INSPIRE

Internet-based Simulation Platform for Inundation and Risk Evaluation

For countries with inadequate resources for disaster preparedness, as is the case for most countries in the Indian Ocean, Southeast Asia and South Pacific Ocean region, identification of areas at high risk to tsunamis is crucial for prioritizing resource allocation. Tsunami hazard and risk assessment, which provides an estimate of potential losses in lives and cost of building damage, would reveal communities that would be highly vulnerable to the hazard and, hence, need to be prioritized for enhancing local tsunami readiness.

INSPIRE is a web portal that provides modules for identifying tsunami sources, simulating tsunami propagation and inundation, integrating exposure data, and performing tsunami loss estimation. The analysis modules are designed to handle multi-dimensional vulnerability data and different levels of data accuracy, reflecting the fact that data available from countries may range from low to high levels of accuracy. This allows users to undertake preliminary tsunami risk assessment using existing data, with progressive improvement in assessment results with the use of more detailed and accurate datasets. INSPIRE has been tested against the dataset from pilot sites of countries in the Indian Ocean and South China Sea.

INSPIRE Components and Functionality

1. Tsunami Hazard Evaluation

INSPIRE uses the numerical model TUNAMI (IUGG/UOC TIME Project, 1997), customized and integrated into the system, for tsunami propagation and inundation simulation.

Tsunami propagation from the source to the coast requires switching of computational grids, from the outermost domain that defines the propagation phase boundary, to the innermost domain that covers the area of interest. INSPIRE requires 4 domains, from the largest and coarsest resolution of 2 arcminutes, to smallest and finest at 5/3 arcsecond resolution. The tool facilitates the nesting of grids of different sizes and resolutions, for smooth transitioning of tsunami parameters.

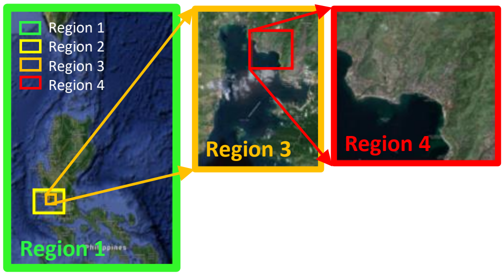


Figure 1. Computational domains at Barangay Barreto, Philippines

A commonly used method to define the initial tsunami surface is to apply the same displacement as the vertical deformation of the ocean bottom due to the earthquake. This initial sea surface displacement, which is a function of the earthquake parameters (Mansiha and Smylie, 1971), may be generated by specifying earthquake source parameters in the tool.

Digital elevation model is a crucial component of detailed inundation modelling. The tool is designed to accommodate data at different levels of accuracy available in the countries. Consequently, resolution of outputs depends on input data accuracy.

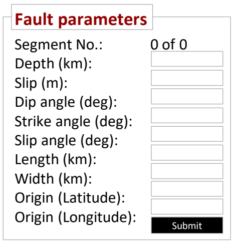


Figure 2. Deform grid tool

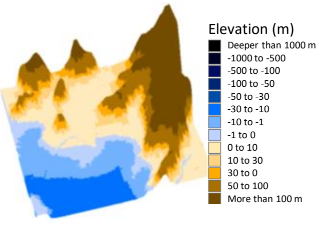


Figure 3. Digital elevation model

Threshold for calculating expected tsunami arrival time can be set according to required sensitivity of the artificial water level gauge, e.g. time stamp at water level of 10, 20 or 30 cm. Manning's coefficient can be specified to reflect the condition of the area (Kotani et al., 1998).

Ground Condition	Manning's Coefficient
Smooth ground	0.020
Shallow area or natural beach	0.025
Vegetated area	0.030
Populated area	0.045

Simulation results are plotted as map estimates of tsunami travel time, inundation height and current velocity overlaid on Google Maps. Computation results can be downloaded by users for further processing and presentation in preferred formats.

Figure 4. Tsunami arrival time

Figure 5. Tsunami flow velocity

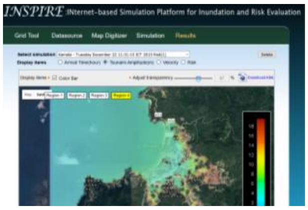


Figure 6. Tsunami wave height

Figure 7. Tsunami inundation

(Kamala Beach, Thailand)

2. Tsunami Risk Assessment

Risk assessment is an important process in assessing and understanding tsunami hazard and its effects to communities. Tsunami risk information can be utilized to raise public awareness, and to develop preparedness planning and response capacity of communities during emergencies.

To assess tsunami risk, three main inputs are required for integrating hazard-vulnerability assessments and generating risk maps:

- Tsunami hazard, e.g. inundation, travel time, and velocity
- Tsunami exposure, e.g. buildings and population
- Vulnerability function, reflecting the correlation between hazard level and probability of damage

INSPIRE's current design includes the function to assess tsunami risk in terms of probability of casualty and building damage. Population statistics are linked to the location of the building for computing probability of casualties. The assessment result is presented in terms of probabilities of survival and death.

Tsunami loss is estimated by correlating the most critical hydrodynamic parameter with exposure location and properties using vulnerability curves. To support various levels of data accuracy, the tool has been developed to compute probability of building damage, ranging from both classified (e.g. building material and height) and unclassified building types, for different levels of damage (e.g. no damage, damage on secondary members, damage on primary members, and collapse). The corresponding fragility curves can be manually imported to the system, based on past damage records.

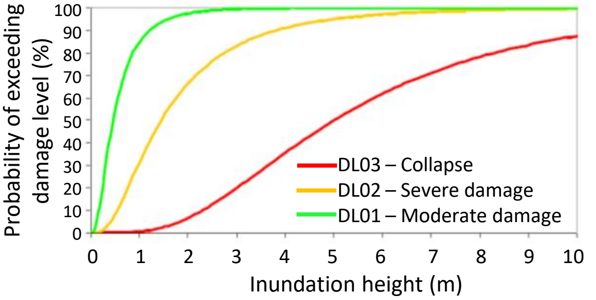


Figure 9. Vulnerability curve for one-story reinforced building (Foytong and Ruangrassamee, 2007)

Risk assessment is calculated for the innermost region only. Outputs provide loss ratio estimate (probability of casualty and building damage in percentage) at different damage levels, corresponding to the vulnerability curves entered by the user. In addition to map results, a *Loss Estimation Report* may be generated for a breakdown of potential losses in each zone, while the *Risk Profile* reports on the number of exposed buildings or population at different inundation depth ranges, classified according to building type, building usage, and population.

Figure 10. (a) Inundation height, probability of building damage to RC > 1 floor for (b) secondary member, (c) primary member

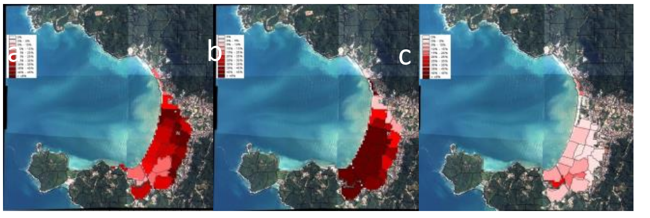
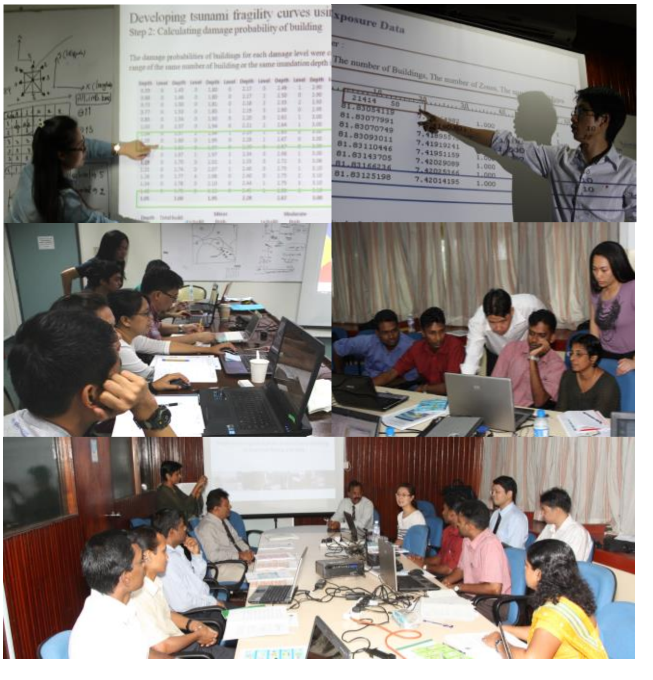


Figure 11. Probability of damage to one-story RC building for (a) secondary member, (b) primary member, (c) collapse

Capacity building on INSPIRE

The training on INSPIRE aims to enhance tsunami hazard and risk assessment capacity. Specifically, it introduces and demonstrates the functionalities and applications of INSPIRE. The training workshop includes theory, practical exercises, interactive and participative lectures, discussion on case studies, and examples.

The workshop is designed for technical officers who have responsibilities in tsunami hazard and risk mapping for tsunami early warning and/or disaster mitigation, preparedness, response, and management.



The **Regional Integrated Multi-Hazard Early Warning System** (RIMES) is an international and intergovernmental institution that is owned and managed by its Member States for the generation and application of early warning information. RIMES helps to build capacity of Member States in the observation and monitoring of seismic, tsunami, oceanic, meteorological, hydrological, and climate phenomena, and in the generation and communication of associated risks, for appropriate and timely user responses to warning.

For more information, please contact:
A.R. Subbiah, Director: subbiah@rimes.int