adapting to sudden flood events. As shown by the respondents’ view, majority urban dwellers have raised the issue of cleaning of drainage at a regular basis, which according to them is a major source of water-logging in their locality. In addition as said earlier they have advocated for long term initiatives like forest and soil conservation etc. During flood events mobility become a challenge in urban locality due to many parallel issues like danger of electrocution with submerged transformer, household inverter, open manholes, etc. In addition vehicular damage that runs on flood water also adds to the damage impact of the urban dwellers.

7.5 Hazard Vulnerability of the Sample Village and Ward Locations

The third part of the structured questionnaire deals with assessment of hazard vulnerability and its related coping mechanism based on community response of the affected sample study location. The data-base is enclosed in form of annexure with appendix IX and X. Some of the observations are enclosed in the following discussion.

7.5.1 Location of the residence

Identification of rural-urban sample location of residence have revealed that rural people belong to those vulnerable villages, which are falling either on a low lying zone or along the river bank with a combined 96.2% of average response. On the other hand average 94.1% urban dwellers live in low-lying area as shown in Figure 7.32.
Analysis based on the perception of respondents towards vulnerability rank in a 10-point scale have also indicated the fact that among the rural highest vulnerability rank goes to Majirgaon, followed by Kasutali and Tatimara (as indicated by figure 7.41). It justifies the fact that villages in close proximity to river are the most vulnerable (exposed to the flood hazard) because of their geographical location itself. Similarly, in case of the urban sample locations, Anil and Nabin Nagar indicated the highest rank in the scale, which falls in the lowest point of the bowl shape structure of the city, which causes natural inundation during the rainy season.

Figure: 7.32 Location of rural-urban residence
7.5.2 Vulnerable structure of the locality

Nature of vulnerable structure vary from rural to urban depending on their type of economic background and development activities which is reflected in the household survey too. In top of the list both rural-urban have responded with house as the most vulnerable structure (average 40.9% and 42.3% respectively). Among the individual location people of Anil and Nabin Nagar have responded with houses as the most vulnerable with highest 73.33% average response. During field visit houses of both Assam type and multi-storied were identified that left abandoned.

After houses, the second most vulnerable structure of both the locality is identified as exclusive of themselves. The rural respondents have identified paddy field with average 29.6% of respondents; while urban have given their weight on public property as the second most vulnerable structure (average 24.6%). So is the case for third most vulnerable structure of rural location, identified as houses of livestock, which was not even recognised in urban condition (average 14.6% of response).

Apart from the responses towards vulnerable structure exclusively either by rural and urban, shops and business establishment and road network is identified as common for both with contrasting response. Shops and business establishment are given a meagre average 2.9% response by the rural, which rose more than five times in urban context to 11.9%. During field survey of shops and business establishment in each urban locality, owner of the establishments have expressed their helplessness and resentment towards the authority concern. In case of the by-lanes and sub-lanes many shops and vendors were noticeable phenomena that lie unused or abandoned. In some cases the shopkeepers try to raise the building, slabs etc. with their own
effort to restrict the flood water from entering the shops. In case of road network too urban responses were just about double with 21% average respondent identified it (11.9% average rural). In urban condition lifespan of roads which are frequently inundated by flood water become short and quickly damaged even after restructuring. Lack of sufficient drainage has also aggravated the problem. Figure 7.33 have identified the comparative situation of exiting vulnerable structure in both rural and urban conditions.

7.5.3 Livelihood security of the household

As understandable, rural-urban sample of the household have reflected contrasting situation of livelihood security. Among the rural respondents a massive average 69.7% respondent feels that there is no livelihood security in their living condition. In addition average 23.9% have no idea at all regarding their livelihood security. A meagre 6.4% feel to have the security. With maximum damage of crop field and livestock, rural economy is severely affected during the flood season, which ultimately reduced their livelihood security.
Contrary to that urban people’s response is equally poised with average 36.6% have claimed to have livelihood security, which is about 6 time’s higher response than the rural. But the concern is equally high average respondents have claimed that they don’t possess livelihood security (average 39.2%). Interestingly 24.2% of average respondents have no idea on their own livelihood security, which is a higher response than its rural counterpart. The situation has been explained by above Figure 7.34.

Figure: 7.34 Livelihood security of the sample household
7.5.4 Resource to tackle hazard

A secured livelihood not only generates people's possession of resource at household level, but also enables them to cope with adverse consequences of situation like flood. When enquired, respondents of both rural and urban have given contrasting situation towards having a healthy resource possession. The resourcefulness refers to their stable livelihood support, indigenous knowledge and skill to tackle crisis situation like flood and other hazards etc.

With a massive average 69.7% rural respondent feels that there is no livelihood security, only 10.5% have admitted to have possession of their own resource. On the other hand average 67.8% said that there is no possession of resource as such, to fight and stand during the period of crisis. Average 21.7% rural respondents have no idea about any such possession, in whatever form. Inability to identify the resource base that they have ultimately make them over-dependent on outside assistance during the period of crisis.

Contrary to rural, 24.6% average urban responded admitted to have their own resource in various form to stand the crisis, which is more than double the rural response. However there is no scope of complacency due to the fact that more than half of the urban respondents (average 55.5%) believed that they don't possess such resource, which can safeguard them during the crisis. Equally good number of 19.9% respondents shows their inability in identifying any such resource in them by responding as no idea. The comparative situation is diagrammatically highlighted in Figure 7.35.

Possession of resource gives people confidence to withstand the impact of hazard events. Contrary to that lack of resource make them dependent on outside
assistance during hazardous crisis. Another interesting observation is lack of idea about resources that the affected people might possess. It is an indication of people’s ignorance about certain resources that they may have, but remain unaware or unutilized in the process. Such ignorance can be reduced by developing people’s awareness towards the resource, which can ultimately benefit them in time of hazard related crisis.

**Figure: 7.35** Perception towards possession of resource

### 7.5.5 Items picked up during crisis

During field survey rural and urban respondents were asked to choose their top five (5) items that they are likely to pick up during an impending flood hazard. Many household have identified even more than five items that they like to pick up during such situation. However among various items top five are identified,
converted them to percentage for analysis. Such data base generation may help towards identifying the belongings and preferences for various household items by the people, who is actually suffering the problem. Apart from that identification of the belonging of the people by themselves may help the authorities concern in estimation of scientific relief and rescue mission during crisis, in time.

It has been observed that both rural and urban have their different types of preferences depending on their type of lifestyle and possession of belongings. Apart from that rural people have identified those belongings which they normally tend to move to safer zone during the crisis. Contrary to that urban people are hardly to move to other places, but at the most, need to live in confinement like house arrest for a day or two. Naturally urban people prefer to stockpile certain items that they may fail to access to during the crisis.

Quite understandably the top three items tend to be picked up by the rural people are food (average 27.5% respondent), livestock (average 22.7%), and cloth (average 19.5%). It is followed by money and cards (14.7%), day-today items (11.6%) and a meager average 3.9% for important documents and papers.

Interestingly the top three preferences to be picked up by the rural respondents are not at all coming under consideration in the minds of urban people. Instead of that three top items that occupies the mind of the urban respondents are first-aid-kit (average 27%), money and cards (25.4%), medicine (21.8%), followed by day-today items (13.1%). Average 12.7% of the respondents identified drinking water to be stockpiled. It is a unique scarcity that the urban people have to face with during the period of crisis in Guwahati. Figure 7.36 and 7.37 have reflected on the entire situation.
**Figure: 7.36** Items picked up during crisis, rural (y-axis indicates % of respondents)

**Figure: 7.37** Items picked up during crisis, urban (y-axis indicates % of respondents)
7.5.6 Participation in decision making

The UN International Conference HABITAT II in Istanbul in 1996 in its final document had stressed on 'local action' towards disaster risk reduction (DRR). The document had claimed that the most effective DRR are usually provided through volunteer contributions and local authority actions at the neighborhood level (Rao, 210). Rio Declaration on Environment and Development states about the people's participation that 'environmental issues are best handled with the participation of all concerned citizens at the relevant levels'. To promote effective participation access to information should be guaranteed. Decision making should not be restricted to authorities concerned. Rather public participation on environmental issues can be a source of additional information and scientific and technical knowledge to the decision makers. For effective participation public need to be aware of means and method of participation and problem solving (Shrivastava, 2015).

In Indian context, management of water resources for diverse uses through participatory approach, involving not only governmental agencies but also the users and other stakeholders are emphasised. Involvement of local bodies including municipality and gram panchayat, role of women etc. are given importance with a view to eventually transfer the management of such facilities to the user-group/local bodies (National Water policy, 2002). In state like Assam with 10.5% of the total geographical area occupied by water resources, promotion of beneficiaries' participation in all aspect of water planning and management is given priority (State Water Policy, Assam, 2007).

Figure 7.38 is an attempt to explore people's participation level both in rural and urban context of the surveyed locations. Respondents were asked to put their
view on whether they participate in their household and neighbourhood local level in various decision making process, by acknowledging as yes, no and partially true. The idea is to see their response, which ultimately help to visualise on their habits of participation or ignorance towards things that happen in and around them.

It has been observed that urban respondents have double the positive response towards participation in decision making at their level with average 25.6, than its rural counterpart (12.9%). But depressing thing is that in both cases a sizeable number of respondents said no to participation in decision making (average 61.8% rural and 56.7% urban). Under such circumstances, to address the issues of their locality people’s participation at various level of decision making have to be lifted up. As various mechanism of people’s participation is incorporated in present developmental activities, people should take it as an opportunity to raise their views.

1/4th of the rural respondents i.e. average 25.3% said that their participation in decision making at their level is partially true, that stand 17.7% in case of urban. Such trend of participation ultimately reflects their ignorance towards various developments around them.

With NDMA mandates of public-private partnership building towards disaster risk reduction approach, participation of all concerned stakeholders become relatively easier to implement. However unless and until the hazard affected people become aware about such mechanism, participation in true sense can’t be expected. In this context certain other developments like overall literacy of the people, NGO role etc. can prove beneficial for the people in long run. People’s participation in decision making will ultimately able to deliver a strong culture of disaster mitigation and prevention.
7.5.7 Asset insurance

Among various hazard preparedness measures insurance still have a greater role to play in developing countries including India. Insurers wanting to provide insurance services to the poor face the challenge of setting up affordable rates which can also ensure the financial sustainability of the programme. In the end even if a risk is considered insurable, it may not be profitable or sustainable as it may be impossible to specify rate for which there is sufficient demand and incoming revenue to cover the development, marketing and claim cost of the insurance and still yield a net profit (Parsad, 2009).

Among non-structural measures insurance against flood requires local action as well as national coordination. It is realized that flood and their negative consequences can only be managed, not controlled. The seasonal rainfall in state like Assam is largely a consequence of heavy rainfall within a period of few days/weeks.
during the monsoon. In this context flood management policy of the state would begin with the premise that people are prepared to live with the flood in ways that are least disruptive and harmful to them (State Water Policy, Assam, 2007). In this backdrop, an insurance mechanism against flood and the affected people can bring a healthy environment to mitigate the loss affect. The case study of selected vulnerable villages and ward locations tries to enlighten on people’s general perception towards flood insurance mechanism.

A clear contrasting situation related to rural-urban response towards insurance is apparently visible from Figure 7.39. Among the rural respondents only 6.94% of average respondents are familiarized with insurance, whereas it rise more than ten (10) times in case of the urban with average 63.3% of respondents. Definitely it is an issue directly related to one’s income. But at the same time
people’s awareness towards importance of insurance can help towards improving the trend in future.

7.5.8 Vulnerability status of the houses

Both rural and urban respondent are asked to identify the state of vulnerability of their houses in qualitative terms as low, medium and high. Maximum of respondents in both cases have identified their houses as moderately vulnerable with average 55.2 and 58.2% of respondents for rural and urban respectively. It was followed by the high vulnerability with 28.9% for rural and 20.7% for urban response. Contrary to both, only 15.9% rural responded identified their houses as low vulnerable, which was slightly higher with 21% of urban response as shown in Figure 7.40.

Figure: 7.40 Vulnerability statuses of houses
7.6 Assessment of Vulnerability Rank

As a part of vulnerability assessment of the affected community and their coping mechanism a 10-point rank analysis was made both in rural and urban situation. For the analysis household were asked to respond to certain variables based on their own perception in a 10-point scale (1-to-10), where value of 1 in the scale refers to the lowest and 10 to the highest of the rank. Accordingly value of all villages and ward locations were listed rank wise.

In case of vulnerability ranking perception based rank value of all villages and ward locations were enlisted rank-wise to calculate the average vulnerability rank (AVR) of the concerned village or ward location. Finally a graphical representation of AVR is prepared for comparative analysis of the situation (Figure: 7.41).

![Average Vulnerability Rank (AVR) in 10-Point Scale](image)

**Figure: 7.41** Average vulnerability rank of sample study area
Findings on vulnerability

i) Overall, average vulnerability of rural locations is marginally ahead of urban with average 4.89 rank values in a 10-point scale, closely followed by urban average vulnerability of 4.12. Both falls in moderate vulnerability.

ii) Among the rural samples Majirgaon under Ajara-circle have the perfect 10-point in the rank, which is the most vulnerable among 10 surveyed villages, which is continuously put in danger by breaching of Dharapur-Majirgaon embankment site.

iii) Majirgaon is followed by Kasutali (6.2) and Tatimara (6.0), located close to the river bank of Diagru and the mighty Brahmaputra in Sonpaur and Chandrapur circle respectively.

iv) Among the urban locations Anil and Nabin Nagar have the maximum of 5.5 ranks in a 10-point scale, which is the most vulnerable part of the city.

(The actual rank-wise value against each village and ward locations in a 10-point scale are enclosed in appendix XI (rural) and XII (urban) respectively).

Figure 7.42 has shown the location map of the survey villages and wards locations of the district with shaded section.
Figure: 7.42 Location map of sample study area
The visual image of land-use land cover of Kamrup Metropolitan is giving us ample scope of understanding the vast undulation of the topography of the region. The entire low-lying belts used by settlers over the years are distributed along the hills and highland that surround the entire district. With growing population the low-lying and surrounding hills are coming under tremendous pressure, leading to growing vulnerability of the entire region in terms of flood, landslide etc.
7.7 Correlation of Vulnerability with Coping Mechanism

How people are going to cope with an adverse situation like flood is determined by a number of factors. It is a general understanding that people who have basic awareness about how to cope with adversity, ultimately survive crisis like flood, while the other start panicky.

As a part of judging the awareness level of people on their own coping capacity, affected people of both vulnerable villages and ward locations were asked to put their view in terms of rank in the same 1-to-10 point scale (lowest-to-highest). For the purpose of analysis four parameters were selected as a part of reflection of coping mechanism, identified as status of community during hazard events. Respondents were asked to put their rank value. The parameters are:

i) People's self-preparation to fight with hazardous situation.

ii) People's view towards government assistance.

iii) Training and awareness programme attended by the people and

iv) NGO functions in the affected locality.

It is obvious that one who is unaware about all these parameters eventually suffer during crisis. After finding out the rank value of each of the parameter a correlation is tried to be established between the parameters under coping mechanism with that of vulnerability status as given in table 7.4 (rural) and 7.5 (urban).
Table 7.4 Rural sample correlation of vulnerability and coping mechanism
(Karl Pearson’s correlation)

<table>
<thead>
<tr>
<th>Villages</th>
<th>V to SP</th>
<th>V to GA</th>
<th>V to TAA</th>
<th>V to NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajabari</td>
<td>-0.194540568</td>
<td>-0.411092284</td>
<td>-0.307056795</td>
<td>-0.360891842</td>
</tr>
<tr>
<td>Tatimara</td>
<td>0.975835957</td>
<td>-0.385536117</td>
<td>-0.324948257</td>
<td>-0.300652146</td>
</tr>
<tr>
<td>Uttar Dimoria</td>
<td>0.816336168</td>
<td>-0.021583829</td>
<td>0.255997349</td>
<td>-0.323963221</td>
</tr>
<tr>
<td>Digarupara NC</td>
<td>0.419892732</td>
<td>-0.329400414</td>
<td>-0.179961995</td>
<td>-0.219333852</td>
</tr>
<tr>
<td>Kasutali</td>
<td>-0.169757612</td>
<td>-0.11093602</td>
<td>-0.378771192</td>
<td>-0.385563394</td>
</tr>
<tr>
<td>Durung</td>
<td>0.17983427</td>
<td>-0.238537404</td>
<td>-0.283773583</td>
<td>-0.188392472</td>
</tr>
<tr>
<td>Murkata</td>
<td>0.011365894</td>
<td>-0.221420275</td>
<td>-0.089034158</td>
<td>-0.006447366</td>
</tr>
<tr>
<td>Amarapathar</td>
<td>-0.02192645</td>
<td>0.363378652</td>
<td>0.148539528</td>
<td>0.176613896</td>
</tr>
<tr>
<td>Sonapurpathar</td>
<td>-0.301940542</td>
<td>0.883176087</td>
<td>-0.064082312</td>
<td>-0.048780528</td>
</tr>
<tr>
<td>Majirgaon</td>
<td>0.814680891</td>
<td>0.583854823</td>
<td>0.842080558</td>
<td>0.246041538</td>
</tr>
</tbody>
</table>

(V=Vulnerability, SP=Self Preparation, GA=Government Assistance, TAA=Training & Awareness attended, NGO=NGO Role)
Table: 7.5 Urban sample correlation of vulnerability and coping mechanism

(Karl Pearson's correlation)

<table>
<thead>
<tr>
<th>Ward Locations</th>
<th>V to SP</th>
<th>V to GA</th>
<th>V to TAA</th>
<th>V to NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anil Nagar &amp; Nabin</td>
<td>0.382969894</td>
<td>-0.106333263</td>
<td>-0.668791277</td>
<td>-0.576925646</td>
</tr>
<tr>
<td>Nagar</td>
<td>0.569931198</td>
<td>-0.435798955</td>
<td>-0.384764234</td>
<td>-0.551832914</td>
</tr>
<tr>
<td>Rajgarh</td>
<td>0.342711769</td>
<td>-0.588956506</td>
<td>-0.235090245</td>
<td>-0.590478777</td>
</tr>
<tr>
<td>Zoo Road</td>
<td>0.508606663</td>
<td>-0.235475674</td>
<td>0.135373925</td>
<td>-0.330808098</td>
</tr>
<tr>
<td>Jonali</td>
<td>0.577350269</td>
<td>0.165900379</td>
<td>-0.328969078</td>
<td>-0.495238336</td>
</tr>
<tr>
<td>Bhaskar Nagar</td>
<td>0.662325633</td>
<td>0.446039289</td>
<td>-0.376858916</td>
<td>-0.194235534</td>
</tr>
<tr>
<td>Pub-Sarania</td>
<td>0.819985758</td>
<td>0.664807688</td>
<td>-0.327589011</td>
<td>-0.117127133</td>
</tr>
<tr>
<td>Sundarpur</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(V=Vulnerability, SP=Self Preparation, GA=Government Assistance, TAA=Training & Awareness attended, NGO=NGO Role)

Findings on the correlation

Statistically correlation coefficient value ranged between ± 1, from where the following type relation can be derived.

• +1.0 = two variables are perfectly related in a positive direction, indicating if one increases other variable will also increase. Now 0 to +1.0 will indicate how strongly or weakly the positive trend shows.

• -1.0 = two variable are perfectly related in opposite direction, indicating if one increases other variable will decrease. 0 to -1.0 will indicate how strongly or weakly the negative trend shows.
Based on the conditions the following type of relations can be derived.

**Vulnerability and self preparation related**

i) Vulnerability and people’s self-preparation to fight with hazardous situation maintain a positive relation in both rural and urban situation, indicating with increasing vulnerability people’s self preparation level to fight with it also increases, which is an ideal condition to mitigate the affect of hazardous incidence. It has some related observations like:

   a) Comparison reveals that urban condition have a strong positive relation between vulnerability and self preparation than the rural with average +0.55 correlation, while rural value stand at +0.29.

   b) Among the rural, riverside villages like Tatimara (+0.98), Majirgaon (+0.81) maintains strong positive relation between vulnerability and self preparation, indicating the fact that with increasing vulnerability, the riverside villages attained corresponding rise in self-preparation. It is generally an accepted fact that those riverside villages having maximum flood exposure are remaining prepared within themselves to withstand the impact of hazard by themselves.

   c) Contrary to rural, among the urban location Anil and Nabin Nagar (+0.38) have the second lowest positive relation between vulnerability and self preparation, though it’s the most severely affected flood zone among the urban locations.

   Looking at the comparative strength of the association, it can be observed that, self preparation level with increasing vulnerability of maximum flood vulnerable rural places like Tatimara (+0.98), Majigaon (+.81) etc. are three times
higher than its urban counter having maximum affect like Anil Nagar and Nabin Nagar (+0.38).

**Vulnerability to government assistance**

i) Vulnerability status and people’s view towards government assistance have maintained a weak positive relation in rural condition (+0.01), while in case of urban the relation is marginally negative (-0.01). Even among 10 villages 7 have maintained negative relation in this context. It indicates an opposite relation between vulnerability and government assistance, especially in urban cases, which need to improve for better management planning.

**Vulnerability to training and awareness programme attended**

i) Vulnerability and training and awareness programme attended by the people in both rural and urban context have reflected negative relation with -0.04 and -0.31 correlation values respectively.

**Vulnerability to NGO function**

iv) Both rural and urban localities under investigation have also maintained a negative correlation between vulnerability and functioning of NGOs in their localities. In rural context an average -0.14 indicate a marginal negative, which has gone down to -0.4 in urban, indicating a moderate negative association. Considering the magnitude of the problem, which is directly associated with loss of life and property of people, a constant grassroots level operation is the need of the hour. In
In this context for a better disaster management strategy an effective plan of action is the need of the hour, where a participatory, people centric mitigation drive can be incorporated. There is scope of formulating government strategy with active participation of people. Under NDMA mandates, partnership building with non-government organization can be effectively utilised. At the same time people's awareness generation towards attending to relevant training and awareness programme can brings much desired change in near future.

Coping mechanism may be thought of in relation to the hazard event period. It is related to preparedness during event and long term event and adaptation to expected further event like moveable item shifting, developing livelihood, attend to emergency and warning system. Vulnerability involves a range of factors like age, gender, economic status of the affected people, resource ownership and access to resources etc. (Wisner, Gaillard and Kelman, 2012). On the light of such issues the above discussion tries to interpret the grassroots situation of flood hazard vulnerability and coping mechanism in rural-urban contrast in Kamrup Metropolitan district.
Figure: 7.45 Circle-wise vulnerable villages (x-axis indicates villages in %)

Based on population density and its converted weight form a vulnerability status of the three most affected circles is prepared as indicated by figure 7.45, where Azara came out with the maximum of 50% of highly vulnerable flood zone of the district and thus remain ahead of the other two circles in terms of flood vulnerability.