URBAN FLOODING FEASIBLE STRUCTURAL MEASURE AND SOLUTIONS FOR BANGALORE VRISHABHAVATHI VALLEY REGION

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ABSTRACT
The changes in the precipitation intensity, duration and frequency as a result of climatic shifts have made the floods more intense and frequent (Parry et al., 2007). This creates several challenges in sustaining resilience across urban ecological, social and economic systems (Hunt and Watkiss, 2010). Floods and the aftermath of the floods have become a major environmental challenge for urban regions across the globe. The Indian cities are vulnerable to floods due to evident climatic changes, improper drainage systems and uncontrolled constructions. The city of Bengaluru is vulnerable to floods in topographically low areas and major traffic junctions. There are about 128 locations identified as flood vulnerable points. The frequency and the intensity of rainfall are increasing in the city. This is causing flash floods which suddenly fill up the drains leading to overflow and causing flooding in the vulnerable areas. The sudden gushing of water has damaging effects on life and property. There is an urgent need of design and execution of flood mitigation measures which can play a major role in this flood disaster management. A carefully planned and executed mitigation measures can reduce the catastrophic flood consequences in urban areas. The present paper highlights on different structural measures like detention ponds and rainwater harvesting which can be conveniently incorporated, and the volume of runoff estimated to be conserved under the proposed scheme is significant.

KEYWORDS: Urban flooding, low laying areas, mitigation, retention ponds, rainwater harvesting, runoff estimation

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1. INTRODUCTION
Flooding is a common phenomenon in urban areas. Bangalore is often under flooding situation: reasons being, lack of planning, drastic land use changes, lakes transformed to layouts –loss of wet land area decrease in storage & recharge capacity, adhoc development of drainage system ,dumping of solid waste into the storm water drains causing choking, climate change which has resulted in higher rainfall intensities in short duration of time.

The city of Bangalore has been witnessing severe rains causing inundations in major city areas for several times in the recent past. Owing to this the city life gets disturbed and has hindered the daily activity of the citizens. A recent tank bund breach has resulted in water gushing onto to the street affecting the public life and property. This rapidly increasing number of floods and the massive damage it causes has made urban flood disaster management a subject of priority. A carefully planned and executed mitigation measures can reduce the catastrophic flood consequences in urban areas. In this context the present chapter details the different types mitigation measures and its applicability in the context of Bangalore city.

2. STUDY AREA
The study area Vrishabhavathy valley watershed lies in the Southern part of the Bengaluru city; no major river crosses the study area. A minor tributary of river Arkavathy rises at Basawanagudi south of Bengaluru and is called as Vrishabhavathy. Geographically, the study area is located at latitude 12.94º and 77.57 º E longitudes, covering a total area of about 156sq Km (Figure1). The study area is a mix of heavy built up area (Congested area) and moderately built up area.

3. OBJECTIVE
Mapping of pervious areas and proposing the techniques to divert the runoff to those areas from the major problematic regions. Estimating the runoff volume and how much it can be controlled/conserved by converting the open areas to storage areas, calculating the percentage runoff. Proposing drainage diversions to channelize the excess water to drainages.
4. METHODOLOGY
Flood mitigation can be undertaken through either structural or non-structural measures. Structural measures represent the actual physical structures that are constructed to control the flow of storm water, whereas non-structural measures refers to the policy, planning and programs involved in reducing flood risks. It also includes use of technology and scientific inputs towards monitoring and management of floods.

The present study focused on the structural measures and the possibility of its implementation in the city of Bengaluru as a means to minimize the adverse effects due to flooding; a clear and the present danger the city is currently facing. The present study proposes some of the green remedial measures which emphasizes on utilizing the open areas like parks, playgrounds for implementing of the green measures. Bengaluru city, though urbanized abundantly, still has some large chunks of open areas. The BBMP (Bruhat Bengaluru Mahanagara Palike) which is the city corporation has established a large number of park/gardens throughout the city. This can be used as a source point to divert the excess storm water. The following chart indicates the methods of mitigation.

4.1. Computation of Vol

<table>
<thead>
<tr>
<th>Methods of mitigation measures proposed in the</th>
<th>Structural measures</th>
<th>Non - Structural measures</th>
</tr>
</thead>
</table>

- **LID Techniques and Green Infrastructure Implementation**
  1. Ground recharge structures (retention and detention ponds)
  2. Roof top harvesting
  3. Diversion of flow
  4. Levees or Flood embankments

1. Flood Forecasting
2. Flood plain zoning
3. Early warning
4. Awareness in public Pre and post flood
5. Precautionary measures like don’t dump wasies as non-degradable materials in drainages

**Figure: 2 Methods of Mitigation**
Computation of Volume of Runoff per Year

The formula for runoff discharge from the reference is

\[
\text{Volume of Water received (m}^3\text{)} = \text{Built-up Area of Catchment} \times \text{Amount of Rainfall}
\]

5. RESULTS AND CONCLUSION

The pervious areas in the study area were mapped using High resolution satellite images. A GIS map of the same is shown in Fig:1. The total pervious areas i.e area of the vrishabhavathy valley region is calculated. The Table: 1 and Table: 2 gives the total volume of the runoff generated in valley and stored in these open areas.
Table 1 Water storage calculations for open lands and parks in V-Valley

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area of open lands in V-valley</td>
<td>154x10^6</td>
<td>Sq.mt.</td>
</tr>
<tr>
<td>Total area of parks in V-valley</td>
<td>2138946</td>
<td>Sq.mt.</td>
</tr>
<tr>
<td>Total area of pervious land in V-valley</td>
<td>1105873</td>
<td>Sq.mt.</td>
</tr>
<tr>
<td>Average rainfall for year</td>
<td>3244820</td>
<td>Sq.mt.</td>
</tr>
<tr>
<td>Total storage capacity of the total pervious lands</td>
<td>900</td>
<td>mm.</td>
</tr>
<tr>
<td><strong>Total storage capacity of the total pervious lands</strong></td>
<td>2920338230</td>
<td>Lts.</td>
</tr>
</tbody>
</table>

Table 2 Total runoff in the Vrishabhavati valley

<table>
<thead>
<tr>
<th>Subwatershed_Id</th>
<th>Area(SqKM)</th>
<th>Runoff Volume(cubic meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN-223</td>
<td>27</td>
<td>65392</td>
</tr>
<tr>
<td>V-100</td>
<td>38</td>
<td>947040</td>
</tr>
<tr>
<td>V-100-303-300</td>
<td>17</td>
<td>315558</td>
</tr>
<tr>
<td>V-200</td>
<td>34</td>
<td>839543</td>
</tr>
<tr>
<td>Rn-181</td>
<td>38.92</td>
<td>867113</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>154.92</td>
<td>3034645.64</td>
</tr>
</tbody>
</table>

The analysis, which has shown in Table 1 made it clear that the study area comprised of 32, 44,820 square meters of pervious land, which is capable of storing a runoff equal to 2920338230 liters (2920338 cubic meter) per year with respect to the average rainfall of 900 mm. Table 2 exhibited that the total runoff in the study area (Vrishabhavati valley) is approximately 3034645 cubic meters. From the comparison of these data, we can infer that if we convert these open
lands and parks into storage areas by taking proper structural measures and divert the surface runoff to these pervious lands, we can save around 96% surface runoff, which in turn help us to a great extent in avoiding floods.

5.1. Runoff Diversion structures

**Figure 4** Sketch showing retention ponds in public park

**Figure 5** Sketch of an example of parks approaching LID and GI techniques

**Figure 6** sketch of proposing LID practice for commercial parks.
5.2. Rain water Harvesting

*Figure 7* Sketch proposing LID technique in playground.

*Figure 8* shows the GIS map of the Roof top areas extracted in Arc Gis. The roof top areas are calculated in Arc GIS.
The outcomes of the flood mitigation measures suggested that 32% of the total runoff volume can be diverted to rainwater harvesting. The existing capacity of open tanks/lakes contributes to 5% of the total runoff volume; and, from Table 1 10% of open land infiltration and evaporation losses, the total surface runoff generated and diverted to the Storm Water Drain (SWD) is 53%.

REFERENCES


