Flooding Vulnerability of the Towns of Santa Maria and Mabitac, Laguna, Philippines

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The Philippines and its climate

- Archipelago
- Western rim of the Pacific
- Cyclonic climate

CLIMATE CHANGE
Objectives of the Study

- Analyze for the study areas, flood vulnerability as a function of elevation, land use and hydrologic/hydrometeorologic parameters;
- Conduct social vulnerability analysis on the flood-prone barangays of the two towns;
- Combine geo-physical and social parameters in the assessment of the flood vulnerability of different barangays in the two towns;
- Recommend environmental management and mitigating measures that can increase the resilience to flooding of the barangays of Santa Maria and Mabitac, Laguna.
Conceptual Framework of the Study

- Hydrologic and Hydraulic Data
- River Profile and Cross-sectional Area
- Thematic Maps and Satellite Images
- Demographic Indicators
- Socio-economic Indicators
- Natural Resource Dependence Indicators
- Public Infrastructure Indicators

Physical Vulnerability Index

Vulnerability Index of the Area

Social Vulnerability Index
Research Methodology

- GIS Flood Mapping using ArcMap and HECRAS
- Input Data
  - Thematic maps
  - DEM
  - Synthetic flow hydrograph
  - river geometric data
Synthetic flow hydrograph modelling

- Hec–GeoHMS Processing
  - terrain processing
  - basin data processing
  - hydrological characterization

- HEC–HMS Processing
  - schematic network containing the basin data
  - meteorological data
  - control specification
Flood Vulnerability Mapping

- Hec-GeoRas Preprocessing
  - conversion of DEM to TIN
  - streamline processing
  - right & left bank processing
  - cross section cutlines processing
  - Creating the GIS Ras Import file

- HEC-RAS Modelling
  - cross section profile construction
  - inputting of manning’s n
  - inputting of synthetic flow hydrograph
  - running the model
  - creating the GIS Ras Import file

- Hec-GeoRas Postprocessing
  - converting the Ras file to xml format
  - creating the flood water surface elevation
  - subtracting the water surface elevation against the TIN model

- Flood Vulnerability Mapping
  - Reclassifying the map to a specified flood category
  - combining the social and geophysical factors
Research Methodology

- Social Vulnerability Analysis
- Input Data
  - secondary data
  - surveyed data
    > socio-economic data
    > Demographic data
    > infrastructure data
    > resource dependence data
RESULT OF THE STUDY
# Synthetic Flow Hydrograph

<table>
<thead>
<tr>
<th>Storm Return Period</th>
<th>Discharge (m³/s)</th>
<th>Rainfall Intensity (mm/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R170</td>
<td>R210</td>
</tr>
<tr>
<td>5-year</td>
<td>32.4</td>
<td>33.6</td>
</tr>
<tr>
<td>10-year</td>
<td>38.5</td>
<td>40.0</td>
</tr>
<tr>
<td>20-year</td>
<td>42.4</td>
<td>43.9</td>
</tr>
</tbody>
</table>
Flow hydrograph at R170
Flow hydrograph at R330
## Estimated Flooded Area (Square Kilometers) for Each Flood Classification in the Study Area

<table>
<thead>
<tr>
<th>Storm Return Period</th>
<th>Classification</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>5-year</td>
<td>5.486</td>
<td>6.734</td>
</tr>
<tr>
<td>10-year</td>
<td>2.376</td>
<td>7.497</td>
</tr>
</tbody>
</table>
Depths and Extent of Flooding of a 5-year Return Period
Depths and Extent of Flooding of a 20-year Return Period
Simulated Flood Depths and Actual Flood Depths
# Overall Social Vulnerability Index (Santa Maria)

<table>
<thead>
<tr>
<th>Barangay</th>
<th>Demographic Index</th>
<th>Socio-economic Index</th>
<th>Resource Dependence Index</th>
<th>Infrastructure Index</th>
<th>Social Vulnerability Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talangka</td>
<td>2.957</td>
<td>3.415</td>
<td>3.323</td>
<td>2.388</td>
<td>3.064</td>
</tr>
<tr>
<td>Adia</td>
<td>3.652</td>
<td>3.866</td>
<td>2.475</td>
<td>2.758</td>
<td>3.406</td>
</tr>
<tr>
<td>Masinao</td>
<td>3.018</td>
<td>3.878</td>
<td>4.132</td>
<td>3.197</td>
<td>3.470</td>
</tr>
<tr>
<td>Coralan</td>
<td>3.441</td>
<td>4.047</td>
<td>3.027</td>
<td>2.826</td>
<td>3.468</td>
</tr>
<tr>
<td>Bagong Pook</td>
<td>2.431</td>
<td>3.115</td>
<td>2.024</td>
<td>2.021</td>
<td>2.514</td>
</tr>
<tr>
<td>Barangay 1</td>
<td>2.824</td>
<td>3.611</td>
<td>2.297</td>
<td>2.374</td>
<td>2.914</td>
</tr>
<tr>
<td>Barangay 2</td>
<td>1.794</td>
<td>3.201</td>
<td>2.500</td>
<td>2.044</td>
<td>2.360</td>
</tr>
<tr>
<td>Barangay 3</td>
<td>2.555</td>
<td>3.524</td>
<td>3.138</td>
<td>2.200</td>
<td>2.880</td>
</tr>
<tr>
<td>Barangay 4</td>
<td>2.173</td>
<td>2.592</td>
<td>2.972</td>
<td>1.856</td>
<td>2.371</td>
</tr>
<tr>
<td>Jose Rizal</td>
<td>3.472</td>
<td>4.205</td>
<td>2.697</td>
<td>2.633</td>
<td>3.450</td>
</tr>
<tr>
<td>Kayhakat</td>
<td>3.129</td>
<td>3.557</td>
<td>2.565</td>
<td>2.403</td>
<td>3.0641</td>
</tr>
</tbody>
</table>
## Overall Social Vulnerability Index (Mabitac)

<table>
<thead>
<tr>
<th>Barangay</th>
<th>Demographic Index</th>
<th>Socio-economic Index</th>
<th>Resource Dependence Index</th>
<th>Infrastructure Index</th>
<th>Overall Social Vulnerability Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Antonio</td>
<td>3.748</td>
<td>4.158</td>
<td>3.580</td>
<td>2.422</td>
<td>3.688</td>
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<tr>
<td>Nanguma</td>
<td>3.739</td>
<td>4.199</td>
<td>3.588</td>
<td>2.622</td>
<td>3.733</td>
</tr>
<tr>
<td>Libis ng Nayon</td>
<td>3.379</td>
<td>3.965</td>
<td>3.559</td>
<td>2.512</td>
<td>3.510</td>
</tr>
<tr>
<td>Lambac</td>
<td>3.737</td>
<td>4.267</td>
<td>3.723</td>
<td>2.557</td>
<td>3.770</td>
</tr>
<tr>
<td>Pag-asá</td>
<td>3.710</td>
<td>4.022</td>
<td>3.246</td>
<td>2.436</td>
<td>3.574</td>
</tr>
<tr>
<td>Bayanihan</td>
<td>3.581</td>
<td>3.998</td>
<td>3.136</td>
<td>2.646</td>
<td>3.541</td>
</tr>
<tr>
<td>Sinagtala</td>
<td>3.500</td>
<td>3.694</td>
<td>3.429</td>
<td>2.580</td>
<td>3.429</td>
</tr>
</tbody>
</table>
Overall Vulnerability Map of the study area
The river cross-section and simulated peak flow in combination with DEM as input to the HEC-RAS modelling system, was able to predict the flood depths and delineate the inundated barangays of the two towns.
The results of the social vulnerability analysis indicated that all of the flood-prone barangays in Mabitac have weak possibilities of recovery. In Santa Maria, Barangays Jose Rizal, Masinao, Adia and Coralan are likewise socially very vulnerable to flooding.
Conclusion

- Low family incomes, unstable jobs, low educational attainment and health services are the primary social factors that must be looked into and resolved in order to increase the coping capacity and resilience of the identified barangays to flooding.
Recommendation

- development of comprehensive social services programs that cater to the health, job and education needs of the residents of the two towns particularly in the identified flood-prone areas
- creation and implementation of environmental programs that will restore the original state of the watershed in Santa Maria, Laguna
Recommendation

- strengthening the flood warning system and emergency response capacity already established by the local authority
END