Disaster Mitigation Module: Planning Flood-Prone Areas using GIS

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Background

The training module is part of the institutional commitment of UP to the CASITA Project to include disaster mitigation in SURP curriculum. As a result, disaster mitigation have been incorporated in the following courses: Land Use Planning as part of hazard mapping and planning special types of land use-flood-prone areas; and Special Problems in Urban Planning: Planning for Flood-Prone Areas.

Disaster Mitigation

Land Use Planning Course

Special Problems in Urban & Regional Planning: Planning for Flood-Prone Areas
Teaching Approach

To accelerate the learning process, a case study was developed to enable the students appreciate the use of GIS in applying land use planning principles in a flood-prone municipality.

In view of this, the module will: (1) involved lectures on Planning Special Types of Land Use: Flood-Prone Areas; and GIS; (2) GIS drill exercises; (3) analysis of the case study using GIS, and presentation of recommendations by the students.

Furthermore, digital data are provided for the students to analyze. They are expected to further process these digital data to produce thematic and decision maps and recommend an option in flood mitigation.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>PROCESS</th>
<th>OUTPUT</th>
</tr>
</thead>
</table>
| Lecture  
• Planning Flood-Prone Areas  
• GIS | GIS Drill Exercises | Case Study Analysis and Recommendation |

Learning Outcome

The students after undertaking the module will be able to:

• organize planning data;
• process planning data;
• produce thematic and decision maps; and
• select a viable option for a disaster prone municipality.
Outline

I. Lecture on: Planning Special Types of Land Use: Flood Prone Areas; and GIS
II. GIS Drill Exercises
III. Presentation of the Case Study and Leveling of Expectations
IV. Tutorial in analyzing the digital data in terms of:
   1. Organizing the Inputs
   2. Deriving Thematic Maps
   3. Formulating Decision Maps
   4. Selecting the Best Option
V. Student Analysis and Recommendations
VI. Resolution of Issues and Concerns

Lecture on Planning Special Types of Land Use: Flood-Prone Areas
Powerpoint Presentation: Refer to Annex A)

Definition of Flood
Causes of Floods
Types of Flood
Typical Adverse Effects
Causes of the Adverse Effects
Evolution of Approaches to Flood Management
Approaches in Dealing with Floods
  • Structural
  • Less Structural
  • Non Structural
Philippine Experience
Lecture on GIS

Characteristics of GIS

- Georeferenced information
  - Longitude
  - Latitude

- One to many relationship between the geometric and attribute information

- Maps with attached database can be converted to themes

- Thematic Maps are organized into layers to:
  - Identify Problems
  - Generate Solutions
  - (Decision Maps)

Georeferenced information
One to Many Relationship in GIS

Database 1  Database 2  Database 3

Map

Base Map Converted to Theme
Base Map: Drainage Map

Base Map Converted to Theme
Theme: Adequacy of Drainage Pipes During Floods Map

Base Map: Street Map Category
Thematic Map: Flooded Streets Map

GIS Process Applied to Flood Mitigation

Base Maps
- Rainfall Map
- Soil Map
- Elevation Map

Thematic Maps
- Permeability Map
- Hazard Map

Decision Maps
- Structural Option
- Less Structural Option

GIS
- Inputting Data
- Database Linking
- Thematic Mapping
- Geographic Analysis
GIS Drill Lessons/Exercises (Hand-outs)
Please Refer to Annex B

Lesson 1: Introduction
Lesson 2: Displaying Your Data
Lesson 3: Mapping in Layers
Lesson 4: Opening Files
Lesson 5: Putting It on the Map
Lesson 6: Selecting
Lesson 7: Labeling your Map
Lesson 8: Working with Layouts
Lesson 9: Using Thematic Maps for Analysis
Lesson 10: Redistricting
Lesson 11: Object Creating and Editing
Lesson 12: Buffering
Lesson 13: Integration

Case Study: Flood-Prone Municipality\(^1\)

The case study is about a municipality confronted by the overflowing of a river during the rainy season causing perennial flooding. Moreover, the case study requires the use of Geographic Information System (GIS) in processing the given inputs so that a viable development intervention can be selected. To accelerate the learning process, digital data are provided for the students to analyze. They are required to process these digital data to produce thematic maps and recommend an option in flood mitigation. Thus, the expectations from the student are:

- organization and processing of planning data using GIS;
- generation of thematic and decision maps; and
- selection of a viable development option for flood-prone municipality

The case study is divided into four modules. Module 1 focuses on the analysis of the given digital data. Module 2 is about digitizing of additional data to supplement the provided data. Module 3 is concerned in linking databases to the maps to be able to perform thematic mapping. Module 4 focuses on the generation of additional thematic maps. Module 5 is about selection of a viable development option by highlighting the issues and concerns.

\(^1\)Note: Refer to Annex C
Digital Data Provided

Digital Data 1 : Rain Gauge Station Map

Digital Data 2 : River Map

Rain Gauge Stations Map provide Rainfall Data

Rainfall Data (Table Data)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<th>Ave</th>
<th>Rain Days</th>
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<tbody>
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<td>22.2</td>
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<td>5.9</td>
<td>200.8</td>
<td>17.4</td>
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</tr>
</tbody>
</table>
Digital 3: Rainfall Map

Digital Data 4: Elevation Map
Digital Data 5 : Soils Map

Digital Data 6 : Land Use Map
Digital Data 7: Parcel Map

Digital Data 8: Street Map
Digital Data 9: Drainage Pipes Map

Digital Data 10: Permeability Map
Digital Data 11: Flood Prone Areas (Hazard Map)

Digital Data 12: Flood Risk Structures Map
Digital Data 13: Structures Affected Along Floodway Map

Digital Data 14: Structures Affected along Flood Fringe Map
Digital Data 15: Levee Map

Digital Data 16: Relocation
Group Discussion & Selection

Organize the Digital Data according to:
• Base Maps
• Thematic or Criteria Maps
• Development Options Map

Group A
Group B
Group C

Thematic Mapping

Base Maps

Thematic Maps
Group Discussion & Recommendation

Perform and Recommend Other Thematic Maps

Development Options

Criteria or Thematic Maps

Decision Maps
Decision Map 1
Levee, River Management, and Flood Insurance

Decision Map 2
Relocation, Rehabilitation, and River Management
Selection

- Cultural Dimension- Compatible with norms and beliefs of affected people.
- Social Aspects- The alternative selected minimizes the number of people affected.
- Political Viability- The option is acceptable to key actors.
- Economic- The alternative is the least cost.
- Continuity- The alternative will promote sustainability.

Decision Matrix

<table>
<thead>
<tr>
<th>Option</th>
<th>Cultural Feasibility</th>
<th>Less People Affected</th>
<th>Political Viability</th>
<th>Least Cost</th>
<th>Sustainability</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Alternative I: Levee and Flood Insurance</td>
<td></td>
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<tr>
<td>Alternative II: Relocation</td>
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</table>
Which Option to select?

Option 1 or 2?

Group Discussion & Selection

Group A  Group B  Group C
### Why?

### Answer

#### Base Maps
- Streets Map
- Rain Gauge Map
- Soils Map
- Drainage Pipes Map
- Land Use Map
- Parcel Map
- Structures Map
- Elevation Map

#### Thematic Maps
- Flood Prone Areas Map
- Flood Risks Population Map
- Permeability Map
- Rainfall Distribution Zones Map
- Drainage Pipes Capacity Map
- Critical Utilities/Land Use Map
- Flood Characteristics Street Map
- Traffic Characteristics Street Map

#### Decision Maps
- Option1
- Option2
Answer

Less People Affected
Option 1: 1906 people subsidizing 238 persons
Option 2: No subsidy required

Sustainability
Option 1
- Occasional Repair
- Rehabilitation
- Reconstruction

Option 2:
- Critical Landusing activities are flood free
- No repair, rehabilitation or reconstruction activities
Least Cost

Option 1: Cost Dimension are:
- Levee Construction
- Levee Maintenance
- Levee Repair
- Expropriation of Affected Properties

Option 2: Cost Dimension are:
- Construction of Infrastructure
- Subsidy in the Construction of Houses

Political Viability and Cultural Feasibility
varies from country to country