A Preliminary Integrated Tsunami Scenario Simulation

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Research Field:
Disaster mitigation by non-structural countermeasure / Evacuation Behavior / Disaster Information /
Disaster Education / Crisis Management /
Research Purpose

- Human damage mitigation from tsunami

- Developing a tool to diagnose tsunami evacuation plan in a coastal community

→ Integrated Tsunami Scenario Simulator
Tsunami Scenario Simulator consists of three model elements

1. **Geographic Information System**
   - **Tsunami Hazard**
     - Scenario Simulation
   - **Disaster Info./Guidance**
     - Plan Scenario Simulation
   - **Evacuation**
     - Plan Scenario Simulation

2. **Current evacuation Plan**

3. **Assessment (Casualty Estimation)**

4. **Best strategy for tsunami disaster preparedness**
Our Concern

Megathrust earthquake along Nankai Trough

- Subducting 4-5 cm/yr
- Magnitude Mw8.6
- Probability: 40～50% within next 30 years

Rupture Area:
- 1605 Keicho, M7.9
- 1707 Houei, M8.4, 5038 dead
- 1854 Nankai, M8.4
- 1854 Tokai, M8.4, 2658 dead
- 1944 Tou-Nankai, M7.9, 998 dead
- 1946 Nankai, M8.0, 1330 dead
- ??
Estimated Tsunami Height

Tsunami Source Area

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What is expected to happen?

Tsunami Hazard
Tsunami Scenario Simulator consists of three model elements

Current evacuation Plan

GEOGRAPHIC INFORMATION SYSTEM

Tsunami Hazard
- Scenario
- Simulation

Disaster Info./Guidance
- Plan
- Scenario
- Simulation

Evacuation
- Plan
- Scenario
- Simulation

Assessment (Casualty Estimation)

Best strategy for tsunami disaster preparedness
The Basic Structure of Simulation

The Disaster information transmission is described as a network generation.
Expression of Oral Communication Network

The base network is composed of oral communication network. The media will be added to this base network.
Expression and Control of Oral Communication

The generation of oral communication network is controlled with 4 parameters.

The Control Parameters of Oral Communication Network

- The Number of Contacts (Receivers)
- The Distance of Each Contact
- The Timing of Each Contact
- Communication Parameters
Communication Parameters

Communication Parameters reflects companionable level of neighbor community ex. Urban Community < Rural Community

\[ P_1 = \pi + (1 - \pi) \eta \]

\( \pi \) : Reflection Bias Parameter
\( \eta \) : Random Choice Probability

\[ P_1 : \text{Linkage Prob. Y to X} \]

\[ P_2 = \sigma + (1 - \sigma) \eta \]

\( \sigma \) : Mutual Bias Parameter
\( \eta \) : Random Choice Probability

\[ P_2 : \text{Linkage Prob. X to Y} \]

\( \pi, \sigma \) : These Bias Parameters work against Random Linkage
Expression of Media (in case of Fixed Loudspeakers)

- The Loudspeaker is combined into oral communication network

The Parameters for Loudspeaker

- #1 Location
- #2 Audible Distance
- #3 Audience Rating
- #4 Announce Frequency and Each Timings
The functions of each media is described by using following parameters in the simulation.

<table>
<thead>
<tr>
<th>Media</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Communication</td>
<td>The Distribution of Number of Contacts, Walking-speed, The Distribution of Distance to Receiver, Commu. Para.</td>
</tr>
<tr>
<td>Telephone</td>
<td>The Distribution of Number of Contacts, Connecting Ratio</td>
</tr>
<tr>
<td>Patrol car, Fire Engine</td>
<td>The Route and Speed, Departure Time, Audible Distance, Audience Rating</td>
</tr>
<tr>
<td>(With Loudspeaker)</td>
<td></td>
</tr>
<tr>
<td>Fixed Loudspeaker</td>
<td>Audible Distance, Audience Rating, Announce Frequency and Timings</td>
</tr>
<tr>
<td>TV, Radio</td>
<td>Audience Rating, Announce Frequency and Each Timings</td>
</tr>
</tbody>
</table>
Diagnosis with three model elements

Current evacuation Plan

GEOGRAPHIC INFORMATION SYSTEM

Tsunami Hazard
- Scenario
- Simulation

Disaster Info./Guidance
- Plan
- Scenario
- Simulation

Evacuation
- Plan
- Scenario
- Simulation

Assessment (Casualty Estimation)

Best strategy for tsunami disaster preparedness
Implementation at OWASE

Tsunami Source Area
City of Owase

Population: 24,000,
Household: 10,000

Computed tsunami waveform at Owase Bay

Estimated inundation depth

- 0 - 1 m
- 1 - 2 m
- 2 - 3 m
- 3 - 4 m
- 4 - 5 m
- 5 - 6 m
- 6 - 7 m
- 7 - 8 m
Tsunami Disaster within the city of Owase
Preliminary model result

Scenario
- Loud speaker: Issue the warning 5 minutes after the ground shaking stops
- Patrol cars: Issue the guidance 5 minutes after the ground shaking stops
- Mass media: Issue the warning 8 minutes after the ground shaking stops

Legend
- Evacuation Pt.
- Loudspeaker
- Patrol car
- Evacuee
Assessment
Estimation of tsunami evacuation time
Preliminary model result

Legend
- Speakers
- Path of patrol cars
- Evacuation Pt.
- Inundation Zone

Time to terminate evacuation (Minutes)
- 0 – 10
- 10 – 20
- 20 – 30
- 30 –
Assessment
Estimation of tsunami evacuation time
Preliminary model result
Future Research

✓ Estimation of casualties
  Interaction between model elements
  What is the best plan?

✓ Model improvement
  Where is model limit?
  What are we trying to simulate? Individuals or Regional characteristics?

✓ Implementation
  Where is the limit of evacuation plan?
  For local government, for public

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Thank you