GDLN Seminar on Disaster Risk Management in East Asia and the Pacific – 2010 series – Summary of June 30, 2010 Video Conference

Conducting Multi-hazard Risk Assessments

Speakers:

- **Dr. Kusnowidjaja Megawati** *(Assistant Professor, Nanyang Technological University)*
  Kusno@ntu.edu.sg

- **Mr. Cao Tuan Minh** *(Project Director of the Natural Disaster Risk Mitigation Project, Central Project Office (CPO), Ministry of Agriculture and Rural Development, Vietnam)*
  minhct@cpo.vn

- **Mr. Nick Horspool** *(Geophysicist & Natural Hazard Risk Assessment Specialist, Geoscience Australia)*
  nick.horspool@ga.gov.au

Main moderator:

- **Mr. Christopher T. Pablo** *(Senior Operations Officer, World Bank Office, Manila)*
  cpablo@worldbank.org

Key topics discussed:

1. Different Types and Characteristics of Natural Hazard Risk Assessments
2. Potentials and Benefits of Natural Hazard Risk Assessments
3. Challenges of Conducting Natural Hazard Risk Assessments

Executive Summary

This video seminar on Disaster Risk Management in East Asia and the Pacific focused on conducting multi-hazard risk assessments. Different approaches and case studies from Singapore, Vietnam and Australia provided insights on how hazard and multi-hazard risk assessments can be developed and what their benefits and limitations are to estimate areas and communities at risk. It was also discussed how multi-hazard risk assessments can be integrated into Disaster Risk Management (DRM) plans and support the decision-making processes of governments.

- Firstly, risk is defined by the multiplication of hazard and vulnerability aspects. During this seminar different types of natural hazard risk assessments were presented to predict areas, infrastructure, and populations at risk. A seismic hazard assessment presented by the Earth Observatory of Singapore (EOS) predicted impacts for future earthquake scenarios in Singapore based on historical data. Approaches taken by Geoscience Australia focused on separating the vulnerability aspect into exposure data and vulnerability curves to map out areas at risk for different types of hazards, like earthquakes, cyclones, and climate change induced sea-level rise, etc. A more multi-hazard-based risk assessment was developed by the Ministry of Agriculture and Rural Development of Vietnam to define the risk of all types of hazards in a simple matrix through aspects of likelihoods and consequences.
- Secondly, outputs of natural hazard risk assessments offer crucial information for planners and decision-makers to take appropriate measures in order to mitigate or avoid negative impacts from potential disasters.
- Finally, the key challenge when conducting hazard risk assessments is the lack of sufficient historical and vulnerability data, for instance, seismic stations in Singapore were only installed less than 15

years ago to capture the ground motions of earthquake which is needed to model future scenarios accurately.

Summary

1. *Different Types and Characteristics of Natural Hazard Risk Assessments*

It was emphasised during this seminar that natural hazard risk assessments are a vital tool to spatially determine areas at risk. Several examples of different types of risk assessments were presented and explained how the likelihood and impact of a natural hazard can be measured.

The institute of EOS developed a seismic hazard assessment consisting of five components (path, source, site, buildings and infrastructure, and social and economic loss) defining the susceptibility of earthquakes in Singapore. The risk assessment model used data from past earthquakes where the trajectories of the ground motions were captured by seismic stations in Singapore to simulate the probability of future earthquakes. It was recorded that most earthquakes above the magnitude of 5 on the Richter scale in Singapore occur (source) in the Sumatra fault in Indonesia and are located within a range of 300 to 1,600 km.

In order to simulate the impacts of future earthquakes in Singapore, the site aspects are crucial in determining the vulnerable areas. Depending on the structure of buildings, and site conditions, the impacts are likely to cause higher or lower damage; accordingly, soft soil conditions are amplifying the usually small ground motions in Singapore by a factor up to 10. Since around 85 percent of the buildings in Singapore are located on soft soils, large areas are at risk.

Geoscience Australia developed a risk assessment framework defined by aspects of hazard, exposure, vulnerability, and impact. Databases for each aspect need to be created. For example, exposure consists of some key features (residential, industrial, commercial and infrastructure) and attributes (spatial location, structural type, contents value, and business information) derived from surveys and census data which determine the grade of exposure (elements at risk) in the area of interest. Vulnerability is calculated from data gained from post-disaster surveys, where the amount of damage (e.g. fatalities, loss of infrastructure) is captured for different hazard intensity levels. This risk assessment framework is applicable to all types of natural hazards.

In a case study in Indonesia, a volcanic ash impact assessment was conducted by Geoscience Australia to predict what would be the potential areas at risk in relation to the number of fatalities. Several types of data and models were required to predict what would be the scenario if West Java's seven most active volcanoes would erupt, such as: eruption parameters from past events (eruption mass, column height), meteorological data (wind profile), a digital elevation model (medium resolution of 90m), an exposure database (building type and population), and vulnerability curves (building vulnerability to ash loading, fatality models of ash fall).

The outcome provided a hazard map predicting the partial or complete loss of buildings in relation to the amount of ash fall (load). As a result, 39.2 percent of the population of West Java would be affected by such a scenario.

In another case study, Geoscience Australia presented a coastal vulnerability assessment to demonstrate how coastal areas in Australia are at risk due to sea-level rise. Using climate change scenarios from the fourth IPCC assessment report, exposure data, high resolutions digital elevation maps (using LiDAR), and vulnerability curves, the number of buildings at risk along Australia's coast were quantified; subsequently, the amount of loss was calculated through the replacement value of buildings. Both predictions showed that the state of Queensland is at highest risk from sea-level rise.

The case study from Vietnam was on the implementation of a Vietnam Disaster Risk Management Project funded by the World Bank. It was presented by the Ministry of Agriculture & Rural Development (MARD) and focused on integrating DRM planning in 12 provinces of Vietnam which are particularly prone to natural hazards. The project is led by the central government but planning, risk assessment and implementation are conducted at the provincial level to identify solutions that suit for each local context.

The probability (risk) of natural hazards defined as likelihood and the consequences (level of impact) of these hazards are forming a risk assessment matrix developed by MARD. This matrix is filled out by community members and experts of a particular province in a subjective manner to identify at what risk a particular province is. Varied levels of likelihood and consequence determine areas at risk and call for different types of mitigation actions, ranging from routine management to urgent risk management measures.

In this project (Vietnam), there are several steps in assessment and risk analysis phases, including workshops to identify current conditions, existing capacity, institutional management and infrastructure facilities, resource availability, data collection, analysis of data collected, and continuous consultation among stakeholders at the community level in collaboration with provincial governments to discuss and review application of risk analysis and identification of prioritized activities.

2. Potentials and Benefits of Natural Hazard Risk Assessments

The example of the multi-hazard risk assessment type in Vietnam (see above) is part of a project to develop integrated disaster risk management plans for the most vulnerable and poor provinces in the country. Accordingly, the potential benefits of hazard risk assessments are to integrate them into the land-use planning and decision-making processes.

The integration of hazard maps into disaster management or contingency plans has the potential to serve for evacuation strategies in case a natural hazard turns into a disaster.

Natural hazard risk assessments also allow the spatial identification of areas which are at high risk, which is a prerequisite for the potential relocation of communities.

The integration of climate change scenarios into risk assessments provides another potential to forecast future areas at risk, like the projected rising sea-level that could inundate large parts of the Australian coastline. Followed by these predictions, the development process can be adjusted where needed.

The development of seismic hazard assessment for earthquakes, as explained above, serves the development of building codes which have an adequate seismic design incorporated and define how buildings need to be built to be more resilient to the impacts of natural hazards.

Finally, natural hazard risk assessments inform policy and decision-makers whether the physical infrastructure, communities, and natural environment are at risk and also, support the development of sound mitigation and adaptation measures.

3. Challenges of Conducting Natural Hazard Risk Assessments

One general limitation for all natural hazard risk assessments is the availability of data. For example, the seismic hazard assessment relies on data from only 12 earthquakes which have occurred since the year

2000 because seismic stations exist only since 1996 in Singapore. Particularly, for earthquake-related risk assessments the lack of sufficient samples of past events is challenging the validity of the predictions.

Similarly, exposure databases and vulnerability models may be deficient of an adequate amount of data to understand the local characteristics precise enough for risk assessments. Accordingly, the vulnerability aspect as a whole has the potential to be defined more accurately.

Regarding the use of digital elevation models, it was discussed during the seminar that these models are not widely used in many developing countries due to their high costs, unlike in Australia where precise high-resolution scanning of the topography was undertaken by using LiDAR technology.

Further Information

For more general information about different research institutes which conduct natural hazard risk assessments and/or provide open source data, please visit the following links:

General:
- Incorporated Research Institute for Seismology (IRIS); for earthquake information: http://www.iris.edu/hg/

Australia:
- Australian Government, Australia Geoscience; information on scientific activities, including natural hazard risk and impact analysis: http://www.ga.gov.au/hazards/
- OzCoasts, Australian Online Coastal Information; information about Australia's coast, including its estuaries, coastal waterways and climate change impact: http://www.ozcoasts.org.au/

Singapore:
- Earth Observatory of Singapore (EOS), an Institute of Nanyang Technological University; conducts research on earthquakes, volcanic eruptions, tsunami and climate change in Southeast Asia: http://www.earthobservatory.sg/