RISK AND VULNERABILITY ASSESSMENT IN PDC'S DISASTER RISK MANAGEMENT FRAMEWORK

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1. Disaster Risk Management

Every year around the world, natural disasters affect millions of people and cause extensive damage and economic losses. The United Nations International Strategy for Disaster Reduction's (ISDR) *Living with Risk: A Global Review of Disaster Risk Management Initiatives*, 2004, estimates that approximately 100,000 lives are lost due to natural hazards yearly and that the global cost of natural disasters will exceed $300 billion a year by 2050. All these dollars are necessarily diverted from other national and municipal investments in environmental, social, educational and infrastructure sectors, any of which produce better returns towards the goal of fostering sustainable and resilient communities.

The result is a negative effect on the overall quality of life—hampering, halting or reversing economic, social and development initiatives.

Risk and vulnerability assessment (RVA) is one key program area in which Pacific Disaster Center (PDC) assists decision makers and communities to better understand their risk and vulnerability to a wide-variety of hazards in order to develop and implement appropriate risk reduction strategies. To this end, PDC has developed an Integrated Risk Reduction Planning Framework as shown in the following two figures. Composed of four components, the Framework is the product of PDC's applied research, based on various long term risk-assessment and mitigation-planning projects, including 1) Multi-hazard Urban Risk Assessment for Marikina City, Philippines, 2) American Samoa Hazard Mitigation Plan, 2003, and 3) Lower Mekong Basin Flood Vulnerability Assessment.

2. Risk and Vulnerability Assessment Goals, Methods and Data Sources

PDC's Risk and Vulnerability Assessment Program has developed a Risk Reduction

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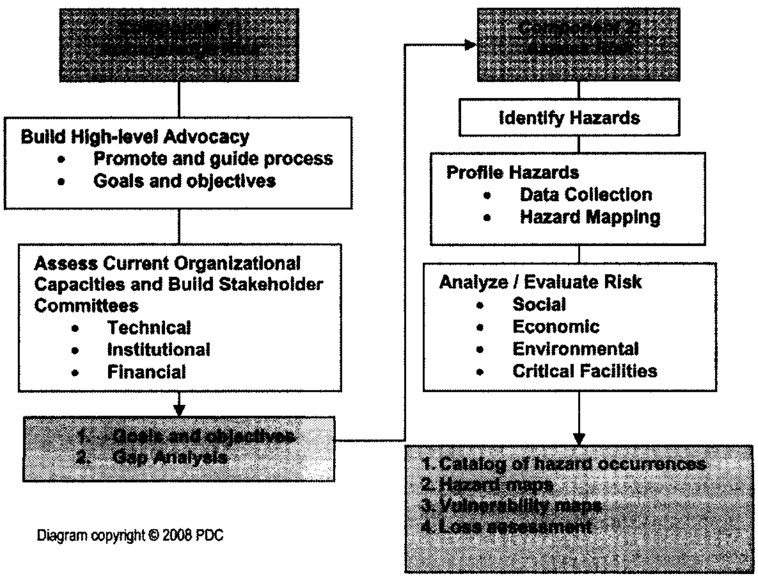
Framework that outlines a four-step process to assess and address risk from natural and human-induced hazards. PDC has successfully implemented this process, working closely with decision makers and planners, to achieve goals of disaster-resilience and sustainable development. Advocacy building among policy makers and engagement of stakeholders and community members, in fact, are components of an important first step that guides and supports the entire risk reduction process, namely Risk Acknowledgement.

The Framework also includes a Risk and Vulnerability Assessment component that assists communities in understanding and quantifying hazards and their potential impacts. The Framework further outlines effective ways of communicating risk to the various stakeholders, including decision makers, elected officials and the general public. The final step in the process identifies and prioritizes mitigation countermeasures that target high-risk areas for implementation.

The flow charts below and on the next page outline the components of PDC's Integrated Risk Reduction Planning Framework. Within these, place- and culture-sensitive processes and methodologies are used to gather required data, perform analyses, communicate results and implement solutions.

PDC has successfully applied the Risk Reduction Framework in a range of urban, rural and island environments, and at varying scales, throughout the Asia Pacific region, demonstrating its adaptability to meet individual community needs.

Starting with the overarching goals of saving lives and creating sustainable and disaster-resilient communities, PDC helps all stakeholders develop a common understanding



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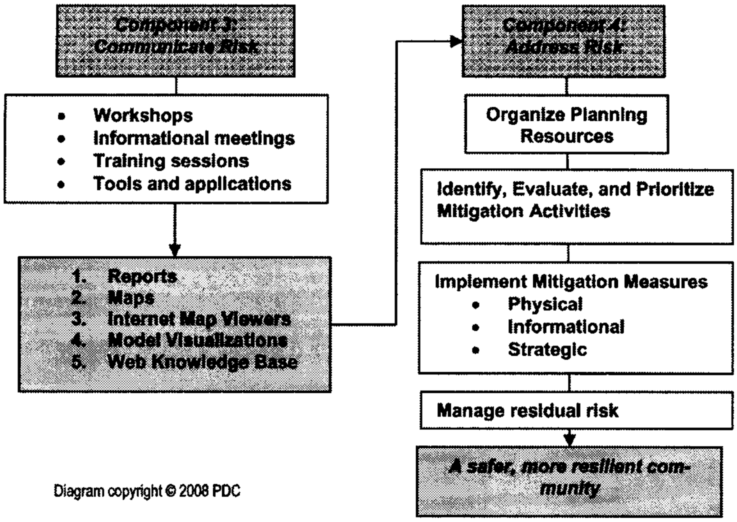

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of the risks; assesses the risks by collecting and reviewing hazard and impact data from appropriate sources; organizes opportunities to communicate the risks through live events, reports, maps and web-based applications; and develops proposals for addressing the risks.

3. Applications of the RVA Process

The following case studies are examples of the application of the PDC RVA process. Each is quite unique because the needs and circumstances of the study areas differ.

3.1 Marikina City, Philippines

The purpose of the study that resulted in the publication of *Multi-hazard Urban Risk Assessment for Marikina City: Philippines And Guidelines for Implementing Multi-hazard Risk Reduction Strategies for an Urban Environment* was to provide Marikina City officials with an integrated, multi-hazard framework for assessing risk and mitigating the impacts from riverine and urban flooding and earthquakes on Marikina City, including its critical facilities, businesses and people.

The final products of the Marikina City project were 1) a multi-hazard risk and vulnerability assessment, and 2) a series of guidelines and representative examples for continuing the risk reduction and mitigation planning processes. Separately, the project also provided a customized map viewer for Marikina, an implementation plan for the map viewer, and a comprehensive training manual.

To accomplish all the objectives outlined by officials and stakeholders for this project, PDC worked with a very large stakeholder community representing more than 30 national, metropolitan and local organizations from government and the private sector, and collaborated with affiliated international experts as well.

Ordinarily, when conducting an RVA, a profile of each hazard is developed, citing historical events of each hazard type to determine the frequency of occurrence, probability of future occurrence, potential magnitude or intensity, geographic extent, and conditions that increase or decrease vulnerability. Previous efforts in Marikina City by a team led by Professor Haruo Hayashi, Kyoto University, and funded by the Japan International Cooperation Agency (JICA) had developed a comprehensive database on seismic hazards. Therefore, only flood hazards required extensive research by the PDC team.

Once the hazard data were established, PDC was able to move quickly into the work of identifying vulnerable areas and developing data layers of hazard areas and assets for the Marikina City map viewer. As these data were prepared for this use, guidelines and templates were developed to expand the critical facilities building inventory as well as that of the business sector.

Enhanced data inventory allowed a more comprehensive assessment of economic, social and critical facilities damage estimates, and potential loss calculations. Other guidelines were developed to facilitate the identification and prioritization of mitigation countermeasures to advance Marikina's previous flood mitigation successes. In addition, a hazard analysis of three areas of priority development was performed to inform the City's long-term planning process.

All the outcomes of the assessment done for Marikina City were incorporated into a web-accessible map viewer that will continue to reflect real-time circumstances for the use of policy makers, planners, decision makers and emergency managers.

3.2 American Samoa

The hazard mitigation process in American Samoa followed the requirements and guidance provided by the Federal Emergency Management Agency (FEMA) of the U. S. Department of Homeland Security. The guidance standardizes the overall process, but allows flexibility in determining how the planning process is best adapted to each jurisdiction. In American Samoa, traditional leaders and chiefs retain authority and respect along with the territorial government. Any planning process must respect the Samoan culture or "fa'asamoa," the Samoan way of life.

The hazard mitigation planning process for American Samoa, therefore, was guided by federal requirements and by the people and government of the Territory. The methods used in the hazard mitigation planning process were drawn from several sources. The primary references were FEMA's State and Local Mitigation Planning how-to guides Getting Started: Building Support for Mitigation Planning (FEMA 386-1), Understanding Your Risks: Identifying Hazards and Estimating Losses (FEMA 386-2), and Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation Strategies (FEMA 386-3).

The American Samoa Mitigation Plan addressed the full range of natural hazards threatening American Samoa: tropical cyclones (including storm surge), floods, earthquakes, tsunamis, landslides, and drought.

The development of a comprehensive Natural Hazard Risk and Vulnerability Assessment was necessary to gain an understanding of the risks of natural disasters to the people of American Samoa. The PDC and UH Social Science Research Institute (SSRI) team, in collaboration with American Samoa government representatives, examined the vulnerability of critical infrastructure to various natural hazards. The Assessment provided a compilation of information and dataset requirements to officials of the government of American Samoa for comprehensive planning purposes to save lives and reduce property losses in future disasters.

The Assessment was formatted to meet the FEMA Interim Final Rule guidance document, profiling each hazard event to assess vulnerability and estimate potential losses by jurisdiction, and to assess vulnerability and estimate potential losses to critical facilities. FEMA realizes that data are not always available to create a complete risk assessment, so the Assessment indicated where data were available and where information gaps existed.

Using data compiled on historical natural hazard events between 1960 and 2003, the Assessment examined the six natural hazards, with storm surge treated as an associated hazard to tropical cyclones. In many cases, historical data were sparse and/or conflicting, with the result that some details, which had minimal impact on the study outcomes, had to be left for later resolution. Numerical models were not used in this assessment.

Meetings were held with government officials, academics, the American Samoa GIS Users Group, the American Samoa Power Authority (ASPA) and other stakeholders and partners to assess the availability of data for the Risk and Vulnerability Assessment. The GIS Users Group provided digital copies of existing data layers. ASPA and the GIS Users Group offered to compile additional information for the Risk and Vulnerability Assessment, recognizing that this effort could improve the conditioning of data and increase their data holdings. In reciprocity for data, the PDC team agreed to the return of all processed and newly created data for use by the GIS Users Group.

The PDC team conducted follow-up meetings and intensive data collection sessions and developed the hazard layers required for the Risk and Vulnerability Assessment. They used national and international databases on climate and extreme weather events, as well as on geologic hazards.

Formats for asset/infrastructure layers and hazard layers were established, and data collection began in earnest.

For some of the hazard layers, only printed maps existed. The Project Team digitized the Flood Insurance Rate Maps (FIRMS) and the Base Flood Elevations from paper maps provided by the American Samoa Government. Landslide risk maps, as well as landslide occurrences, were also digitized. The National

Oceanic and Atmospheric Administration's Pacific Services Center (PSC) helped the American Samoa Government acquire Ikonos imagery, which provided a base layer for adjusting detailed maps and information.

Information was compiled on the impacts of tropical cyclones Tusi, Ofa, and Val from FEMA and reports of the Territorial Emergency Management Coordination Office.

PDC and the Social Science Research Institute at the University of Hawaii at Manoa obtained disaster frequency information from the Centre for Research on the Epidemiology of Disasters (CRED)/U.S. Office of Foreign Disaster Assistance (OFDA) database, and received potential flood loss data from FEMA.

As data resources were collected, each hazard type was profiled. Vulnerability reports were compiled by jurisdiction, and an estimate of potential losses of critical infrastructure was developed.

The American Samoa Mitigation Council had adopted a specific goal: "Reduce the risks of all identified hazards to the Territory, thus alleviating loss of life and property from tropical cyclones (including storm surge), floods, landslides, tsunamis, earthquakes, and droughts and insure the overall well being of the people of American Samoa." In collaboration with its partners and local stakeholders, PDC developed a Hazard Mitigation Plan in keeping with that goal, one that envisioned changed building codes, improved land use management and regulation, and better regulations for floodplain management as well as specific mitigation projects.

3.3 Lower Mekong Basin

The study that resulted in the publication of *The Lower Mekong Basin Flood Vulnerability Atlas* (Chiesa et al., 2005), was undertaken in response to the question, "How does vulnerability to natural hazards vary across a region?" and the related questions, "What contributes to the vulnerability and its spatial variation?" and, more important, "What can be done to reduce vulnerability and its underlying components?"

The geospatial analysis methodology that was applied in this study helped answer these questions. Additionally, it can support policy development and decision making to reduce the factors that contribute to natural hazard vulnerability.

Preliminary work addressing food security in Africa, especially as influenced by drought, floods and other natural hazards (Cicone et al., 2003), based on a conceptual framework developed by Turner et al. (2003), was adapted to investigate vulnerability to flooding within the Lower Mekong Basin, using geospatial information technologies including Geographic Information Systems (GIS) software and GIS-based analytical models. The resulting approach explored Vulnerability (V) as a function of Exposure (E), Presence (P), Sensitivity (S) and Resilience (R). It generally used physical and environmental databases available at a one-kilometer spatial resolution and socio-economic databases at a provincial and district level.

The Mekong River watershed is subject to periodic flooding events that place life, property, and livelihoods at risk. The impact of these flood events on populations varies as a function of physical factors, such as weather patterns and topography, as well as social factors that determine the populations' preparedness to cope with floods, and their ability to recover from them. Hence vulnerability to flooding is determined from assessing a combination of physical and social factors. This study applies an analysis strategy to examine vulnerability to extreme flood events as a function of both sets of factors.

The method employed is premised on a conceptual framework referred to in scientific literature as Vulnerability, Exposure, Sensitivity and Resilience (VESR). The underlying concept is that Vulnerability (V) to a natural hazards event is related to the risk of Exposure (E) to the hazard by the Presence (P) of populations that are Sensitive (S) to that exposure. Resilience (R), or ability to endure and/or overcome impacts, may lower the overall vulnerability of a population.

Specifically, these terms are geospatially computed and then combined as follows:

$$V = P \times E \times S \times (1-R)^{1/4}$$

The availability of regional area data on physical and social conditions in the Lower Mekong Basin, at scales on the order of one-kilometer resolution, provided the opportunity to create a model of vulnerability that could be expressed as a map. This scale of analysis proves useful as a practical solution to synoptically observe regional conditions for such a large area.

Physical and social data about the Lower Mekong River Basin were used to create quantitative indicators of exposure, presence, resilience and sensitivity. The indicators were then combined and visualized to aid in communication about the highly complex underlying physical and social processes involved in flood disasters.

Among other findings, it could be seen how areas of overall similar levels of flood vulnerability required different mitigation strategies ranging from improved early warning capabilities for some regions and investments in establishment of local reserves of emergency relief supplies in others. Furthermore, direct and indirect impact of potential investment projects on overall vulnerability in the region, both positive and negative, could be modeled via various proxy measures developed under this assessment project.

4. Disaster Management Objectives of Busan City, Republic of Korea

Rapid environmental changes on the earth have brought about abnormal climate conditions and global warming. Because of this, even in our daily lives, we observe and hear of tremendous disasters, which are unprecedented in history.

Korea is no an exception to this global trend. Typhoon Rusa and Typhoon Maemi, both in 2003, dealt harsh blows to Korea, causing suffering and severe pain that were nearly too much to endure. According to the statistics from National Emergency Management Agency of Korea, in 2006, there were 62 lives lost and property damage amounting to 834.4 billion KRW. It was reported there was 19.2 trillion KRW in property damage and 29.5 trillion KRW as recovery cost from disasters in just last decade.

In the case of Busan City, it is located directly on a sea coast. As a result, 11 container cranes in Busan harbor, each weighing over 800 tons, were collapsed or run off their tracks due to the heavy winds brought on by Typhoon Maemi in September 2003. Meanwhile, an ocean tourist hotel in Haewoondae, which weighs 7,000 ton, was overturned by great waves and heavy winds. The amount of damage associated with the effects and impacts of abnormal weather was incalculable.

Therefore Busan City has planned and executed Secure Busan 2020 projects as part of a vision to "Build Integrated Ubiquitous Safety Network for Secure Busan."

According to Busan officials involved, the main strategies are as follows:

- Establish long-term strategies through prevention and prediction,
- Cultivate participation culture on self-responsibility to establish safety awareness habituation,
- Proactively find and clear out the areas which were not covered by disaster management
- Develop disaster program in which local geographical or historical characteristics reflected
- Develop come to strategies which include trainings, modernization of disaster recovery system, and system implementations for damage protection.

These strategies are mainly focused on building system-wide and localized practical methods to be used for disaster reduction and impact mitigation.

As part of the proactive approach of the Busan decision makers, the city worked with partners to conduct a Risk and Vulnerability Assessment.

5. Applying RVA and Risk Reduction Framework in Busan City

PDC, BMC and their partners, including PKNU and UH, have proposed to undertake a pilot RVA project to better understand the hazards and vulnerabilities within Busan. The project will also explore potential cooperation on overall risk reduction activities within Busan City, throughout the Republic of Korea and across the broader region.

To scale this initial project to a manageable effort—one with short term beneficial outcomes—and to best leverage existing PDC data assets and modeling resources, the parties agreed to limit the Busan City RVA to selected hazards and a sub-set of the City. Specifically, the RVA is intended to assess typhoon risks (and associated flood and landslide hazards) for a study area within the city.

The overall activity is composed of four tasks and is consistent with PDC's Risk Reduction Framework. Each task will require collaboration between PDC and BMC and their partners.

5.1 Project Initiation

The first task is the Kick-off Meeting and Stakeholder Workshop. The Kick-off Meeting will outline project goals, scope, participants, timelines, and anticipated outputs and outcomes; and the Stakeholder Workshop will provide (select) attendees with a detailed understanding of the project methodology, and provide the project team with insights into interagency communications needs and processes.

The Meeting and Workshop also provide an opportunity to review and revise, if necessary, elements of the draft plan, including the study area, hazards of interest, desired outcomes, etc.

5.2 Data Collection

Two main activities, to be undertaken immediately following the Kick-off Meeting and Stakeholder Workshop, will begin the process of collecting the data required for the RVA.

First, there will be a Hazard Orientation Tour of Busan Metropolitan City. The tour will include locations of critical infrastructure (sea ports, rail ways, power/water/ communications facilities, etc.) and locations of previous hazard conditions (e.g., landslide locations, flooding areas, storm surge areas).

Second, a Stakeholder Meeting for Data Collection will be held. This meeting will support a concurrent survey of disaster management capacity. Participants will be from the organizations and agencies that support disaster management processes within BMC, including those that collect and manage data and information (i.e., GIS, imagery, maps, etc.), especially population data (e.g., census data, demographic data, vulnerable population centers or facilities); data on transportation infrastructure (e.g., roads, bridges, tunnels, ports), water and waste water infrastructure (e.g., pipelines, pumping stations, treatment facilities), power infrastructure (e.g., transmission lines, sub-stations, generation plants), and communications infrastructure (e.g., radio, television, telephone towers, switches). Additionally, data related to known hazard zones, previous disaster events, etc. will need to be collected.

Both before and after these main data collecting activities, members of the project team will interact to support additional data gathering.

5.3 Risk and Vulnerability Assessment

The RVA will be conducted using methods developed and applied throughout the region by PDC, as previously described, and refined by BMC and PKNU representatives and other stakeholders during the Project Initiation task. The team will prepare appropriate reports of findings in detail and maps to visualize the results. As this task is done, a "gap assessment" will also be undertaken to compare existing disaster management, warning and response capabilities within BMC to accepted "best practices."

During this period, PDC will meet regularly with BMC representatives to resolve questions that may arise regarding interpretation of data and results, as well as to allow BMC to guide the analysis and development of output products. A representative of BMC or of PKNU might be hosted at PDC during this task if it is deemed to be potentially useful.

5.4 RVA Workshop

Once the RVA is completed, a Risk and Vulnerability Assessment Workshop will be organized, The purpose of the Workshop is to review and communicate the results of the Busan RVA Pilot Project. Additionally, it provides an opportunity for the various stakeholders in BMC and PKNU to gain technical skills in undertaking PDC's RVA process. Workshop participants would be provided with copies of the final report(s) and maps, as well as the data used to conduct the RVA. This would allow them to explore how to extend the RVA to other study areas within Busan Metropolitan City and/or to consider other hazards.

In addition to reviewing the UH-PDC-BMC-PKNU joint pilot project, the RVA Workshop would include:

- RVA Method used-data collection; assessment, mapping and visualization of risk; disaster management capabilities gap assessment; and mitigation planning,
- Discussion of findings and planning to address recommendations in the RVA,
- Discussion and planning to support application of project outcomes to other key locations in the Republic of Korea.

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