3 assessing the risk

Risk cannot be totally eliminated.
Neither does risk assessment itself reduce risk.

Chapter Brief

- Risk is the possibility of harmful consequences and result of interactions of three elements - hazard, exposure and vulnerability. If the influence to the society of one or more elements can be eliminated or reduced the risk also can be eliminated or reduced.
- Risk assessment is an essential component in the disaster risk management decision-making process.
- The purpose of risk assessment is to define the nature of the risk problem, answering questions about characteristics of potential hazards (such as frequency, severity), vulnerabilities of communities and potential exposure to given hazard events.
- Identification and assessment of nature and impact of hazard, vulnerability assessment and inventory of elements at risk are essential components of a risk assessment.
- Geological hazard maps, hydrological maps, meteorological data, seismic activity data local weather data etc are essential hazard data that are necessary to carry out risk assessment.
- Risk assessments are multi-hazard, multi-sectoral, multi-level, multi-stakeholder, and multi-phase.
- Risk evaluation helps prioritization of risk reduction measures, giving due consideration to most severe, frequent and harmful hazard impacts; cost effectiveness of the measures; availability of funds etc.

Introduction

A risk assessment determines the likelihood that adverse consequences (risks) will occur as a result of potential hazards, such as floods or earthquakes and the elements that are exposed to those hazards. The risk assessment process facilitates risk reduction decisions by identifying, structuring and presenting the best available risk information for consideration. The risk assessment guides, but does not dictate decisions about risk. The significance of risk depends upon the point-of-view of the specific groups involved in initiating the risk assessment. These differences in point-of-view guide the selection of disaster risk reduction measures best capable of achieving each group's pre-established goals and objectives.

What is risk?

Risk may be simply stated as the probability that negative consequences will occur. Risk consists of the interaction of three elements:

Hazard: probability of occurrence, severity and duration of analysis; e.g. 10% probability of 0.3g ground shaking occurring within 50 years; a qualitative description may be conveyed in a scenario describing the impact of a hazard event on an area of concern. The scenario can be displayed on one or more hazard maps.

Exposure: characteristics of values at risk, i.e. inventory, that will be analyzed under hazard conditions; for example, light wooden buildings lacking structural connections, struts, etc.

Vulnerability: expresses the potential loss of life, damage or estimated costs caused by the impact of potential hazard events on the exposure inventory. Disaster events reveal community risks by demonstrating the vulnerability of existing social, environmental and development practices.

How is risk created?

- Changes in the hazard environment (global climate change, sea level rise, activation of dormant fault zones, etc);
- Increase in vulnerability (physical, social, economic, environment);
- Increase in exposure (due to urbanization, land scarcity, economic pressure for higher production etc);
- Decline in capacity to cope (resource constraints for training and capacity building, different political priorities affecting disaster reduction, etc).

How is risk perceived?

People perceive risk differently, depending on their experiences, exposure and understanding. They often set an arbitrary level of risk that they consider acceptable. This arbitrary level may be based on past experience, convenience, culture or resource availability. Future risk decisions will generally be based on this arbitrarily defined level of acceptable risk. Governments may also establish arbitrary levels of acceptable risk. Risk reduction actions defined according to an arbitrary baseline may be insufficient to achieve society's social, economic and environmental goals. On the other hand, if they are overly protective, may result in excessive risk reduction costs.

How is risk reduced?

Methods to reduce risk are discussed in Chapter 4 (preparedness) and Chapter 5 (mitigation). These two methods may be classified as:

- **Preparedness**, including steps taken before a disaster to plan, train and exercise emergency response and recovery actions that must be implemented in case a disaster occurs.

see chapter 4

- **Mitigation**, including long-term, on-going efforts to develop disaster resistant nations, communities, neighborhoods, etc. mitigation actions may be taken before, during and after a disaster and may include mitigation planning, training and, the enforcement and adoption of engineering building codes etc.

see chapter 5

Key Words

Acceptable risks

The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

> *In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or'acceptable practice' based, among other issues, on a known probability of hazard.* (UNISDR, 2004)

Capacity

A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effect of a disaster.

> *Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.* (UNISDR, 2004)

Geographical Information Systems

Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer program for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced.

> *Geographical information systems are increasingly being utilised for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.* (UNISDR, 2004)

Hazard

A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

> *Hazards can include latent conditions that may represent future threats and can have different origins: natural*

(geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency and probability. (UNISDR, 2004)

Hazard analysis

Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour. *(UNISDR, 2004)*

Hazard Assessment

Hazard assessment implies the determination of the magnitude or intensity over time. For processes like floods it is much easier to evaluate their probability of occurrence. Mass movements often correspond to gradual (landslides) or unique events such as extremely rapid flows. It is therefore difficult to predict the return periods. The level of severity of natural hazards can be quantified in terms of the magnitude of the occurrence as a whole (event parameter) or in terms of the effect the occurrence would have at a particular location (site parameter). *(AUDMP-ADPC UDM materials)*

Risk

The probability of harmful consequences, or expected losses (death, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Conventionally risk is expressed by the notion:
RISK=HAZARD x VULNERABILITY.

Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.

Beyond expressing possibility of physical harm, it is crucial to recognise that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes. (UNISDR, 2004)

Residual risks

Risks that cannot be reduced because no risk reduction solution exists or potential solutions are not feasible, are called residual risks.

Risk assessment / Analysis

A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

> *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*(UNISDR, 2004)

Risk Evaluation

The social and political judgement of the importance of various risks by the individuals and communities that face them. This involves trading off perceived risks against potential benefits and also includes balancing scientific judgements against other factors and beliefs. *(AUDMP-ADPC UDM materials)*

Vulnerability

The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

> *For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.* (UNISDR, 2004)

Vulnerability Assessment

Assessment as the degree of loss to a given element at risk (or set of elements) resulting from a given hazard at a given severity level. *(AUDMP-ADPC UDM materials)*

Concepts of Risk Assessment

The risk assessment forms the core of the Disaster Risk Management Process and results in the identification of potential risk reduction measures. Risk assessments integrated into the development planning process can identify actions that meet both development needs and reduce risk. Identified risk reduction actions can be incorporated into development polices and legal arrangements. For example, policies and associated laws and regulations to reduce the risk of fire can require or encourage the replacement of old water pipes and fire hydrants as part of road improvement projects.

Risk assessment is an essential element of the disaster risk management decision-making process. The assessment includes risk identification, risk analysis and risk evaluation. The focus is on identifying, structuring and presenting the best available risk information to define the risk problem (e.g. the risk created by the interaction of the hazards, exposure inventory and vulnerability inventory). Risk assessment determines the likelihood (probability) that negative impacts will occur as a result of identified hazards and the potential severity of those impacts.

The risk evaluation determines the significance of risk. Its significance depends upon the point-of-view of those involved. Risk is subjective and varies over time. The context that frames the risk assessment is also dynamic. These differences in point-of-view and context guide the selection and prioritization of disaster risk reduction measures.

The risk assessment guides, but does not dictate decisions about risk. Authorities responsible for the policy formulation, legal arrangements and institutional frameworks that are required for effective implementation must be convinced of the need to reduce risk and must have confidence in the measures selected. The result of a risk assessment can change the perception of risk by community leaders, program managers, high-level officials etc. leading to increased concern about the need to implement risk reduction measures in order to achieve a sustainable society. This concern may support the inclusion of risk in the development agenda, resulting in improved development decisions.

Purpose of Risk Assessment

The purpose of the risk assessment is to define the nature of the risk problem. The risk assessment provides a systematic process to answer questions about the frequency and severity of potential hazards and national and/or community vulnerabilities. Asking questions helps establish the scope of the risk assessment.

There are many advantages in defining the nature of the risk problem, including:

- Identification of the hazards to which the area you are assessing is susceptible.
- Identification of the location, nature and probability of hazard events.
- Determining who and what are vulnerable, to what degree, and how have they become vulnerable.
- Identification of the capacities and resources available for reducing vulnerabilities.
- Determining acceptable levels of risk, based on people's perception of risk.
- Providing a tool for determining the potential socio-economic, physical and environment risk.
- Providing an instrument for decision-making, policy formulation, conceptual improvements and accounting.
- Allowing for projection of future performance of physical build up, social and environmental elements and economy.
- Allowing for determining the capacity of the government to face reconstruction tasks in an event of a disaster.
- Facilitating training, capacity building and resource mobilization to face future events.

(Adapted from ISDR, 2002)

When are risk assessments carried out?

Risk assessments can be conducted anytime. For example: subsequent hazard events provide opportunity for testing the validity of our design decisions, safety factors applied, implementation methodology and performance during the design period of existence.

Immediate consequences following a disaster will reveal the deficiencies in emergency management. Risk assessments initiated during the response phase commonly focus on concern for victims and the safety of first responders. Risk assessments initiated during the recovery, rehabilitation and reconstruction phases can facilitate a change in risk perception, increase integration of risk reduction measures into development practice and strengthen resistance to future disasters, which potentially reduces response and recovery needs.

Characteristics of a Risk Assessment

Risk assessments are:

Multi-hazard: identify the range of hazards and the impact of these hazards on current and planned investments, on different groups of people, and their ability to resist and cope with the impact of hazards.

Multi-sectoral: consider current and planned land use, the building type, communication networks, people's livelihood, health and education systems, and people's awareness and commitment to protecting themselves.

Multi-level: look at the national, provincial and local policies, plans and activities to see how they have contributed to increased or reduced risk, their strengths and weaknesses in dealing with risks, and what resources are available at different levels to reduce risks.

Multi-stakeholder: involve relevant individuals and organizations. They may be directly responsible for reducing a specific risk, such as fire. They may be directly affected by risks and/or the measures selected to control them, such as the local residents and business owners. They may have information important to mapping hazards or assessing risks, such as local geologists, engineers, land use planners, etc.

Multi-phase: consider actions for response, recovery, mitigation and preparedness.

Steps in a Risk Assessment

A hazard risk assessment essentially involves:

Hazard identification: including estimation of probabilities of occurrence of various hazards of different magnitudes;

Risk estimation: combining information on the magnitude and frequency of hazards with vulnerability to them;

Risk evaluation of the significance and acceptability or tolerance of risk, examining the balance between risks and benefits; and

Risk management involving decisions on the acceptability of risks and implementation of mitigation measures to reduce or eliminate unacceptable risks and damage.

(EC 2000: World bank 1997)

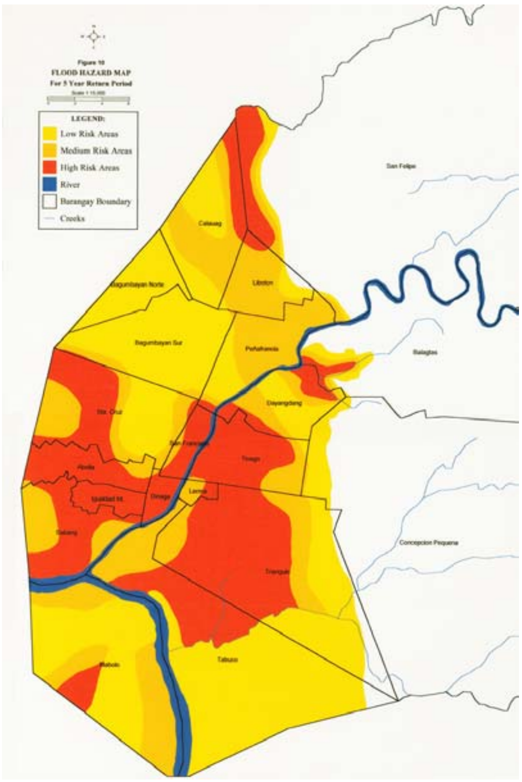
see tools and techniques
page xxx

The methods used to organize and analyze the scientific knowledge and information about potentially hazardous events varies according to the availability of hazard information, inventory data, vulnerability functions and the capacity of those performing the risk analysis to apply qualitative and/or quantitative analysis methods (see tools and techniques).

Hazard Identification

To perform risk calculations we need to know the probability of the occurrence of a hazard of a certain level of severity, within a specific period of time, in a given area. The level of severity of natural hazards can be quantified in terms of the magnitude of the occurrence as a whole (event parameter) or in terms of the effect the occurrence would have at a particular location (site parameter).

Figure 3.1
Naga City flood hazard map



Hazard data is potentially available in various forms (*Twigg 2004, see fig.3.01*):

- Geological hazard maps showing fault lines or unstable slopes liable to cause landslides
- Hydrological maps of flood-prone areas
- Wind, rainfall and sea-surface temperature data
- Recordings of seismic activity from monitoring stations
- Local rainfall and flood level records

Modern technology has advanced hazard mapping and prediction of future events considerably through techniques such as geological mapping and satellite imagery, production of high-resolution maps and computer modeling. New geographic information system (GIS) mapping techniques in particular, are revolutionising the potential capacity to analyse hazards, risks and vulnerability *(EC 2000: World Bank 1997)*

A Summary of Primary and Secondary effects of natural hazards is presented below: *(source: ICE UK, 1995)*

Table 3.1
Summary of Primary and Secondary effects of natural hazards

Natural Hazards	Primary Phenomena	Secondary Phenomena
Cyclone	Strong winds, Heavy rains	Flood and sea surge, Landslide, Water pollution
Flood	Flooding	Water pollution, Landslide, Erosion
Tsunami	Flooding*	Water pollution, Landslide, Erosion, Deposition
Earthquake	Violent ground motion, Fault rupture	Soil liquefaction, Fire, Flood, Landslide, Tsunami, Water pollution
Landslide	Ground failure	Flooding via river damming, Water pollution, Debris flow
Volcano	Lava flow, Pyroclastic flow/ surge, Ash fall, Volcanic gases	Fire, Air pollution, Tsunami, Lava flows, Water pollution, Ground subsidence

* Note on Tsunami: Some additional primary phenomena were observed in the December 26, 2004 Tsunami. The box below shows additional characteristics of tsunami waves

Box 3.1

Characteristics of Tsunami (Seismic Sea Wave): (Carter, ADB 1991)

- The velocity of the wave depends on the depth of water at the point where the seismic disturbance occurs. Initial wave velocity may be as high as 900 kph (560 mph), slowing to approximately 50 kph (31 mph) as the wave strikes land
- Warning time depends on distance from point of wave origin
- Speed of onset varies (see above)
- Impact on shoreline can be preceded by a marked recession of normal water level prior to arrival of the wave. This can amount to a massive outgoing tide, followed by the incoming tsunami wave. People may be trapped whilst investigating the phenomenon of the outgoing tide and then being struck by the incoming wave.
- The tsunami wave can be very destructive; wave heights of 30 metres have been known
- Impact can cause: flooding; salt water contamination of crops, soil and water supplies; also destruction of or damage to buildings, structures and shoreline vegetation

Vulnerability

Vulnerability is the susceptibility of things to be damaged by a hazard. People's lives and health are at risk directly from the destructive effects of the hazard. Their incomes and livelihood are at risk because of the destruction of the buildings, crops, livestock or equipment, which these depend on. Each type of hazard puts a somewhat different set of elements at risk. Most disaster mitigation work is focused on reducing vulnerability, and in order to act to reduce vulnerability, development planners need an understanding of which elements are most at risk from the principal hazards that have been identified.

Principal Vulnerable Elements

It is important for development planners to make some effort to quantify the tangible aspects of vulnerability and loss to assist mitigation and preparedness planning. Some methods for doing this are discussed below. But, as explained earlier, the 'intangible' aspects of vulnerability will often be as important as the quantifiable aspects and must not be neglected. Local experience is a good guide to what is vulnerable in a society, and the list of potentially vulnerable elements should be supplemented by a study of written reports and the knowledge (often never recorded) of those who lived through previous disasters.

Table 3.2
Principal vulnerable elements

	Principal vulnerable elements	
	Tangibles	**Intangibles**
Floods	Everything located in flood plains or tsunami areas. Crops, Livestock, Machinery, Equipment, Infrastructure, Weak Buildings	Social cohesion, community Structures, cohesion, cultural artifacts
Earthquakes	Weak buildings and their occupants. Machinery and equipment, infrastructure, Livestock, Contents of weak buildings	Social cohesion, community structures, cohesion, cultural artifacts
Volcanic eruption	Anything close to volcano. Crops, livestock, people, combustible roofs, water supply.	Social cohesion, community structures, cohesion, cultural artifacts
Land instability	Anything located on or at base of steep slopes or cliff tops, roads and infrastructure, buildings on shallow foundations	Social cohesion, community structures, cohesion, cultural artifacts
Strong winds	Lightweight buildings and roofs. Fences, trees, signs: boats fishing and coastal industries	Social cohesion, community structures, cohesion, cultural artifacts
Drought/ desertification	Crops and livestock. Agricultural livelihoods. Peoples' health	Disruption of populations. Destruction of the environment. Cultural losses
Technological disasters	Lives and health of those involved or in the vicinity, Buildings, equipment, infrastructure, crops and livestock	Destruction of the environment. Cultural losses. Possible population disruption.

Elements at risk in human settlements

Elements at risk under go damage or destruction due to the non-availability, non- enforcement, or non-compliance of land-use regulation and building codes.

Box 3.2

Physical

- Infrastructure, for example: roads, railway, bridges, harbour, airport etc...
- Critical facilities, for example: emergency shelters, schools, hospitals, nursing homes, fire brigades, police etc...
- Utilities: Power supply, Water supply
- Services: transport, communications etc...
- Government services: all levels - national, provincial, local
- Machinery and equipment
- Historical structures and artifacts

Economic

- Business and trade activities
- Access to work
- Agricultural land
- Impact on work force
- Productivity cost
- Opportunity cost

Societal

- Vulnerable age categories
- Low-income group people
- Landless/Homeless
- Disabled
- Gender

Environmental

- Environmental Resources: air, water, fauna, flora
- Biodiversity
- Landscape

Quantifying vulnerability

Vulnerability can be quantified as the degree of loss to a given element at risk (or set of elements) resulting from a given hazard at a given severity level.

The distinction between this definition and that of risk is important to note. Risk combines the expected losses from all levels of hazard severity, taking account also of their occurrence probability. The vulnerability of an element is usually expressed as a percentage loss (or as a value between 0 and 1) for a given hazard severity level. The measure of loss used depends on the element at risk, and accordingly may be measured as a ratio of the numbers of killed or injured to the total population, as a repair cost or as the degree of physical damage defined on an appropriate scale. In a large number of elements, like building stock, it may be defined in terms of the proportion of buildings experiencing some particular level of damage.

Risk Evaluation

Risk evaluation determines the significance of the risk analysis to the ability of project participants to achieve pre-established goals and objectives.

Ranking of risks

Risks are ranked according to:

- Their significance
- Existence and feasibility of risk reduction solutions
- Cost effectiveness of potential risk reduction solutions, etc.

Residual risks

Risks that cannot be reduced because no risk reduction solution exists or potential solutions are not feasible are called residual risks. Residual risks may be addressed through risk financing mechanisms. Risk funding mechanisms do not reduce potential damage and harm, but do reduce potential financial loss.

Acceptable risks

Risks that have been analyzed, but will not be addressed by the implementation of risk reduction actions are considered acceptable risks. Note that acceptable risks are ones that have been assessed and evaluated. Risks that do not affect initial areas of concern may be addressed at a later time if they exceed a level of agreed upon risk acceptance.

Risk Assessment Process

Risk Assessment Steps

The basic steps of a risk assessment process include planning, data collection, risk analysis, risk evaluation and risk communication (presenting data and results).

Step One: Planning

Plan your risk assessment**.** The objectives and context of the assessment needs to be clear from the start because they will determine the type of data to be collected, how it will be presented, and the tools and techniques to be used. Risk assessments need to address the priorities, interests and capacities of the community at risk to ensure that their problems will be addressed with cost-effective and sustainable interventions. Planning activities may include:

- Setting up goals, objectives and parameters (scale, methodology, tools to be used and area coverage).
- Encourage commitment and participation. Mapping is an effective tool to encourage participation of the community. Agreeable ideas or conflicts can be identified during the mapping process.
- Stakeholders, partners and coalitions. It is fundamental that all groups in the community participate in the risk assessment (e.g. elders, monks, women, children and others). Additional support may come from national and international organizations and institutes.

Step Two: Data collection

Data collection is a major part of the risk assessment process. The access to reliable and accurate data poses a big challenge to data collection

- Select the type of data **(data related to potential hazards, vulnerabilities, degree of exposure)** needed, based on the goals and objectives identified in Step One.
- Identify a data manager to direct the data collection process, including setting data standards, training and education, selection of staff for data collection and maintaining the risk assessment data base.
- Identify data sources. This may include newspaper archives, scientific and engineering reports, interviews, field research, tax records, etc.

Step Three: Risk analysis

Choose an appropriate method to analyze the data collected. The method will depend upon the application of results, data completeness, analysis capabilities (qualitative or quantitative), training and education, hardware and software etc.

Step Four: Risk Evaluation

Review the capability of the identified risk reduction actions to meet the criteria for a good solution established during the planning phase. Risk reduction actions should further project goals and objectives.

Step Five: Risk Communication and Consultation

Risk communication and consultation are essential and on-going parts of the Disaster Risk Management Process throughout, including the risk assessment. Communication and consultation with all stakeholders ensures that the risk assessment addresses issues of concern, keeps stakeholders up-to-date on progress and provides evolving information on the nature of the risk.

Step Six: Presentation of results

Presentation of results should be appropriate for the intended audience. Simple maps and descriptions are useful for all audiences, but especially for those lacking a technical background. Equations, engineering studies, probability maps are more appropriate for technical audiences. Results may be presented at stakeholder workshops, scientific and engineering conferences; in newspaper articles, pamphlets, and documents; and, on Web sites and radio and television programs.

Results should be easy to understand and easily accessible to all.

Step Seven: Monitoring and Review

Monitoring and review occur through out the Disaster Risk Management Process, including the risk assessment. These are long-term, on-going tasks to ensure that lessons learned are incorporated into the process. Lessons learned could be derived from:

- Experience in disaster events, demonstrating the effectiveness of the decisions taken and actions implemented
- New planning initiatives (cost benefit analysis will give the appropriateness of actions)
- New projects (new projects will provide new opportunities for implementation)
- M&E process.

Tools and Techniques

The tools and techniques used to carry out risk assessments range from qualitative, non-technical approaches to highly sophisticated, quantitative analyses using advanced computer modeling. The approach chosen will vary according to the project goals and objectives, available expertise, resources (funding and equipment) and the desired presentation format (e.g. complex equations or area maps) of project participants.

Hazard information and inventory data that is routinely collected, such as in archives or for tax assessment purposes, provides a source of knowledge and information that can be used in the risk analysis. This can be augmented by interviews with local inhabitants. Scientific studies of geologic, social and engineering features, etc provide input for quantitative analyses.

- Qualitative, non-technical approaches may be used to produce scenarios describing the impact of hazards over the study region. Information from interviews, newspaper reviews, existing inventory data and interpretations of the hazard characteristics will provide the foundation for development of risk scenarios.

- Maps showing the distribution of hazard characteristics, such as estimated level of flooding, can be placed over maps showing the distribution of building inventory, population, etc. to provide a qualitative risk scenario.

- Physical vulnerability may be estimated through visual evaluation (age, construction material, workmanship, technology used in construction) or using advance technology such as modeling and simulations (as example shake table demonstrations, wind tunnel simulations, computer modeling of buildings and structures etc).

- Vulnerability of environmental resources such as air, water, land, flora and fauna can be assessed quantitatively.

- Economic vulnerability also could be analyzed quantitatively.

- Social vulnerability (social components of society, poverty, gender, cultural, institutional vulnerabilities) cannot be measured in quantitative terms.

- Quantitative methods can be used to prepare complex risk scenario maps using data on the likelihood and severity of hazards, characteristics of the inventory (e.g. building data) and damage functions for calculating the probability of potential inventory damage or economic loss. For example, a quantitative earthquake risk scenario can be made by estimating the probable ground shaking for a specific period of time (e.g. the level of ground shaking with a 10% probability of occurring in 50 years), applying that level of ground shaking to the characteristics of the building inventory using relationships between ground shaking, inventory characteristics and building damage functions.

- The past two decades have witnessed technological improvements in hazard monitoring as well as an increased use of computer applications designed to support the decision-making process (Geographic Information Systems, Information Systems, Remote Sensing, Internet and satellite imaging, modeling and simulations). These tools facilitate the use of large data bases, complex models, incorporate new types of data and can rapidly produce attractive maps to illustrate the level of risk. These methods have been used to compare results with and without measures to strengthen the building inventory as a means to estimate costs versus benefits.

- These highly sophisticated approaches are reliable and presentable to a non-technical audience to increase the awareness but also have a number of limitations, including

  - The need to invest a large sum of money in hardware, software, and training

  - The difficulty in managing qualitative data, e.g. how hazards have affected different social groups, how they have coped with disasters and how they perceive risks

  - The difficulty of keeping data current and updating vulnerability models.

Instead of highly sophisticated approaches less expensive methods can be used in risk assessment through community based risk assessment techniques.

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Assessing the Risk: Checklist

Working at Provincial, Municipal, City and District Level

Plan your risk assessment.

- Identify study region: province, municipality, district, city and village.
- Establish boundaries for comparing variations in risk.
- Establish a multi-stakeholder team.
- Identify risk assessment objectives based on risk reduction goals in policy statements, legislation, plans, focus group discussions, interviews, historic events, etc.
- Look for any risk assessment results and guidelines developed in the past in the study region.
- Consult stakeholders on what data is needed.

Choose an appropriate method.

- Choose tools and techniques for data collection, data processing and data presentation that will provide results required for making decisions.
- Use development objectives and available resources of the study region to choose appropriate tools and techniques.
- Estimate and budgets for costs for collection, processing and presentation.
- Prepare a plan that outlines tasks, responsibilities, budgets, etc.
- Provide specialized training for risk assessment such as interview techniques, mapping, GIS, etc.
- Practice risk assessment, e.g. small pilot study.

Involve communities at risk.

- Include the priorities, interests and capacities of the communities at risk, to ensure that problems will be addressed with cost-effective and sustainable interventions.

The process could also enable community groups to better prepare for and respond to hazards themselves.
- Consult stakeholders including communities on the results of the risk assessment.

Disseminate the results.

- Disseminate results using a range of different media. Maps and reports could be developed and presented at stakeholder workshops. Other ways of dissemination include the newspaper, pamphlets, radio, television and the Internet.
- Obtain the commitment of officials in the study region to risk reduction and assessment.
- Provide guiding principles based on the steps taken above.

Develop mechanism for ongoing monitoring, evaluation and feedback.

- Document risk assessment process.
- Analyze significance of risk assessment to the decision-making process.
- Review and revise risk assessment process as necessary.
- Share results of the risk assessment with stakeholders. Feedback allows information to be reviewed and validated. It also informs stakeholders and facilitates their wider involvement in the risk reduction process.

Working at community levels -Participatory and community-based risk assessment

Participatory risk assessment often conducted at the community level may include tools and techniques used in rapid rural appraisal (RRA), participatory rural appraisal (PRA) and participatory learning and action (PLA). They differ in important ways, including the degree of participation they enable, and the information, ideas and understanding they produce. (Some of the tools and techniques commonly used can be found in the resources in the illustrated example in ***Chapter 7 – Bringing Risk Management to local Level***)

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Case Studies

India

India
Vulnerability Atlas provides a national resource for planning

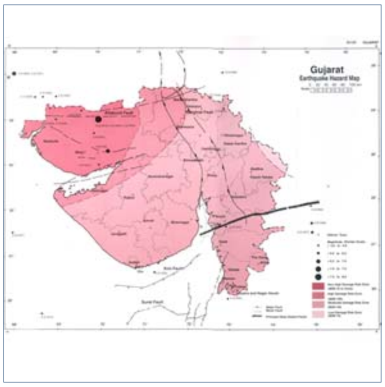
Purpose

A Vulnerability Atlas of India was completed in 1997 making available district-wide hazard maps for earthquake, cyclone and flood hazards, and risk tables showing the vulnerability of different building types. It was intended to be a pro-active approach to addressing disaster management.

The atlas has helped state governments and local authorities to strengthen regulatory frameworks by incorporating disaster risk reduction measures in the building by-laws, regulations, master plans and land-use planning regulations. It has also been used as a baseline to enable appropriate objectives to be set for recovery programs.

Methodology

In July 1994, the Government of India employed an expert group to focus specifically on natural hazards and the impact on housing and infrastructure. The group conducted work in monitoring hazards, hazard zonation mapping, vulnerability assessment, prediction and forecasting, disaster risk assessment and mapping, retrofitting of existing unsafe structures and buildings, and preparation of building guidelines.



Hazard maps of each state (including unions and territories) for earthquakes, wind and cyclone, and floods were produced with the collaboration of various universities and government departments. For example, maps were drawn at scale of 1:2.5 million using 'Survey of India Maps' of the same scale to use as a base. The seismic zoning map of India for 1893 and 1984 was used as a base to mark out seismic-tectonic features and epicenters marked with intensity.

Risk tables were drawn to identify building types and their vulnerability to each hazard. The risk tables included details such as wall materials, roof types and number of buildings of each type.

Vulnerability and Risk Assessments were conducted to determine the local hazard intensity and vulnerability of existing building types for each district. The data was presented in a table. The aim of providing information on a macro scale was to bring vulnerable areas to the attention of potential development planners, decision makers, professionals and households.

Link to policy
The expert group has urged the government to restructure National Policy on Disaster Management to:

- Make appropriate amendments to legislative and regulatory instruments coupled with enforcement mechanisms.
- Ensure the use of disaster resistant construction techniques in all structures by making disaster resistant codes and guidelines mandatory.
- Create an institutional mechanism at national/state level to advise and assist existing long and short term plans for disaster management

Legislation is still needed at urban level development, land-use zoning, safety requirements for building by-laws of local bodies (panchayats) especially for new buildings and the upgrade of old buildings.

For more information visit
http://www.bmtpc.org/disasters.htm (accessed July 2004)

Vietnam
Developing Framework for Joint Assessments

Vietnam

Purpose
A framework on joint assessments for disaster response has been developed by a group of government, non-government and United Nations agencies to enhance participation and coordination in response and recovery in Vietnam.

Method
Procedures for conducting the joint assessments and assessment tools / formats for data collection have been developed. To start, it was agreed that UNDP will function as the coordinating agency for joint assessments between July 2003 and June 2004. Joint assessment teams were mobilized during the floods in the central provinces in October and November 2003. The Ministry of Agriculture and Rural Development, CARE Vietnam, Catholic Relief Services, Oxfam, NDM-Partnership, Save the Children Alliance, UNDP, UNICEF and World Vision participated in the joint assessment.

see chapter 5

Data Collection

Assessment tools have been developed for collecting data on: shelter; child protection; food security; nutrition and livelihood; health; water; sanitation; and education. These tools combine the checklists that have been used by different agencies in the past. Sphere Standards (see Ch. 5: Disaster Preparedness for Response and Recovery) have also been applied to develop the common formats.

Dissemination of Results

The data collected has been widely disseminated in print and made accessible on the NDM-Partnership website. *(NDM-Partnership, 2003)*

Lao PDR

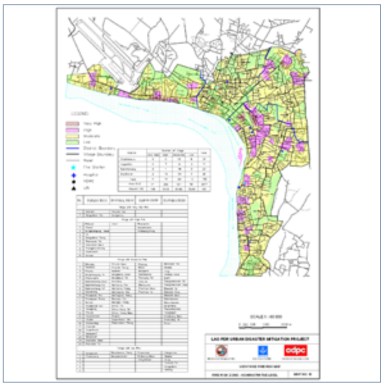
Lao PDR
Reducing Fire Risks

Purpose

The Government of Lao PDR's new policy promoting private sector investments resulted in a construction boom, focused on roads and large modern buildings. At the same time, urban fires caused more damage than any other hazard events over the past few years, particularly in Vientiane. The city government would like to know what can be done to reduce fire risks in Vientiane.

Data Collection

Through stakeholder consultation it was decided that data would be collected on seven elements: 1) building material type, 2) availability of fire sources (quantity of fuel), 3) effectiveness of fire fighting services determined by availability of water and space to mobilize fire fighting team, 4) quality of electrical wiring, 5) fire history, 6) building density, and 7) accessibility. All information, except for fire history was collected through field survey. Information on fire history was obtained from the Fire Prevention and Protection Police Department.



Fire Risk Assessment

Lao PDR's Urban Research Institute (URI) with technical assistance from ADPC and Chiang Mai University conducted a Fire Risk Assessment of Vientiane together with stakeholders including the National Disaster Management Office and the Vientiane Disaster Management Committee. The outcome of this assessment led to the development of a city action plan to reduce fire risk in Vientiane.

A Fire Risk Map overlaying a 1:10,000 land use and infrastructure map of Vientiane obtained from the National Geographic Department was produced to display the data collected. Scores were given to the seven elements and when combined gave four categories in which the map was divided into: very high, high, moderate and low risk areas. Since URI did not possess GIS capacity, integration was done through manual method. In addition, qualitative data was collected on the vulnerabilities of people, building, infrastructure and facilities.

The Vientiane Fire Risk Map covered the four urban districts of Vientiane: Sikhottabong, Chanthabouli, Sisattanak, and Xaysettha and there were 100 communities in the four districts. The scoring results classified more than half of the 100 communities in the high-risk area, and six communities in the very-high risk area. Qualitative records showed the causes of vulnerabilities. For example, rehabilitation of the old water pipes under the roads had not been included in the road improvement projects, and the fire hydrants were not being replaced as the road surfacing is completed.

Risk Communication
Upon the completion of the risk assessment process, a series of stakeholder workshops were organized to develop a city-level action plan to identify priority areas for implementation, to be carried out by whom and within what time frame.

Recognizing the fact that when a fire occurs, it takes time before external assistance could reach the affected area, it is important that communities and individuals consider fire risk reduction. Ban Hatsdy Tay community in Vientiane was selected to pilot a **community-based risk assessment**. A map was produced showing high, moderate and low risk areas based on similar elements: fire history; fire sources; building materials; building density; quality of electrical wiring system; accessibility; and houses where there are elderly and young children. From these maps, a community action plan consisting of priority mitigation and preparedness strategies was developed for fire risk reduction.

(safercities 9, 2004)

Sri Lanka
Reducing Landslide Risks

Sri Lanka

Purpose
The heavy loss of life and grave damage to property and infrastructure during landslides in the monsoon seasons of 1986 and 1989 prompted the Government of Sri Lanka (GOSL) to act. Soon after, the National Building Research Organization (NBRO)

received technical and financial support from UNDP and UNCHS (now UN-Habitat) to assess landslide risks in the pilot areas of Nuwara-Eliya and Badulla districts in a Landslide Hazard Zonation Mapping Project. The other landslide-prone districts selected for replication were Ratnapura and Kegalle in 1996 and, Kandy and Matale in 2001 under government grants. Mapping of the Kalutara district is expected to commence in 2005. The GOSL recognized the importance of this mapping process and planned to develop similar maps in all landslide-prone districts in Sri Lanka. After flood and landslide disaster in 2003, areas in other districts viz., Galle, Matara and Hambantota were identified as prone areas, where mapping has commenced.

Methodology

Between 1990 and 1995, a methodology for landslide hazard zonation mapping was developed. By looking at the range of factors that directly or indirectly influence slope stability, the slopes could be graded in terms of their estimated degree of instability and hazard potential. Basic data (see below) were gathered from field surveys as well as from desk studies and were presented on maps. Using an appropriate scoring system these data were analyzed by a computer program to develop scale 1:10,000 landslide hazard zonation maps.

- Slope category
- Bedrock Geology and structure
- Past landslides and overburden deposit
- Landform
- Land use and management
- Human settlements and infrastructures
- Hydrology

image source
Sri lanka Urban Multi-Hazard Disaster Mitigation Project, Kandy Municipal Council Planning Workbook, UDA 2000

These maps were developed with the participation of civil engineers, geo-technical engineers, geologists, architects, planners, human settlement specialists, computer scientists, environmentalists, surveyors, cartographers and sociologists. These maps were combined to form an integrated landslide hazard map.

figure 3.2
Sri Lanka landslide hazard map

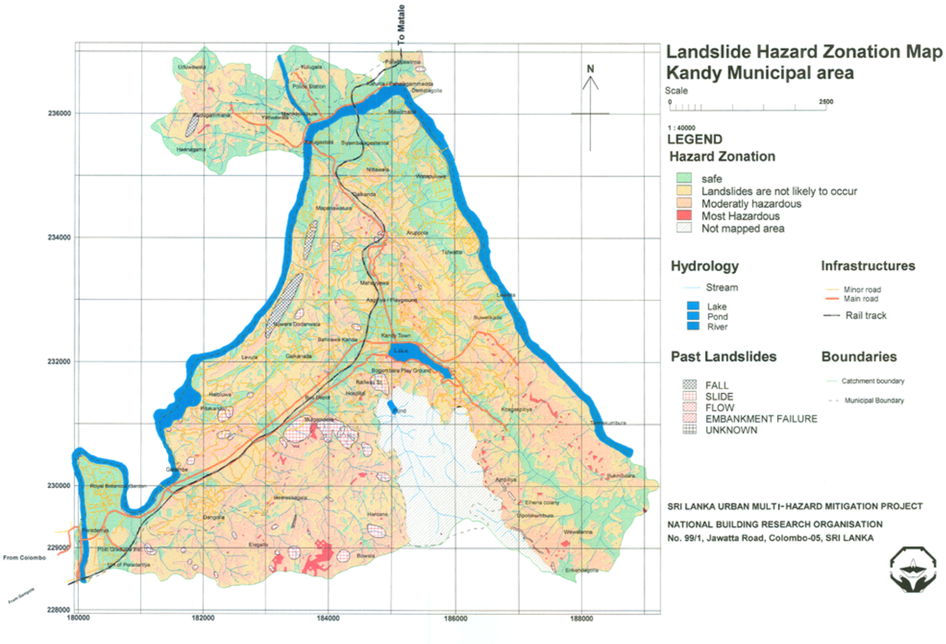


image source
Sri lanka Urban Multi-Hazard Disaster Mitigation Project, Kandy Municipal Council Planning Workbook, UDA 2000

Application

To facilitate the use of these maps in planning and development, the Sri Lanka Urban Multi-Hazard Disaster Mitigation Project (SLUMDMP) developed the knowledge of stakeholders including politicians, planners, masons, school children and community groups.

This was achieved through a combination of policy review; advocacy and awareness campaigns; training courses; education programs; development of construction guidelines in disaster prone areas; and facilitation of emergency management and response planning and action planning.

The landslide hazard zonation maps were used to:

- Prepare the Development Plan of cities (example; under SLUMDMP in Ratnapura Municipal Council in Ratnapura district.)
- Develop the Disaster Mitigation Action Plans (example under SLUMDMP in Nawalapitiya Urban Council in Kandy district.)
- Help in land use policy planning (in Mahaweli Upper watershed area and implementation and assist the Urban Development Authority in land use planning.)
- Create awareness of town planners, surveyors, lawyers and construction workers.

see chapter 8
page xxx

- Identify most vulnerable communities to pilot community-based disaster risk reduction projects. (see case study in chapter 8 – CBDRM practices in Nawalapitiya Urban Council)
- Plan resettlement (as example; after 2003 May landslide incidents in five districts Bandara, AUDMP lessons learned workshop proceedings 2002)

Nepal

Nepal
Ward 34 takes matter in their own hands

Initiation
One of thirty-five wards in Kathmandu Metropolitan City, Ward 34, took an interest in disaster issues following increasing media coverage on the vulnerability of Kathmandu Valley to a big quake in the near future. A Disaster Management Committee (DMC) was formed, chaired by the Ward Chairman and comprised of 22 residents of Ward 34.

Presentation of Results
With technical guidance from Nepal's National Society for Earthquake Technology (NSET), members of the DMC together with some volunteers prepared hazard maps for flood, fire and environmental degradation. These were simple maps that would require further technical improvement for designing any structural mitigation works, but they were useful for identifying problems and raising awareness.

The community hazard map showed streets that were too narrow for fire trucks to pass. These narrow streets marked in red compelled the map viewer to think about the problems of the ward. This map was enlarged and posted on the wall of the DMC office. Copies were also made available for distribution.

Additional Concerns
Other concerns of Ward 34 residents include bad road conditions that could impede a quick response to disaster, improper disposal of waste, poor sanitation and health systems that could increase residents' vulnerability, and poor drainage systems that could trigger flooding. Perhaps influenced by the risk assessment of the DMC, the Ward office relocated an electric pole erected from the middle of a narrow street.

Case Study Lessons Learned

- A risk assessment facilitates the decision-making process by structuring, analyzing and presenting information in a way that can be used by those making disaster risk reduction decisions.

- Risk assessment is a diagnostic tool: It can show the affects of hazard events on your community, city, district, province, state, or country (depending on the area being assessed).

- Risk assessment is a planning tool: It can provide insight to help assign risk reduction priorities, identify areas on which to focus, estimate necessary resources and identify those capacities necessary to implement and maintain risk reduction measures.

- National organizations can provide leadership by helping establish guidelines, setting expectations and providing incentives for local risk assessment and planning activities.

- Multi-hazard assessments are difficult to accomplish due to the different approaches used to assess specific hazards. A number of disaster risk indices for individual and multiple hazards have been developed to guide hazard comparisons. Identifying and assigning priorities to risk reduction measures require a means to understand the affects of each type of hazard.

- Mechanisms to regularly update materials produced by risk assessments, such as the Risk Atlas, are essential, especially in a rapidly changing environment.

- Joint assessments can be carried out to foster participation and coordination in response and recovery efforts. Joint assessments can enhance the effectiveness of disaster risk reduction. The partnership established during the joint assessment can improve cooperation during the implementation of interventions. The joint assessment can also provide participants with greater awareness of the risks involved and increase their commitment in reducing these risks.

- Data collection is a major part of the risk assessment process. The access to reliable and accurate data poses a big challenge to data collection. The data collection process can be extremely time consuming

Discussion Questions

"It is not the answers that show us the way, but the questions."

Rainer Maria Rilke, Czech poet

- Do you know the hazards, vulnerabilities and capacities of your jurisdiction?
- Are policies and legislation developed based on results of a risk assessment, e.g. development policy and building codes; land use restrictions, etc?
- Has legislation been passed (with necessary compliance and accountability process) that requires risk assessments for all development projects?
- Are disaster-related information collection, analysis, storage and dissemination standardized and systematized?
- Are there regional and national guidelines for conducting risk assessments?
- Is there a focal point for coordinating risk assessments?
- What mechanisms need to be in place to ensure that results of risk assessments are incorporated in development policies and plans?
- What mechanisms need to be in place to ensure that risk assessments are regularly conducted and results shared are shared with stakeholders each time?
- Is information on disaster risk reduction current, accurate, consistent, widely available and targeted at users within the country and to other countries in the region?
- Is there an ongoing commitment to periodically review and update the information?
- Are risk assessments conducted prior to implementation of development projects?

- Are the risk assessments conducted comparable with other assessments?
- Are the results of risk assessments widely shared with stakeholders?
- Are there regular monitoring and evaluations conducted on the impacts of policy and project decisions on vulnerabilities and capacities?

Questions for working at Community Level:

- Are risk assessments conducted prior to implementation of community level projects such as human settlement development projects, infrastructure development projects?
- Are all groups in the community participating in the risk assessment process (e.g. elders, monks/imams/other religious leaders, women, children and others)?
- Are the results of the risk assessment easy to understand and easily accessible to all?
- Are the results of the risk assessment reviewed and widely shared with stakeholders?
- Are the risk assessments conducted comparable with other assessments at district and provincial levels?

Challenges

Risk assessment of a community or even a nation can be a daunting, controversial and delicate operation. The assessment may expose risks rooted in long-established inequalities and access to resources and power. The assessment report could be deeply political and unacceptable to national authorities, or even to the leadership of the organization conducting the risk assessment. The assessment process may also raise unrealistic expectations among vulnerable people that their problem may vanish. Or it may end up creating a wish-list of priorities beyond the capacities of local and national organization to deliver.

In the last two decades there has been much progress in the development of methodologies for risk assessments. There have also been many reports of risks assessments conducted at national, state, provincial and local levels for single and multiple hazards throughout Asia by different organizations. However, challenges remain in:

- Access to reliable and accurate data
- Capability to use multiple data formats
- Systematic incorporation of risk assessment across all sectors in development
- Standardization of risk assessment methodology for comparable results within and across nations
- Commitment and making resources available for improving data quality and availability within and across nations
- Commitment and making resources available for participation of all stakeholders in the risk assessment process
- Accessibility and use of risk assessments in development policy and planning
- Developing tools for user friendly vulnerability assessment
- Making mandatory provisions for risk assessment prior to decision making at all levels of governments to avoid arbitrary decision-making

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Resources

Risk mapping and GIS

Geographic Information System (GIS) tools to manage, analyze and present data and results is becoming increasingly popular. GIS has been widely used in mapping hazards and assessing physical vulnerability (e.g. buildings, power lines and infrastructure).

HazPac
http://www.crowdingtherim.org/docs/ctr/map.html
HazPac is a free, interactive, digital natural hazards map of the Pacific Rim region. HazPac's GIS overlays the map with data regarding natural hazards, population, and infrastructure. It illustrates how hazards can affect the people and economies of local and distant communities. HazPac's versatility lets you design and manipulate the map while exploring regional interconnections and shared risk of the Pacific Rim.

HAZUS
http://www.fema.gov/hazus/hz_index.shtm
United States' Federal Emergency Management Agency developed HAZUS to provide individuals, businesses, and communities with information and tools to work proactively to mitigate hazards and prevent losses resulting from disasters.

Using GIS technology, HAZUS allows users to compute estimates of damage and losses that could result from an earthquake. To support FEMA's mitigation and emergency preparedness efforts, HAZUS is being expanded into 'HAZUS-MH,' a multi-hazard methodology with new modules for estimating potential losses from wind and flood (riverine and coastal) hazards. In addition to estimating losses, HAZUS contains a database of economic, census, building stock, transportation facilities, local geology and other information that can be used for a number of steps in the risk assessment process.

Pacific Disaster Center's Asia Pacific Natural Hazards and Vulnerabilities Atlas (Version 1.1)
http://atlas.pdc.org/APNHVA/kickoff.html

This online Atlas combines baseline geographic and infrastructure data layers with historical and near-real time data on natural hazard events including: earthquakes, tsunamis, volcanoes, and tropical storms. Its main objective is to provide a venue for exploring regional and national level issues related to risk and vulnerability and for assessing impacts of natural hazard events.

RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters)
http://www.geohaz.org/radius

RADIUS is a simple-to-use tool based on a spreadsheet (Microsoft's MS Excel) and a free GIS software (ESRI's Arc Explorer) to estimate earthquake damage. It was developed through the support of United Nation's International Decade for Disaster Reduction and the Government of Japan to raise awareness and provide practical tools for earthquake risk reduction. The RADIUS tool has been simplified in order to promote an understanding of the process among decision makers and the public. The results are preliminary and the tool cannot be used for a detailed and sophisticated study.

All the activities of the RADIUS project have been summarized on a CD-ROM together with this tool, which can be used as a tutorial for users. The CD-ROM includes the RADIUS project description, reports from the case-study cities, report on the comparative study, the guidelines for RADIUS-type projects, proceedings of the RADIUS symposium, and other reports.

Vulnerability and Capacity Assessment

The need to assign a quantifiable value to the elements analyzed into the spatial models used by GIS is not always possible for social and economic dimensions of vulnerability. Vulnerability and capacity is much more than the likelihood of buildings collapsing or infrastructure being damaged. It is also about the complexity of people and societies that include:

- Initial well-being (nutritional status, physical and mental health, morale)
- Livelihood and resilience (amount of savings, income and production options and opportunities, resources available)
- Self-protection (the degree of protection afforded by capability and willingness to build safe homes, use safe sites)
- Social protection (forms of risk reduction measures provided by society e.g. building codes, evacuation centers, and willingness to cooperate in sharing resources and saving lives during disasters)
- Social and political networks and institutions (the leadership available and organizational structure to solve problems and conflicts, and people's rights to express needs and access to resources).

(Cannon, et. al., undated)

Different methods of vulnerability and capacity assessments have been used by a number of NGOs in project design and implementation, and in training courses. The assessment is often implemented at the local level and emphasizes people's participation in the process.

Participatory and community-based risk assessment

Asian Disaster Preparedness Center
ADPC, undated, **Community-Based Disaster Risk Management Course Curriculum** (including Trainer's Guide, Coordinator's Guide, Participant's Workbook and Reading Materials).

Citizens' Disaster Response Network, Philippines
CDRN have documented their experiences of community-based disaster risk management in the Phillippines over several years, including the application of capacity and vulnerability assessments and other information-gathering and planning methods in their publication below.

Heijmans, A & Victoria, L.P., 2001, **Citizenry-Based & Development-Oriented Disaster Response: Experiences and Practices in Disaster Management of the Citizens' Disaster Response Network in the Philippines**, Quezon City: Center for Disaster Preparedness.
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ECLAC, 2003, **Handbook for Estimating the Socioeconomic and Environmental Effects of Disasters**, United Nations Economic Commission for Latin America and the Caribbean (ECLAC) and International Bank for Reconstruction and Development (The World Bank).
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This report provides a good overview of vulnerability and capacity concepts and tools for analysis, including an inventory of methods and documents.

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