Ecological and Energy Efficient Practices for Storm Water Management

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Problem Faced in Urban Water Sector

**Problem of more water**
Flooding due to high water yield from the surrounding catchments because of conversion of forest land to urban area

**Problem of inadequate drainage**
Reduction in drainage capacity due to high sediment yield from the upper catchments and their deposition in the drains and river.

**Problem of less water**
Water scarcity due to rapid depletion of ground water for reduced recharge and extensive pumping
Energy Involved in Management

Energy in pumping flood water

Energy for clearing water way

Lower the GWT more is the energy

More energy to drive
3D View of Guwahati using DEM
Effects of Vegetative Cover on Water Yield

<table>
<thead>
<tr>
<th>Present Maximum outflow at pilot watershed (cumec)</th>
<th>Outflow if bareland and open mix forest area are covered by vegetation (cumec)</th>
<th>Outflow if all the vegetation cover is removed from the watershed (cumec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.031</td>
<td>5.27</td>
<td>7.25</td>
</tr>
</tbody>
</table>

Map Showing 20 Flow Paths from Different Watersheds
Effect of Deforestation (RUSLE)

<table>
<thead>
<tr>
<th>Present annual sediment yield in tons/yr</th>
<th>Annual sediment yield in tons/yr if bare land and open mix forest area are completely covered by vegetation</th>
<th>Annual sediment yield in tons/yr if vegetation cover is removed completely from the watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>20943.88</td>
<td>7903.27</td>
<td>289412.6</td>
</tr>
</tbody>
</table>
Comparison of the watersheds

Lush green vegetation cover

Construction of house exposing subsoil strata to erosion
Runoff from the two watersheds

Clearer runoff from the undisturbed watershed

Sediment laden runoff from the disturbed watershed
Water samples from the watersheds

undisturbed watershed

disturbed watershed
Validation and Generation using GCM

An increase in the precipitation up to 20 % in the monsoon period could be seen by 2050’s.

Such high intensity rainfall will cause
• High erosion in the hilly catchment
• High Peak flow
• Longer dry spell
Measures for runoff and sediment control

Sedimentation basin
Measures for Controlling Water and Sediment Yield
GRASS LAND

SLOPE STABILIZATION STRUCTURE

Perforated Concrete Block
ROFTOP RAINWATER HARVESTING

HADGE FOR ROAD SIDE PROTECTION

PAVED GROUND WITH SPACE FOR RAINWATER PERCOLATION

FOREST LAND
RAIN WATER HARVESTING FOR URBAN FLOOD PEAK REDUCTION
Buildings and Drains in Hatigarh Watershed
Rain Water Harvesting Options

Solution 1

Solution 2

Solution 3

Solution 4
### Summary of RWH Analysis (Contd.)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Before Solution</th>
<th>After solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Only RTRWH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RTRWH +10 FW/ha</td>
</tr>
<tr>
<td>Water level in drains (m)</td>
<td>1.78</td>
<td>1.62</td>
</tr>
<tr>
<td>Sediment in drain (m)</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Depth of outlet drain (m)</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Flood with sediment control (m)</td>
<td>0.78</td>
<td>0.62</td>
</tr>
<tr>
<td>% Reduction in Maximum Runoff Volume</td>
<td>-</td>
<td>12.2</td>
</tr>
<tr>
<td>% Peak Discharge Reduction</td>
<td>-</td>
<td>12.20</td>
</tr>
<tr>
<td>% Flood Reduction in Drains (without Sediment Control)</td>
<td>-</td>
<td>20.5</td>
</tr>
<tr>
<td>% Flood Reduction in drains (With Sediment Control, Studied by Bracht and Sarma)</td>
<td>-</td>
<td>20.5</td>
</tr>
</tbody>
</table>
We need to go for Optimal Ecological Management (EMP) Practices
Experimental Watershed

- Denudation leads to:
  - Increase in total sediment yield: as high as 21 times
  - Changes in Chemical Composition of Water

- Efficiency in Sediment control:
  - Grass = 65%-100%
  - Herb = 38% - 97% (compared to barren land)

- Sediments in runoff

- Denudation leads to:
  - Increase in total runoff volume: as high as 54 times
Integrated Planning and EMPs for Hazard Mitigation

Technical Core Committee (TCC) with 11 govt. departments was constituted in June 2010

- Plots under single ownership
  - OPTEMP-LS model
- Plots under multiple ownership
  - OPTEMP-LM model
  - OPTEMP-LDM model

Work accomplished under pilot project planning

- **August 2010**: Initial concurrence from state govt.
- **June 2011**: Final concurrence from state govt.
- **January 2012**: Work order issued for land survey
- **March 2012**: Survey work completed

- **October 2012**: Completed the Conceptual DPR
- **May 2013**: Govt agreed to implement the EMP concept
Urban Carrying Capacity (SAFE)  
(Sustainable Accommodation through Feedback Evaluation)

**Step 1:** Delineation of hilly urban area for which carrying capacity need to be calculated.

**Step 2:** Demarcation of non-developable areas

**Step 3:** Computation of area required for different infrastructure and facilities

**Step 4:** Assessment of net area available for residential development

**Step 5:** Estimation of Floor Area Requirement per person

*Based on socio-economic status of the prospective residents of the developable hilly area, an average floor area required for each person is determined.*

**Step 6:** Carrying Capacity Calculation through iterative procedure

\[
CC = (A_U - (A_{NDA} + A_{IF}[CC])) \times FAR/S
\]

**Step 7:** Feedback Evaluation: Recheck for Drainage, Sediment yield etc.: If insufficient- Apply EMP (Technical Intervention), or adjust FAR
153B Channel Design

Fig: Stepped Chutes (from E to F, length = 50m)
Detail Planning in Already Developed Area
Retaining wall
Grass Plantation
Perforated Blocks
Step Drain
Creepers
Steps Along the slope
Made of concrete

Grass Plantation

Creepers
Geosynthetics
Urban Drains

Hole for flow of logged water

Gravel Road
Thanks