Risk Reduction

Risk = Hazards $\times$ Vulnerability

Disaster Preparedness Training Programme

International Federation of Red Cross and Red Crescent Societies
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Background and uses

This module is one of nine modules that have been prepared by INTERWORKS for the International Federation of Red Cross and Red Crescent Societies Disaster Preparedness office in Geneva. This module can be used as for independent study, as a reference guide on the subject, and to provide participants at a workshop training event on this topic. It is intended to accompany the trainer's notes on this topic. Their intended use is global, and they are written for generalists, planners and professionals with disaster preparedness and/or emergency response responsibilities both within the Federation and in the National Societies. Non-governmental organisations interested in disaster preparedness and preparedness planning, government emergency commissions, local disaster committees and civil defence training units may also find these modules useful.

This material can be used as:
• A general reference material on disaster preparedness
• Training and workshop modules and trainer's guides
• An orientation to disaster preparedness for Delegates and NS officers
• A guide for assessing or planning disaster preparedness capabilities

All nine of these modules are revised and updated versions of modules that were initially developed for the Central Asia IFRC Disaster Preparedness Regional Delegation DP project in 1998. This project resulted from recommendations and training needs expressed by Central Asian National Society and Emergency Commission staff attending the IFRC sponsored regional disaster preparedness conference held in Tashkent, Uzbekistan from June 24-26, 1996.

The overall aim of the Central Asia DP training project was to support the National Societies in further developing their own structures for preparedness in conjunction with those of the Emergency Committees, Ministries and Civil Defence organisations in each of the five countries in the region. To date, disaster preparedness in the region has been typified by highly response oriented, well maintained and trained Civil Defence organisations; and largely unprepared, and untrained local populations and non-governmental organisations. Disaster management has traditionally consisted of preparedness for efficient and centralised emergency response, not the development of community-based or localised preparedness capacity. The Central Asia DP training programme was one attempt to change this emphasis and was proposed as a starting point from which revisions, and modifications for use on a country-by-country basis were expected and welcomed.

This material is based on a “multi-hazard” approach, and is typically applicable to preparedness in all of the hazard situations represented. However, the specific country context of the readers and trainees will necessitate a focus on the hazard types that are most applicable to their situation. While the modules and accompanying trainer’s notes are written for use at national level workshops, individuals with training responsibilities are encouraged to use and adapt the material for use at more local regions and towns.
The nine disaster preparedness modules and trainer’s notes

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Acknowledgements

These nine modules and their accompanying trainer's notes were prepared for the International Federation by INTERWORKS, a consulting group with disaster management training and consulting experience in over 60 countries worldwide. Review and critique of these modules were provided by a team of Central Asian disaster management specialists, the disaster preparedness officers of five Central Asia National Societies, the Federation disaster preparedness staff in Geneva and delegates in Central Asia, the Caribbean and East Africa.

The following documents served as references for the compilation and writing of this particular module:

1. *Introduction to Hazards*, 3rd edition. Sheila Reed of InterWorks for DHA Disaster Management Training Programme. 1997. In collaboration with the University of Wisconsin-Disaster Management Center and InterWorks.


Risk Reduction

Aim and audience

This module introduces the interrelated concepts of hazards, vulnerability and risk and their association to risk reduction strategies and activities. In the last section of this module general and hazard-specific risk reduction measures are presented as well as measures which can be implemented at the community level.

This module is appropriate for anyone who has general responsibilities for disaster and risk reduction planning and programme implementation. Non-technical personnel interested in acquiring a better understanding of the elements that make people vulnerable to disasters and the strategies and measures to reduce their risks can also benefit from reading this module.

Main points

- factors affecting vulnerability
- why and how individuals perceive risks differently
- community hazards, risks and capacity mapping
- the relationship between hazards, vulnerability, capacities and risk
- different types of risk reduction measures
- hazard-specific risk reduction strategies
- hazard-specific, community based risk reduction strategies

1. Introduction

Disasters occur when natural or technological hazards have an impact on human beings and their environment. Those who have more resources—both economic as well as social—often have a greater capacity to withstand the effects of a hazard than the poorer members of a society. Rapid population growth, urban or mass migration, inequitable patterns of land ownership, lack of education and awareness, and subsistence agriculture on marginal lands lead to vulnerable conditions such as unsafe siting of buildings and settlements, unsafe homes, deforestation, malnutrition, unemployment, underemployment, and illiteracy.

Individuals and organisations responsible for planning risk reduction and emergency response measures should begin by understanding the nature and probability of occurrence of the hazards that people face. They must assess the societal elements at risk (people, structures, services, and activities) due to these hazards, if and when they occur. Planners should also have a solid grasp of the target population’s specific vulnerabilities and capacities to help them effectively choose and design meaningful risk reduction measures that utilise and build on the target population’s strengths while reducing their vulnerabilities. They must also understand how a society or target population perceives its risks and what importance they place on reduction of specifics risks.
The concepts of vulnerability, hazard, and risk are dynamically related. The relationship of these elements can be expressed as a simple formula that illustrates the concept that the greater the potential occurrence of a hazard and the more vulnerable a population, then the greater the risk. It is also important to note that human vulnerability to disaster is inversely related to human capacity to withstand the effects of disasters.

\[
\text{Risk} = \text{Hazards} \times \text{Vulnerability}
\]

The following definitions serve as an orientation to these interrelated concepts.

**Vulnerability:** *Human vulnerability* is the relative lack of capacity of a person or social group to anticipate, cope with, resist, and recover from the impact of a hazard. Vulnerability has two components: exposure to hazards (e.g. drought, earthquake, etc.) and difficulty in coping with and recovering from them (due to lack of resources). Since human vulnerability is inversely related to the concept of human capacity, we also offer a definition of that concept below.

**Structural or physical vulnerability** is the extent to which a structure or service is likely to be damaged or disrupted by a hazard event. A building is said to be vulnerable to earthquake tremors if its construction lacks elements which would resist the effects of such tremors.

**Capacities:** *Human capacities* are the qualities and resources of an individual or community to anticipate, cope with, resist and recover from the impact of a hazard. According to Mary Anderson's People-Oriented Planning (POP) framework, human capacities include a person's or a community's material resources (food, animals, tools); social and organisational capacities (leadership, community groups); and attitudinal and motivational capacities (ideas, work values, efficacy) (People-Oriented Planning at Work: Using POP to Improve UNHCR Programming. M. Anderson, UNHCR 1994).

A **hazard** is defined as the potential occurrence, in a specific time period and geographic area, of a natural phenomenon that may adversely affect human life, property or activity to the extent of causing a disaster. Methods of predicting various hazards and the likelihood and frequency of occurrence vary widely by type of hazard.

**Risk** refers to the expected or anticipated losses (lives lost, people injured, property damaged, and economic activities or livelihoods disrupted) from the impact of a given hazard on a given element at risk over a specific period of time. Risk is defined differently by people in different situations. Risk, as perceived by the politician or the disaster...
manager, is different from risk as understood by a scientist, or by an insurance company salesman, or by a family living in an earthquake zone.

2. **Factors affecting human vulnerability**

Before developing risk reduction programmes, it is important to understand some of the major factors which make a population vulnerable. These factors include:

- Poverty
- Increased population density
- Rapid urbanisation
- Changes in way of life
- Environmental degradation
- Lack of awareness and information
- War and civil strife

In the discussion below, you will notice that these seven factors frequently are interrelated. For example, poverty often results in people migrating to urban areas in search of work. Limited resources and opportunities in urban areas result in people settling in unsafe locations and can also produce tensions leading to civil unrest.

2.1 **Poverty**

Most disaster studies show that the wealthiest members of a population either survive a disaster unaffected or are able to recover quickly. Poverty generally makes people vulnerable to the impact of hazards. Poverty explains why people in urban areas are forced to live on hills that are prone to landslides or why people settle near volcanoes or rivers that invariably flood their banks. It also explains why famines more often than not are the result of a lack of purchasing power to buy food rather than an absence of food.

### Dealing with drought: vulnerabilities and capacities

People in drought-prone areas such as the Sahel expect drought every seven years or so. In between they face seasonal food shortages prior to every harvest. These are all "expected" contingencies. People sell off small stock, fall back on drought resistant crops and generally cope. They do not develop as families or communities because of these regular contingencies. When there are two bad years back-to-back, however, people are not able to cope. They have to sell off productive assets—maybe even land. Poor people become poorer while the richer people in the community gain from this process by buying assets from the poor.

*From: IFRC Vulnerability and Capacity Toolbox (2nd draft)*

2.2 **Increased population density**

There is an obvious connection between the number and magnitude of losses from a disaster and the size of the population. If there are more people and structures where a
disaster occurs, then it is likely there will be more of an impact. Population growth means that more people will be forced to live and work in unsafe areas and that more people are competing for a limited number of resources (such as employment opportunities and land), which may lead to conflict.

2.3 **Rapid urbanisation**

Rapid population growth and migration are related to the major phenomenon of rapid urbanisation. It is characterised by the rural poor or civilians in an area of conflict moving to metropolitan areas in search of economic opportunities and security. As a result, fewer opportunities are available. Competition for scarce resources, an inevitable consequence of rapid urbanisation, can result in human-made disasters.

**Earthquakes and vulnerability in Cairo, Egypt: the 1992 earthquake**

On October 12, 1992, an earthquake measuring 5.6 on the Richter scale shook Cairo, Egypt and the city’s surrounding areas. The earthquake, which would have registered as a moderate, or even small, event had it occurred in Japan or along the Western coast of the United States, devastated hundred of buildings and rural homes and resulted in over 500 hundred deaths and 4,000 injuries. Most of the damage, deaths and injuries occurred in the densely populated (and older) inner-city slum districts of Cairo, where hundreds of old, poorly constructed, and already dilapidated, buildings collapsed.

Most of the buildings that collapsed were in violation of city building codes and safety regulations. For example, the 14-story building which collapsed, killing 61 people in the rich northern suburb of Heliopolis, had originally been constructed as a six or eight story building. The remaining stories were added later illegally—a practice not uncommon in Cairo. In addition to homes and businesses, many school buildings were damaged. One national survey noted that 1,087 seriously damaged schools would be closed, while another 5,870 schools required either extensive or partial repairs and restoration.

The earthquake’s effects were not limited to Cairo. In three of the seriously affected rural villages in the western Nile valley, over 2,600 houses were reported completely destroyed. The destroyed houses included traditional ones made of mud brick and timber, as well as more modern constructions which had not been designed to withstand even minimal earthquake tremors.

*Adapted from:*

2.4 **Changes in way of life**

All societies are constantly changing and in a continual state of transition. These transitions are often extremely disruptive and uneven and may leave gaps in social coping mechanisms. These transitions include nomadic populations that become sedentary, rural
people who move to urban areas, and both rural and urban people who move from one economic level to another. These transitions may also include severe changes in the way a country's economy or political system is managed. Many of the countries in the former Soviet Union have experienced this extreme transition from a centralised economy to a market economy, with a resulting increase in many people's vulnerability.

When people move from rural to urban centres, they may lose the social support system or network that traditionally would have assisted them in recovering from a disaster. Since these traditional coping mechanisms may not exist in the new setting, the population increasingly depends on outside intervention to help in the recovery process. Conflicting as well as transitional cultural practices can lead to civil conflict, for example, as a result of communal violence triggered by religious differences.

2.5 Environmental degradation

Many disasters are either caused or exacerbated by environmental degradation. Deforestation leads to rapid rain run off, which contributes to flooding. Companies that engage in mineral extraction often form disposal banks containing toxic substances which may lead to an increase in certain diseases among the population.

The creation of drought conditions—and the relative severity and length of time the drought lasts—is mainly a natural phenomenon, but agricultural development and the system of food distribution may exacerbate conditions. Similarly, climate changes, which are presumed to be a result of the phenomenon of global warming, may result in more disasters due to such hazards as flooding and desertification.

2.6 Lack of awareness and information

Disasters can also happen when people who are vulnerable to them simply do not know how to get out of harm’s way or what protective measures to take. There may be a lack of awareness about what measures can be taken to build safe structures on safe locations. Some people may not know about safe evacuation routes and procedures whereas others may not know where to turn for assistance in times of acute distress. In most disaster-prone societies, however, there is a wealth of understanding about disaster threats and responses. This understanding should be incorporated into external assistance efforts.

2.7 War and civil strife

War and civil strife can be regarded as hazards, that is, extreme events that produce disasters. War and civil strife often result in displaced people who are more vulnerable as a result of their dislocation. Causes of war and civil strife include competition for scarce resources, religious or ethnic intolerance, and ideological differences—the same factors that increase vulnerability to disasters.

3. Perception of risk

Individuals and organisations responsible for designing and implementing effective risk reduction measures must consider how the target population perceives its risks. A detached, scientific or professional assessment of risk, while technically accurate, often will fail to consider the local or target population's perceptions of risk and the choices available
Disaster risks are unlikely to be considered important among populations that face much greater everyday threats from disease and food shortages. Even if the disaster risk is quite significant, it is unlikely to compare with the risk of child mortality in a society with a minimal or weakened primary health care system. Where resources and capacities are limited and everyday risks are too great, it becomes difficult to invest time and money in reducing a potential hazard risk. Most people affected by disaster events, who often already live in poverty, see no real difference between needs arising from disasters and those arising from everyday problems—they all have to be coped with.

**Every-day problems in Lima, Peru: water scarcity**

In many countries one of the most pressing urban problems is the disposal of human and industrial waste. Compounding this is the general scarcity of water, a situation that exists in Lima, Peru. Many urban poor in Lima use untreated wastewater to grow vegetables for human consumption. This practice has resulted in frequent outbreaks of typhoid and hepatitis and in high incidences of diarrheal diseases (*adapted from Disasters and the Environment, 2nd ed., Disaster Management Training Programme, UNDP/UNDHA 1995*).

Populations in disaster-prone areas may also trade-off perceived risks against real or potential benefits. Living near a chemical processing plant may pose certain risks but may also bring the benefit of employment and jobs for the nearby population. To those who choose to live near the plant, the benefits may outweigh the risks of a chemical accident. Similarly, the risks associated with vaccinations and travelling to work are generally considered acceptable because the benefits are immediately obvious. To most people in a community, the exposure to natural and environmental hazards does not have any specific benefit associated with it—the exposure is a simple consequence of living or working in a particular location. Generally, the levels of acceptable risk appear to increase according to the benefits derived from exposure.

Where literacy and access to the media and other sources of information are limited, people will lack knowledge or awareness of the hazards that threaten them. Loss of traditional knowledge of local threats can also reduce hazard awareness over time. People’s perception of risks may decrease during times of rapid social and technological change or when there are long periods between major disaster events. Organisations such as National Red Cross/Red Crescent Societies can increase a community's awareness by informing the public of potential risks. Programmes to raise awareness are not only useful to increase perceptions of risk, but also to educate the public that risks are preventable and to encourage them to participate in protecting themselves.

A community's willingness to do something about its risks does not depend entirely on the actual risk level. It is often a subjective choice based on value judgements. Organisations and staff responsible for planning disaster preparedness programmes have to be aware of...
this reality and balance scientific or professional judgements against the social, economical, cultural and political assessment of risks made by the individuals and communities that face them.

4. Community hazard, risk and capacity mapping

One way to raise awareness and change perceptions about potential risks is by engaging individuals and groups in producing local community hazard, risk and capacity maps. These maps can be useful for showing the general pattern of risks threatening a certain population and the capacities they possess for overcoming those risks. In addition to intermittent, larger scale, natural hazards such as earthquakes or floods, community risk maps can be used to highlight daily emergencies—unemployment, nutritional deficiencies, unsafe housing conditions and limited access to health care—all of which become more acute during a natural disaster. These maps can also be used to highlight local resources and capacities—such as skills, food reserves, emergency housing options, community and social organisations, businesses, local leaders, cultural values and attitudes, and transportation sources such as school buses or ox carts—that will help communities cope with disasters. Finally, hazard maps assist in the preparation of plans which can reduce the danger in a community and in the identification of evacuation plans for risk areas.

Teachers, schoolchildren, social and health care workers, Red Cross/Red Crescent volunteers, and others in a community can create these maps using the simplest of tools: crayons or coloured pencils and paper. The information that is generated can be used to help plan risk reduction measures and initiatives. The Pan American Health Organization (PAHO) has identified four main steps to produce a community risk and capacity map.

1. Identify and prioritise a list of common problems and needs
2. Visit areas and sites in the community that pose a risk
3. Based on these visits, draw distinct and detailed maps which show potential hazards, vulnerable people and resources in case of emergency. (Ideally, one map is drawn for each: one for the hazards, one for vulnerable people and one for community capacities and resources)
4. Organise a local disaster committee to plan risk reduction measures and/or to formulate a local emergency preparedness and response plan

Any plans that are generated based on these maps need to be widely discussed and disseminated in a community—ideally through community meetings and presentations. The strategies for reducing risks will also need to be realistic and achievable, lest they raise expectations that cannot be met.

5. Reducing hazards vs. reducing vulnerability

From the equation below, one can see that protection against risk can be achieved by removing its causes (reducing or modifying the hazard) or by reducing vulnerability.
Risk = Hazards X Vulnerability

In certain circumstances, some natural hazards can be reduced. The construction of levees along the banks of certain rivers reduces the chance of flooding in surrounding areas. It is also possible to prevent potential known landslides and rockfalls by stabilising land pressures, constructing retaining walls and improving the drainage of slopes. Engineering works can contain the destructive agents of some natural hazards or can divert the threat away from important elements with channels and excavation. In some cases, tree planting can be an effective way either to reduce the potential for floods and mudslides or to slow desertification.

Obviously, preventing industrial accidents from occurring in the first place is the best method of mitigating these disasters. Fires, chemical spills, technological and transportation accidents are all hazards that are essentially preventable. The focus of disaster mitigation for these human-made disasters is preventing the hazards from occurring or reducing their impact if they do.

Local capacity building measures seek to reduce human vulnerability by building and reinforcing a local community's skills, organisational systems and abilities and offering incentives to reduce risks. They also help communities prepare to respond effectively in case of disasters.

Since members of the local population of disaster-stricken areas are the first ones at the disaster site—performing search and rescue activities as well as providing emergency treatment and relief to their families, friends and neighbours—organisations such as Red Cross/Red Crescent Societies and the local Civil Defence can play an important role in improving the skills and knowledge of these “spontaneous” disaster responders. Offering education and training in preparedness measures, basic rescue techniques, and first aid and emergency treatment is an important component of risk reduction plans.

These organisations might also play a role in helping to organise local populations or settlements around specific risk reduction or mitigation activities. Local areas often have the technology or knowledge required to reduce their own vulnerability but may be missing some key local or social structure that prevents them from realising the benefits of vulnerability reduction. The objective of organising at the local level for risk reduction is to empower local people to act together and to overcome barriers to successful action. For earthquakes this may mean implementing a local awareness campaign highlighting earthquake risks and some simple building techniques for strengthening homes and businesses. For landslide risk reduction, local populations might be mobilised to construct
structures with stronger foundations, compact the ground, reforest slopes, and create rockfall barriers using trees and earth banking.

6. Risk reduction measures

The range of risk reduction measures can be classified into the following categories, each of which is discussed below:

- Societal
- Physical planning
- Economic
- Engineering and construction
- Management and institutional memory

6.1 Societal

Risk reduction will occur when there is a consensus that it is desirable, feasible and affordable. Risk reduction planning should aim to develop a “safety culture” in which all members of society are aware of the hazards they face; know how to protect themselves; and will support the protection efforts of others, of society and of the local population as a whole.

Public education campaigns aim to create this safety culture. Public awareness can be raised in a number of ways, from short-term, high profile campaigns using broadcasts, literature and posters, to more long-term, low profile campaigns that are carried out through general education. Planning disaster awareness and disaster preparedness activities in isolation from people's daily lives will rarely succeed. Therefore, these programs are most effective when linked to ongoing and immediate daily community needs such as basic health care, water scarcity and potability, sanitation concerns, employment and community based first aid.

The objective is to develop an everyday awareness of the possibility of hazard occurrence in which people take conscious precautions. Their understanding should include an awareness of what to do in the event of a hazard; and a sense that their choice of house, the placement of a bookcase or stove and the quality of construction of a garden wall around an outdoor work or play area all affect their safety.
Diarrhea prevention and treatment in Bangladesh

The most effective way to protect children from diseases and epidemics is to involve their mothers. In many communities, mothers are the traditional providers and protectors of their children. If these natural strengths are supported by basic health and nutrition education, mothers will ensure that their children are vaccinated, that they have as nutritious a diet as resources permit, and that they are given the simple salt and sugar preparation that can be made at home (oral rehydration solution) in the event of diarrhea—all of which will protect their children against the impact of disasters and save young lives.

In Bangladesh, for example, village women were trained in simple seven point messages about diarrhea prevention and its treatment and in how to make a homemade version of oral rehydration solution. They then went from village to village, door to door, instructing other women in this basic lifesaving therapy. In this manner, 12 million households—far more than could ever be reached by conventional health service coverage—were made aware of the importance of oral rehydration therapy in the treatment of diarrhea in their children.

Adapted from “Saving Lives after disaster strikes,” by Rosemary Fieth in Stop Disasters, Number 24, 1995.

Local involvement in risk reduction planning processes can include public meetings and consultations; public inquiries; full discussion of decisions at special meetings and involvement in generating hazard, risk and capacity maps. Awareness can be developed through regular practice drills, practice emergencies, quizzes and anniversary remembrances. In hospitals, schools and large buildings, it is necessary to rehearse what the occupants should do in the event of a fire, earthquake or other hazard. This reinforces awareness and develops automatic behavioural responses.

6.2 Physical planning

Careful location of new facilities—particularly community facilities such as schools, hospitals and infrastructure—plays an important role in reducing vulnerability. In urban areas, deconcentration of elements especially at risk is an important principle. That is, services provided by one central facility are always more at risk than those provided by several small facilities. This principle also applies to population density: a denser concentration of people will always increase the potential for disaster compared to a more dispersed population.

6.3 Economic

Linkages between different sectors of the economy may be more vulnerable to disruption by a disaster than the physical infrastructure. Diversification of the economy is an important way to reduce risk. A strong economy is the best defense against disaster. Within a strong economy, governments can use economic incentives to encourage individuals or institutions to take disaster mitigation actions.
6.4 Engineering

Engineering measures range from large-scale engineering works to strengthening individual buildings and small-scale, community-based projects. Codes of practice for disaster protection (such as building codes) are unlikely to be effective unless they are accepted and understood by the community. Training local builders in techniques that incorporate better protection into traditional structures—such as buildings, roads, and embankments—is likely to be an essential component of such measures.

6.5 Management and institutional

Building disaster-protection takes time. It needs to be supported by a programme of education, training and institution-building to provide the professional knowledge and competence required.

7. Risk reduction strategies

This section focuses on specific activities for reducing the risks associated with the following hazards:

- Earthquakes
- Land instabilities
- Volcanic eruptions
- Floods and water hazards
- Storms (typhoons, hurricanes, tropical storms and tornadoes)
- Droughts and desertification
- Chemical and industrial accidents

General risk reduction strategies and local community risk reduction measures for each of these hazards are discussed below. The general risk reduction strategies often are costly or necessitate enforced legislation and thus will require government, private sector or donor support. The local measures are less costly and promote the use of locally available resources and capacities.

7.1. Earthquakes

General risk reduction strategies

There are several hazard mitigation strategies for earthquakes. Structures can be engineered to withstand vibration forces and governments can develop and enforce seismic building codes and higher standards of construction quality. Governments can also ensure that important public sector buildings are constructed according to high engineering design standards. Additional measures can include training programmes to improve construction techniques in the building industry and public education programmes about these techniques.
Besides structural engineering, the effects of earthquakes can be mitigated by implementing location planning to reduce urban densities on geological areas known to amplify ground vibrations. In addition, incentives could be offered to remove unsafe buildings or buildings on unsafe sites or, more feasibly, to upgrade their level of safety.

Government supported public education campaigns are also very important. Nearly every country has a means of communicating with its most remotely located citizens, either through the media or through informal communication networks. Public awareness programmes can be designed to reach every vulnerable person and may significantly reduce the social and material costs of an earthquake. Some examples of information to be provided include:

- causes of earthquakes and warning signs
- awareness of earthquake risks and ways to minimise personal vulnerability
- practical ways to reinforce vulnerable houses
- what to do in the event of an earthquake (with possible participation in a drill)
- how to form teams to assist in the search for injured people and other post-disaster recovery activities
- volunteer fire fighting and first aid training

**Community-based risk reduction measures**

An important element of earthquake mitigation is community awareness and participation. Awareness of earthquake risk and a desire to live in houses safe from seismic forces help motivate construction of earthquake-resistant buildings. Knowledge of what to do in the event of an earthquake can be increased by earthquake drills and public awareness programmes. Community fire fighting, search and rescue, and first aid training groups can also be formed. These groups can take responsibility for readiness and maintenance of fire extinguishers, excavation tools and other civil protection equipment.

Community organisations and local officials should develop plans to prepare and react to the emergency. The plan might include the following elements and activities:

- identifying and training teams for search and rescue operations
- ensuring the rapid availability of detection equipment
- identifying and training teams for disaster assessment
- identifying safe sites and emergency shelters where vulnerable populations could be relocated
- training personnel in trauma care and first aid
- planning for an alternative water supply
- preparing plans to clear streets for emergency access
- preparing emergency communication systems and messages to the public regarding their security
- training teams to determine if buildings are safe for reoccupancy
- preparing flood plans for susceptible areas
- coordinating preparations with voluntary organisations
7.2 Land instabilities (including landslides, mud flows, etc.)

General risk reduction strategies

A primary mitigation strategy for landslides is location planning to avoid the use of hazardous areas for settlements or as sites for important structures. In addition, landslide risk may be reduced by creating shallower slope angles in hillsides through excavation of the top layers of earth; by increasing deep drainage and surface run-off drainage capacity; and by constructing engineering works such as pilings, ground anchors, and retaining walls. Terracing slopes and reforestation can also prevent loss of surface material. If expected, debris flows can be directed into specially constructed channels and rockfall protection barriers such as trenches; silt dams and vegetation barriers can also be constructed to protect settlements.

Most experts do not consider strengthening existing buildings and infrastructure a viable option for mitigation of damage due to landslides, as vulnerability for structures built in the path of landslides is nearly 100 percent. Enhancements and protective measures may be added to sites, such as improvement of soil drainage (by addition of permeable materials), slope modifications (reduction of slope angle prior to construction), and re-vegetation of slopes. Concrete retaining walls may stabilise possible sites. Large scale engineering works may also be considered.

Public education programmes may involve descriptions of climatic conditions or hazards that provoke landslides and what actions to take when such conditions exist. Evacuation plans for high risk areas should be established and practised, particularly when the risk of landslide is interconnected with the threat of seismic, volcanic or flood activity.

Community-based risk reduction measures

The most damaging landslides often occur as a result of the activities of people. Construction of roads, housing, and other infrastructure frequently causes landslides. Thus the most effective preparedness measures are those taken before people occupy a vulnerable area. Public education programmes help people understand the causes and effects of landslides in addition to helping them identify unstable areas and avoid settling there.

Communities should be trained to recognise potential land instabilities, identify active landslide areas, and avoid siting houses in hazardous locations. In addition, communities can reduce the risk from land instabilities by constructing structures with strong foundations, compacting ground, preventing deforestation of slopes, stabilising slopes through terracing and forestry, and creating rockfall barriers using trees and earth banking.

Areas susceptible to landslides may be monitored to allow timely warning and evacuation. Monitoring methods include field observation and use of inclinometers, vibration meters and electrical fences or tripwires. Immediate relay of information is essential in places where rockfalls or debris flows are likely to occur rapidly. In these cases, use of the media or other widely reaching information systems may be required. Monitoring and warning systems should place inhabitants on alert when heavy rains occur or if ground water levels rise.
7.3 Volcanic eruptions

General risk reduction strategies
Potential methods for reducing the impact of volcanic eruptions include location planning to ensure that areas close to volcano slopes are not used for important activities and channelling, damming or diverting lava and debris flows away from settlements through the use of engineering works. Monitoring volcanoes is often feasible and can provide significant lead-time information about volcanic activity. Risks associated with volcanic eruptions can also be reduced by promoting fire-resistant structures as well as engineering structures to withstand the additional weight of ash deposits.

Community-based risk-reduction measures
Communities play an important role in mitigating their risk from volcanic eruptions. Community members should be aware of volcano risk and should identify potential danger zones. In addition, communities and families can prepare and practice evacuation plans. These should include a monitoring and scaled early warning system to alert the local population of eruptions.

7.4 Floods and water hazards

General risk reduction strategies
The main risk reduction strategies for floods and water hazards include land-use control and planning to avoid locating vulnerable facilities in flood plains. Retaining walls and levees along rivers, and sea walls along coasts may keep high water levels out of flood plains (although levees may create other problems over time or elsewhere downstream). Structures which are located in flood plains should be engineered to withstand flood forces and designed with elevated floors to reduce damage from flood waters. Dams are capable of storing water so that it can be released at a manageable rate. Levees and dams are subject to failure and can also be damaged by earthquakes. They must be carefully engineered to anticipate maximum water levels since failures may cause much more damage than if the facilities had not been built.

Water regulation (slowing the rate at which water is discharged from catchment areas) can be achieved by constructing reservoirs, increasing vegetation cover to slow down run-off, and building sluice systems. Removing silt buildups or dredging deeper channels and constructing alternative drainage routes (new river channels, spillways and pipe systems) may prevent river overload. Storm drains in towns assist drainage rates; and beaches, dune belts, and breakwaters can sometimes reduce the power of tidal surges.

Flood reduction aims to decrease the amount of runoff, usually by altering the watershed, and is most effective when employed over most of the drainage basin. Typical treatments include reforestation or reseeding; contour plowing or terracing; and protection of vegetation from fire, overgrazing and clear-cutting. Other approaches involve clearing sediment and debris from streams, deepening and widening the riverbed and constructing or preserving farm ponds and other water holding areas. In urban areas, water holding areas can be created in parks and ponds.
Flood-proofing helps reduce the risk of damage. Temporary measures include blocking or sealing entrances or windows and the use of sandbags to keep flood waters away. Permanent measures include the use of hazard resistant designs such as raising living or working spaces high above the possible flood level. Houses may be elevated by structural means (stilts) or by raising the land using landfill. Buildings should be set back from water bodies. Land surrounding buildings and infrastructure should be protected against erosion. Streambeds should be stabilised with stone masonry or vegetation, especially near bridges.

**Community-based risk reduction measures**

The majority of deaths and much of the destruction created by floods can be prevented by mitigation and preparedness measures. Communities can be actively involved in reducing the risk of flood damage. Where construction in flood-prone sites is necessary or cannot be avoided, houses can be constructed to be flood resistant using materials resistant to water damage and strong foundations. Awareness of water hazards can be reflected in living practices such as constructing elevated storage and sleeping areas. Crop cycles can be modified to avoid the flooding season, and flood-resistant crops can be introduced. Community members should also be aware that deforestation can exacerbate flooding.

Communities can reduce the risk of personal harm by preparing flood evacuation plans which include the identification of evacuation routes and availability of boats or other appropriate transport and rescue equipment. Monitoring and warning systems at the local (and regional) level are also important components of a risk reduction strategy.

Inhabitants of flood prone areas usually have a number of traditional methods for coping with floods. Some aspects of flood planning and response can be managed at the village level and upgraded with outside assistance. These are:

- issuing warnings at the local level
- participating in flood fighting by organising work parties to repair embankments or clear debris from drainage areas, pile sandbags and stockpile needed materials.
- facilitating agricultural recovery
- planning emergency supplies of food and clean drinking water
- identifying traditional mitigation and preparedness measures and determining their effectiveness

Programmes to promote public awareness of flood hazards may contain the following components:

- Explanations of the function of flood plains, location of local flood plains and drainage patterns
- Identification of flood hazard and warning signs
- Advice on how to flood-proof possessions and develop personal escape plans
- Explanation of local evacuation plans and warning systems, and appropriate post-disaster activities
- Emphasis on personal responsibility for flood prevention/mitigation in day-to-day living practices. This includes the use of proper farming practices, prevention of deforestation and maintenance of drainage systems
• Provision of escape routes—neighbourhoods should have clear escape routes and designated areas of refuge on higher ground
• Evacuation procedures should be practised on a regular basis and ways to disseminate warnings via radio, television, warning sirens or bells should be devised

7.5 Storms (typhoons, hurricanes, tropical storms and tornadoes)

General risk reduction strategies
The main mitigation strategies for hazards due to storms include a public that is well informed regarding the hazard and an effective warning system. Engineering structures to withstand wind forces, developing wind load requirements in building codes and wind safety requirements for non-structural elements are also important. In addition, siting key facilities in less vulnerable areas (such as in the lee of hillsides), planting windbreaks, and planning forestry areas upwind of towns can also reduce the risks associated with storms. Strong, wind-safe public buildings which can be used for community shelter in vulnerable settlements can also reduce the risk to community members whose homes are not safe in storms. Crops can be protected by introducing agricultural practices and crops which are more resistant to high winds.

Community-based risk reduction measures
Communities can help reduce their risk of damage from storms by preparing evacuation plans and warning systems to be implemented in the event of a storm; by constructing wind-resistant or easily rebuilt houses; by securing and fastening down those elements that could blow away and cause damage or injury elsewhere, such as metal sheeting, fences, and signs; by taking shelter in strong, wind-resistant buildings; by taking protective measures for boats, building contents or other possessions at risk; and by protecting food storage facilities from storms.
Reducing cyclone risk—Andhra Pradesh, India

Andhra Pradesh is the fourth most populous state in India, with an estimated population in 1995 of around 60 million people—approximately 195 people per square kilometre. It has a vast coastal line of 1,030 km abutting the Bay of Bengal. Two of India's largest rivers, Krishna and Godavari, flow through the state. Two out of every five cyclones arising in the Bay of Bengal affect this coastal line. From 1900-1990, approximately 57 devastating cyclones hit the coastal districts.

In 1977, a catastrophic cyclone, with wind speeds measuring 200 km/hour accompanied by tidal waves over 15 meters high, moved inland up to 12 km and affected 3.4 million inhabitants—killing 10,000 people and 230,000 head of cattle. In 1990, another cyclone, with wind speeds of 240-250 km/hour, tidal waves over four meters and heavy rainfall for 48 hours moved inland up to 25 km in the same area. It affected 7.7 million inhabitants and resulted in the death of 910 people and 27,000 cattle. This dramatic reduction in cyclone impact reflects the State's deliberate shift from relief to preparedness, following the 1977 cyclone.

After the 1977 cyclone, information, involvement and initiatives were the cornerstones of India's long-term cyclone mitigation strategy. The disaster early warning system was improved and upgraded, allowing for more accurate cyclone forecasting and more timely and accurate early warning. In addition, the State formulated and made operational a detailed contingency plan for evacuation, emergency relief and health care. The State involved NGOs in a major education campaign regarding cyclone early warnings and preparedness to handle sanitation and emergencies during the isolation period following a cyclone. The contingency plan also laid out detailed evacuation routes, location of cyclone shelters and prepositioning of medicines, and provided for a unified command, pre-determined rescue teams and emergency health teams to be dispatched immediately in case of a cyclone. By 1990, 740 cyclone shelters were in place in strategic locations. Thanks to these preparedness measures, nearly 650,000 people were evacuated to safer places in 1,098 temporary relief camps. The lesson learned from the 1977 and 1990 cyclones is that better warning systems, community education and involvement, efforts to improve facilities and operational efficiency contribute to significant reduction in the impact of disasters.

Adapted from B. Narasimhan, "Andhra Pradesh's (India) Hard Road Forward" in Stop Disasters, No. 25.

7.6 Drought and desertification

General risk reduction strategies

Although rain shortfall is uncontrollable, drought and desertification can be reduced by improved land and water management practices, such as water conservation practices, infiltration dams, irrigation, forest management, and range management (control of land use and animal grazing patterns).
The main risk reduction strategies for drought and desertification include rationing water; conserving or replacing failing water supplies through watershed management and construction of dams, pipelines or aqueducts; conserving soil and reducing erosion rates by using check dams, levelling, planting, and managing herds; reducing firewood cutting by using improved fuel stoves; introducing flexible farming and cropping patterns; raising awareness about the benefits of population control; and developing education and training programmes.

**Community-based risk reduction measures**
Communities can construct check dams, reservoirs, wells and water tanks as well as develop planting and re-forestation efforts to reduce the risks of drought and desertification. They can also change cropping patterns and livestock management practices, introduce water conservation policies, build sturdier wells, start dry-season well-irrigated gardens and develop alternative non-agricultural industries.

### 7.7 Chemical and industrial accidents

**General risk reduction strategies**
Technological hazards can be reduced by improving safety standards in plant and equipment design, by anticipating possible hazards in plant design, by developing safe design and operating procedures, by safe and regulated disposal of hazardous materials, and through proper preparedness planning. In addition risk reduction strategies include using fire-resistant materials, building fire barriers or installing devices to extract smoke, improving detectors and warning systems, engaging in preparedness planning by improving fire fighting and pollution dispersal capabilities, and emergency relief and evacuation planning for plant employees and nearby settlements (crew and passengers in the case of vehicles). In addition, on-site and off-site safety plans should be initiated and drills should be conducted in conjunction with local fire departments and other civil authorities.

The effects of a technological disaster may be reduced by providing accurate inventories and maps of storage locations of toxic/hazardous substances and their characteristics to those responding to technological disasters. An important feature of hazard mapping is the determination of possible zones and intensity of contamination. This requires knowledge of the nature of the chemicals and may include a review of historical accident records. In addition, steps taken to limit or reduce the storage capacity of dangerous or flammable chemicals will reduce the probability of occurrence of a technological disaster.
Community-based risk reduction measures
Communities should participate in actions to monitor pollution levels, ensure inspection and enforcement of existing safety standards, and improve safety legislation. They should also develop evacuation plans to be followed in the event of a technological disaster as well as regulate hazardous-materials transport routes away from schools and residential areas. Local leaders and officials also have a role to play with regard to chemical and industrial accidents. They represent the concerns or views of their constituents. Their responsibilities include:

• Communicating with local authorities and industry leaders regarding issues of concern to the local population
• Communicating with their constituency on programmes related to protecting public health and the environment
• Encouraging locally based organisations to participate in and conduct safety and preparedness training