A-GIS BASED APPROACH FOR EVACUATION MODEL FOR TSUNAMI RISK REDUCTION

Case Study for Tsunami Evacuation Route Modelling
In Cilacap-central Java, Indonesia

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• Introduction
• Objective
• Method
• Result & Discussion
• Conclusions
Field of Study

http://explorations.ucsd.edu
Introduction

Why Cilacap needs an EVACUATION PLAN

- Cilacap has a flat topography
- Higher buildings are very limited
- It has many important facilities
- Many settlements along the coastline
Introduction

- Need an effective evacuation plan
- Improvement of measures to support evacuation of residents is necessary

Struck by tsunami on July 17, 2006

7.7 magnitude of Earthquake
> 600 people died & destruction to coastal villages and towns
• Tsunami has long period, rapidly, little warning

• No certain building → dedicated only for shelter building

• Finding suitable building is important → High building construction cost & efficiency in space occupation
Objectives

- To determine of potential suitable Evacuation Shelter Building (ESB): 1) location, and 2) evacuation capacity
- To develop a methodology to choose the most effective evacuation routes
The evacuation model is started from the concentration of evacuees

Needed detailed data from high resolution image → Building maps and road network
# Research activities

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Results

Building inventory

The purpose:
- to obtain information regarding the use of the buildings,
- number of occupants during daytime and nighttime population scenarios.
Results

Building Assessment for shelter building

Characteristics of building design required are:

- Earthquake and tsunami-resistant

- Elevated above the wave height and parallel to the expected direction of flow

- Able to load a large number of people

- Easily accessed

- Have an adequate stairs, or ramp to meet the building safety requirement
## ESB capacity estimation

<table>
<thead>
<tr>
<th>Build. ID</th>
<th>Name of Building</th>
<th>Floors</th>
<th>Build. Area (m²)</th>
<th>TEBC (person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1114</td>
<td>SD Islam Al Azhar</td>
<td>2</td>
<td>2,368</td>
<td>710</td>
</tr>
<tr>
<td>1123</td>
<td>SMP Islam Al Azhar</td>
<td>2</td>
<td>1,360</td>
<td>408</td>
</tr>
<tr>
<td>1131</td>
<td>SMA Al Irsyad</td>
<td>3</td>
<td>6,460</td>
<td>1,938</td>
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<tr>
<td>3158</td>
<td>STIKES</td>
<td>3</td>
<td>3,662</td>
<td>1,098</td>
</tr>
<tr>
<td>1282</td>
<td>Masjid Al Islah</td>
<td>2</td>
<td>448</td>
<td>349</td>
</tr>
<tr>
<td>1281</td>
<td>SMP Al Irsyad</td>
<td>2</td>
<td>2,312</td>
<td>694</td>
</tr>
<tr>
<td>3864</td>
<td>SMK Srimukti</td>
<td>4</td>
<td>2,721</td>
<td>816</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>6,014</strong></td>
</tr>
</tbody>
</table>
Results

Population estimation & scenario

Day scenario

Night scenario

Total population during day time 24.566 orang
Total population during night time 24.357 orang
Results

Network dataset

- Existing road data
- Detailed road data

- High resolution image and field observation were used to obtain detailed road network
- Speed of walking in particular road by considering impedance was applied
Generating evacuation model

- Service area
- Additional ESB
- Routes

Proposed additional shelter building
Proposed evacuation route
• The realistic model from tsunami evacuation model is determined by the detailed input data of road network, network attributes and population data.

• The detailed road network will enhance the model since the travel will be carried on from the centroids of tessellations (point of origin) to the closest network.

• The detailed building type is necessary so that the number of evacuees could be estimated.
Future work

• This evacuation model can be improved further if congestion areas can be identified by identifying the number of evacuees that passes a certain road or travel path segment.

• If we can formulate the problem in optimization form, we can answer such what-if question, as the followings:
  • What is the effect of increasing (or decreasing) the capacity of ESB?
  • What changes when an ESB is removed or added from the network?
  • What happened if the new roads are constructed?
  • What will be the result of an increase (or decrease) of population?
Thank you for your attention
Method

1. Quick-Bird Image
2. Visual Interpretation
3. Interpretation Key
4. Tentative Building Use Map
5. Fieldwork Observation
6. Building requirements for tsunami resistance
7. Verified Building Use Map
8. RW Map Number of households
9. Hexagonal Tessellation
10. Building Assessment
11. Intersection
12. Existing ESB
13. Building Maps as inputs for Population Estimation

Note:
- Data Source
- Process
- Result
- Workflow
Building Assessment
Network Datasets

- Detailed road network
- High resolution image and field observation
- Speed of walking in particular road by considering impedance
The results have made contributions of this research, as follows:

- The method which was developed in this study can be adopted by local government for developing evacuation planning as part of emergency planning.
- The evacuation model can be used to help elevate awareness and educate both residents and local government regarding tsunami mitigation.
- Existing ESBs, proposed additional ESB locations and evacuation routes resulted in this study can be used as valuable information for local government and community to anticipate problems and possible solutions for tsunami disaster reduction as well.