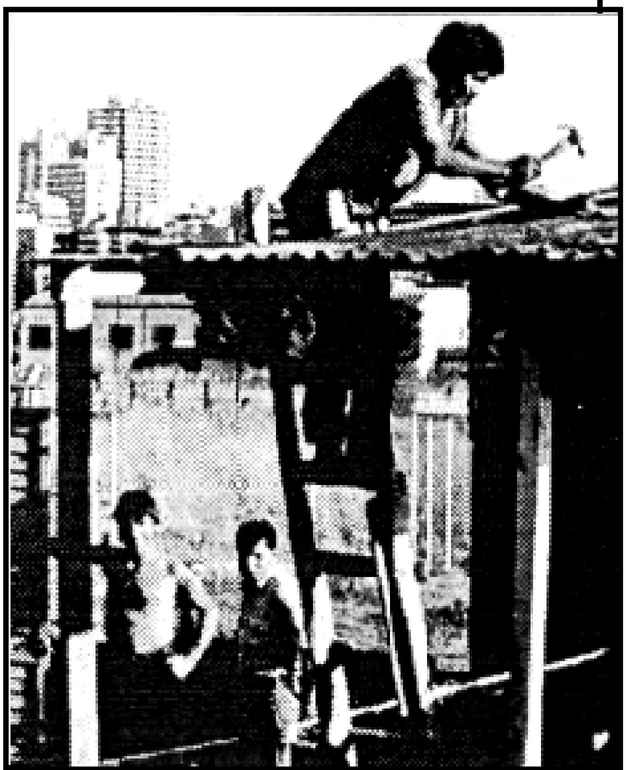
2nd Edition

Disaster Mitigation



Disaster Management Training Programme

Disaster Mitigation

2nd Edition

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DHA

Disaster Management Training Programme **1994**

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■ CONTENTS

United Nations reorganization and the Disaster Management Training Programme

Since this module was written, there have been reorganizations within the United Nations system. This section describes these organizational change and explains the expanded role of the United Nations in Disaster Management.

In December 1991 the General Assembly of the United Nations adopted resolution 46/182* establishing the **Department of Humanitarian Affairs (DHA)** in order to strengthen **"the coordination of humanitarian emergency assistance of the United Nations»** and ensure **"better preparation for, as well as rapid and well-coordinated response to complex humanitarian emergencies as well as sudden and natural disasters."** The Department incorporates the former UNDRO as well as former UN emergency units for Africa, Iraq and South-East Asia. The Secretariat for the International Decade for Natural Disaster Reduction (IDNDR) also forms part of the Department.

With regard to complex emergencies, DHA often operates in the grey zone where security, political and humanitarian concerns converge. Policy planning and policy coordination are performed in New York, where DHA works closely with the deliberative organs of the United Nations and with the political, financial and economic departments of the Secretariat.

The Geneva Office (DHA-Geneva) concentrates its activities on the provision of emergency operational support to governments and UN operational entities. It is also responsible for the coordination of international relief activities related to disaster mitigation. It continues to handle the UN system's response to all natural disasters.

An Inter-Agency Standing Committee (IASC) chaired by the Under-Secretary-General for Humanitarian Affairs has been established pursuant to General Assembly resolution 46/182. It associates non-governmental organizations, UN organizations, as well as the International Committee of the Red Cross (ICRC) and the International Federation of Red Cross and Red Crescent Societies (IFRC). The Executive heads of these agencies meet regularly to discuss issues relating to humanitarian emergencies. An inter-agency secretariat for the IASC has also been established within DHA.

Several Special Emergency Programmes (SEP) have been organized within the Department, including the Special Emergency Programme for the Horn of Africa (SEPHA), the Drought Emergency in Southern Africa Programme (DESA), the Special Emergency Programme for the New Independent States (SEP-NIS), as well as the United Nations Office for the Coordination of Humanitarian Assistance to Afghanistan (UNOCHA).

DHA promotes and participates in the establishment of rapid emergency response systems which include networks of operators of relief resources, such as the International Search and Rescue Advisory Group (INSARAG). Special attention is given to activities undertaken to reduce the negative impact of sudden disasters within the context of the International Decade for Natural Disaster Reduction (IDNDR).

The Disaster Management Training Programme (DMTP), which was launched in the early 1990s, is jointly managed by DHA and UNDP, with support from the Disaster Management Center of the University of Wisconsin, on behalf of an Inter-Agency Task Force. It provides a framework within which countries and institutions (international, regional and national) acquire the means to increase their capacity-building in emergency management in a development context.

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*Copy is included in *The Overview of Disaster Management Module.*

INTRODUCTION

Purpose and scope

This training module, ***Disaster Mitigation***, is designed to introduce this aspect of disaster management to an audience of UN organization professionals who form disaster management teams, as well as to government counterpart agencies, NGOs and donor. This training is designed to increase the audience's awareness of the nature and management of disasters, leading to better performance in disaster preparedness and response.

The content has been written by experts in the field of disaster management and in general follows the *UNDP/UNDRO Disaster Management Manual* and its principles, procedures, and terminology. However, terminology in this field is not standardized and authors form different institutions may use the same terms in slightly different ways. Therefore, there is a glossary of terms used in this module at the end of this text. Definitions found in the glossary are those of the *UNDR/UNDRO Disaster Management Manual.* Definitions in the text are those of the UNDRO expert meeting, 1979.

Overview of this module

Disaster mitigation is the term used to refer to all actions to reduce the impact of a disaster that can be taken prior to its occurrence, including preparedness and long-term risk reduction measures.

It includes both the planning and implementation of measures to reduce the risks associated with known natural and human-made hazards, and the process of planning for effective response to disasters which do occur.

The purpose of this training module is to introduce the trainee to basic mitigation concepts and to discuss the range of mitigation actions which can be considered as a response to the variety of natural and human-made hazards which may be encountered.

The first section discusses the concept of mitigation and briefly surveys the range of hazards which may need to be considered, describing their nature, consequences and some of the mitigation actions specific to each.

The second section describes the types of mitigation actions which might be appropriate, including engineering and construction, physical planning, economic, institutional and social measures, discussing the usefulness and potential limitations of each type.

The third section considers how the various types of measures available may be combined to form a comprehensive disaster mitigation strategy, how alternative possible strategy options may be assessed, and discusses opportunities and obstacles to implementation of disaster mitigation plans.

The final section looks at the role of the UN, and in particular DHA and UNDP in promoting the incorporation of disaster mitigation into a country's own development planning and institution-building processes, and examines the possible contribution of other UN agencies to this activity.

The module should be read in conjunction with the accompanying modules on *Disasters and Development* and on *Vulnerability and Risk Assessment,* with which part of its scope overlaps, and which treat certain aspects of disaster mitigation in greater detail.

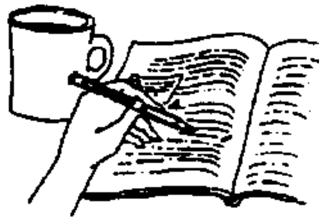
Training methods

This module is intended for two audiences, the self-study learner and the participant in a training workshop. The following training methods are planned for use in workshops and are simulated in the accompanying "training guide». For the self-study learner the text is as close to a tutor as can be managed in print.

Workshop training methods include:

- group discussions
- simulations/role plays
- supplementary handouts
- videos
- review sessions
- self-assessment exercises

The self-study learner is invited to use this text as a workbook. In addition to note-taking in the margins, you will be given the opportunity to stop and examine your learning along the way through questions included in the text. Write down your answers to these questions before proceeding to ensure that you have captured key points in the text.

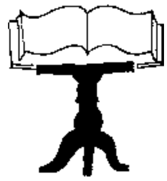


PART **1**

INTRODUCTION TO MITIGATION CONCEPTS

This part of the module should provide you with insight into the concept of disaster mitigation in general and will provide specific mitigation information for several major hazard types. You will also learn where to use mitigation activities to their best effect.

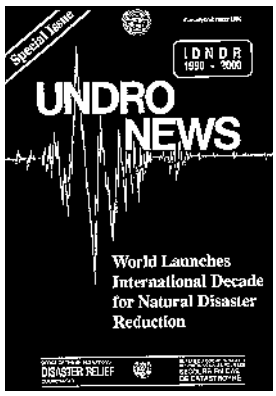
MITIGATION



The sanitary revolution: a paradigm for disaster mitigation

Mitigation means taking actions to reduce the effects of a hazard before it occurs. The term mitigation applies to a wide range of activities and protection measures that might be instigated, from the physical, like constructing stronger buildings, to the procedural, like standard techniques for incorporating hazard assessment in land-use planning.

The 1990s will be a decade of major effort to encourage the implementation of disaster mitigation techniques in development projects around the world. The United Nations has adopted the decade of the 1990s as the International Decade for Natural Disaster Reduction. The aim is to achieve a significant reduction in the loss of life and material damage caused by disasters by the end of the decade. DHA and UNDP will play a central role in encouraging national governments and non-governmental agencies to tackle disaster related issues through projects focused directly on reducing the impacts of hazards and through incorporation of risk awareness as part of the normal operations of development projects.



Special issue announcing the ***International Decade for Natural Disaster Reduction-1990-2000***

Jan/Feb 1990

A useful analogy with the recently developing science of disaster mitigation is the implementation of public health measures that began in the mid 19th century. Before that time tuberculosis, typhoid, cholera, dysentery, smallpox and many other diseases were major causes of death and tended to assume epidemic proportions as the industrial development of cities fuelled increasing concentrations of population. These diseases had a major effect on life expectancy at the time and yet were regarded as just part of the everyday risks of living. The apparent randomness with which the diseases struck and the unpredictability of epidemics meant that superstition, mythology and a certain amount of fatalism was the only public response to the hazards: the high risk of disease was generally accepted because there was little alternative.

As the understanding of what caused diseases increased, chiefly through the efforts of scientists and epidemiologists in the 19th century, so the incidence of epidemics and illnesses generally became demystified.

It became evident that disease was preventable and gradually the concept of public protection against disease became accepted.

It became evident that sanitation, purification of the water supply, garbage disposal and public hygiene were key issues for public health. The measures necessary to reduce the risk of disease were expensive-massive investment in infrastructure was needed to build sewers and clean water supply networks-and required major changes in public practices and attitudes. Social historians refer to this as the "Sanitary Revolution". Garbage collection and disposal had to be organized. It became socially unacceptable to throw garbage or to dispose of sewage in the streets. Personal hygiene, washing and individual sanitation practices became important. Initially encouraged by public awareness campaigns, they gradually became part of the social norms and were taught by parents to their children. Attitudes changed from the previous fatalism about disease to a public health "safety culture", where everyone participated in reducing the risk of communal disease.

"Father Thames Introducing His Offspring to the Fair City of London» from *Punch,* 1858.

The "children» are named Diptheria, Scrofula and Cholera.

Public health advances went hand-in-hand with public medicine, medical care, vaccination, preventive health care and a health industry that in most developed countries today consumes a very significant proportion of national economic production. Today public epidemics are unacceptable. High levels of risk from disease are not tolerated and outbreaks of disease are followed by outbursts of public opinion demanding medical and government response to protect them. Everyone now considers it normal to participate in their own protection against health hazards and accepts the high levels of cost involved in society's battle against disease. The level of risk from public health hazards that is judged acceptable by modern society is far lower than it was three or four generations ago.

Disasters today are seen in much the same way as disease was in the early 19th century: unpredictable, unlucky and part of the everyday risk of living. Concentrations of people and rising population levels across the globe are increasing the risk of disasters and multiplying the consequences of natural hazards when they occur. However, the "epidemiology" of disasters-the systematic science of what happens in a disaster-shows that disasters are largely preventable. There are many ways to reduce the impact of a disaster and to mitigate the effects of a possible hazard or accident.

Just as the Sanitary Revolution occurred with the development of a "safety culture" for public health, so disaster mitigation has to develop through the evolution of an equivalent "safety culture" for public safety.

Just like the fight against disease, the fight against disasters has to be fought by everyone together and involves public and private sector investment, changes in social attitudes and improvements in the practices of individuals. Just as the Sanitary Revolution occurred with the development of a "safety culture" for public health, so disaster mitigation has to develop through the evolution of an equivalent "safety culture" for public safety. Governments can use public investment to make stronger infrastructure and a physical environment where a disaster is less likely to occur, but individuals also have to act to protect themselves. Just as public health depends on personal hygiene, so public protection depends on personal safety. The type of cooking stove an individual uses, and an awareness that a sudden earthquake could tip it over is more important in reducing the risk of conflagration than the community maintaining a large fire brigade. The type of house an individual builds and the sites that each individual considers a suitable place to live affects the potential for disaster in a community more than large engineering projects to reduce flood risk or landslide stabilization or sophisticated typhoon warning systems.

The science of disasters is in a similar state of development to that of epidemiology in the latter half of the 19th century: the causes, mechanisms and processes of disasters are becoming understood rapidly. As a result of this understanding, the more developed countries have begun to implement individual measures to reduce the risk of future disasters. A catalogue of techniques are known for disaster mitigation, and their relevance to the countries that need them most is now clear.

Disasters are very largely a developmental issue. The great majority of casualties and disaster effects are suffered in developing countries. Development achievements can be wiped out by a major disaster and economic growth reversed. The promotion of disaster mitigation in the projects and planning activities of development protects development achievement and assists populations in protecting themselves against needless injury.

Disasters are very largely a developmental issue.

Q. Do you agree with the "Sanitary Revolution» analogy presented here as a parallel to modern day disaster mitigation programs? If so, what are parallels, and if not, what are the differences?

A. ____

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Know your enemy: hazards and their effects

The most critical part of implementing mitigation is the full understanding of the nature of the threat. In each country and in each region, the types of hazards faced are different. Some countries are prone to floods, others have histories of tropical storm damage, and others are known to be in earthquake regions. Most countries are prone to some combination of the various hazards and all face the possibility of technological disasters as industrial development progresses. The effects these hazards are likely to have and the damage they are likely to cause depends on what is present in the region: the people, their houses, sources of livelihood and infrastructure. Each country is different. For any particular location or country it is critical to know the types of hazards likely to be encountered.

The understanding of natural hazards and the processes that cause them is the province of seismologists, volcanologists, climatologists, hydrologists and other scientists. The effects of natural hazards on sturctures and the man-made environment is the subject of studies by engineers and risk specialists. Death and injury caused by disasters and the consequences of damage in terms of the disruption to society and its impact on the economy is a research area for medical practitioners, economists and social scientists. The science is still relatively young-most of the recordings of damaging earthquakes by strong motion instruments were obtained in the past twenty years, for example, and only since satellite photography has it been possible to routinely track tropical storms. The understanding of the consequences of failure of social organizations and regional economies is even more recent. However there are now many books and case studies that document the incidence of disasters and a growing body of knowledge about hazards and their effects.

Understanding hazards involves comprehension of:

- how hazards arise
- probability of occurrence and magnitude
- physical mechanisms of destruction
- the elements and activities that are most vulnerable to their effects
- consequences of damage

Brief summaries of some of the major hazards and their effects are given in hazard-specific disaster mitigation summaries in the following pages.

These demonstrate that hazards have different effects on different parts of the community, sectors of the economy and types of infrastructure: floods tend to destroy agricultural produce but cause less damage to the structure of buildings; earthquakes tend to destroy structures but have little impact on crops growing in fields. The *vulnerability* of people, buildings, roads, bridges, pipelines, communications systems and other elements is different for each hazard.

Saving life and reducing economic disruption

The worst effects of any disaster are the deaths and injuries caused. The scale of disasters and the number of people they kill are the primary justifications for mitigation. Understanding the way that people are killed and injured in disasters is a prerequisite for reducing casualties. Among the sudden onset disasters, floods and earthquakes cause the most casualties worldwide, with storms and high winds being less deadly but far more widespread.

In earthquakes over 75% of fatalities are caused by building collapse. In floods deaths occur by drowning, mainly outdoors and in fast flowing currents or in turbulent water. Saving lives in earthquakes means focussing on prevention of building collapse. Reducing fatalities from floods means limiting the exposure of people to rapid inundation-either by keeping people out of the track of potential water flows or by preventing the flows from occurring.

The consequences of physical damage are often more important than the damage itself. A damaged factory can no longer continue to manufacture jobs. The jobless have no income to spend in their local shops and the whole local economy suffers. Damage to infrastructure and to the means of production depresses the economy.

Mitigation also entails the protection of the economy from disasters. Economic activity in the more industrialized societies is complex and interdependent, with service industries dependent on manufacturing, which in turn relies on supplies of raw materials, labor, power and communications. This complex interdependency is extremely vulnerable to disruption by hazards affecting any one link in the chain. Newly industrializing societies are most vulnerable of all.

Agricultural sectors of the economy are most vulnerable to drought but also to floods and high winds, disease and pest attack and pollution. Industry is more vulnerable to earthquake damage and the disruption of transportation and utilities networks. Commerce and finance are most vulnerable to disruption of production, population migration and to breakdowns in communications systems. Mitigation measures that focus on protecting the most vulnerable elements and activities–the weakest links–in the different sectors of the economy will help protect the achievements of economic development.

The consequences of physical damage are often more important than the damage itself.

Targeting mitigation where it has most effect

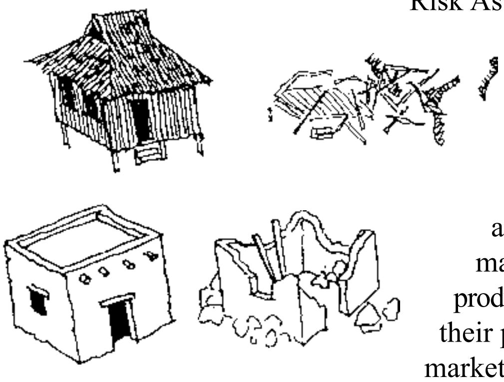
The understanding of how the occurrence of a natural hazard or an accident turns into a disaster enables us to forecast likely situations where disasters are possible. If there were no human settlements or economic activities affected, an earthquake would be a harmless act of nature. The combination of settlements *(elements)* and earthquake *(hazard)* makes the disaster possible. Some elements are more *vulnerable* to earthquake effects than others. Identifying which these are–he ***elements most at risk***–indicates priorities for mitigation.

Disasters are often the result of combinations of factors occurring together: a fire source, a dense residential area and combustible houses for example, or a seismic fault rupturing close to a city formed of high occupancy weak buildings. The contributory factors of past disasters can be identified to highlight similar conditions elsewhere. This is the process of risk analysis.

Identifying situations where combinations of risk factors coincide indicates the *elements most at risk.* The elements most at risk are the buildings, community services, infrastructure and activities that will suffer most from the effects of the hazard or will be least able to recover after the event. At a regional level, the concentrations of population and infrastructure in large cities make it likely that the losses inflicted by even low levels of hazard will exceed the total losses inflicted by severe levels of hazard on all the villages in the region. Mitigation measures in the city may have the most effect in reducing future losses. The portions of the housing stock in the city most likely to be damaged can be identified and mitigation measures applied to that sector will have the effect on reducing risk. The number of elements likely to be affected by a hazard, together with their *vulnerability* to the hazard will identify where mitigation is most effective.

Vulnerability

Houses built form cane and thatch that can be blown apart in a tropical storm are more vulnerable to wind loads than a brick building. A brick building is more likely to disintegrate with the violent ground shaking of an earthquake than a strong reinforced concrete frame structure (or cane and thatch hut) and is more *vulnerable* to earthquake hazard. Vulnerability is the degree of expected damage form a particular hazard. Targeting mitigation efforts relies heavily on correctly assessing vulnerability. Vulnerability assessment is discussed in more detail in the module on Vulnerability and Risk Assessment.



This concept of vulnerability assessment can also be extended to social groups or economic sectors: People who rent their houses rely on a landlord to repair the damage and are more likely to be made homeless in the event of a disaster. Correctly identifying the groups of tenants and establishing rights of tenure and landlords' obligations to repair may reduce the number of people made homeless in a disaster. Similarly, food growers sending their produce to market through a single mountain pass will be unable to sell their produce if the pass is blocked. Developing an alternative route to market will reduce the vulnerability of the agricultural sector to damage by disaster.

Q. What factors must be known in order to determine the most effective areas to initiate mitigation activities?

A. ______________________________

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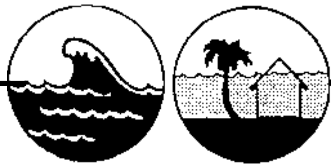
Specific Hazards and Mitigation

The following several pages (13-19) deal with the particular characteristics of several hazard types and the main mitigation strategies used to reduce their effects.

■ FLOODS AND WATER HAZARDS



Mechanism of destruction

Inundation and flow of water with mechanical pressures of rapidly flowing water. Currents of moving or turbulent water can knock down and drown people and animals in relatively shallow depths. Debris carried by the water is also destructive and injurious. Structures are damaged by undermining of foundations and abutments. Mud, oil and other pollutants carried by the water is deposited and ruins crops and building contents. Flooding destroys sewerage systems, pollutes water supplies and may spread disease. Saturation of soils may cause landslides or ground failure.

Parameters of severity

Area flooded (km^2), depth or height of flood, velocity of water flow, amount of mud deposited or held in suspension. Duration of inundation. Tsunamis or tidal waves measured in height (meters).

Causes

River flooding results from abnormally high precipitation rates or rapid snow melt in catchment areas, bringing more water into the hydrological system than can be adequately drained within existing river channels. Sedimentation of river beds and deforestation of catchment areas can exacerbate conditions leading to floods. High tides may flood coastal areas, or seas be driven inland by windstorms. Extensive precipitation in urban areas or drainage failures may lead to flooding in towns as hard urban surfaces increase run-off loads. Tsunamis are caused by underwater earthquakes or eruptions. Dam failures or collapse of water retaining walls (sea walls, dikes, levees).

Hazard assessment and mapping techniques

Historical records give first indication of flood return periods and extent. Topographic mapping and height contouring around river systems, together with estimates of capacity of hydrology system and catchment area. Precipitation and snow-melt records to estimate probability of overload. Coastal areas: tidal records, storm frequency, topography and beach section characteristics. Bay, coastal geography and breakwater characteristics.

Potential for reducing hazard

Retaining walls and levees along rivers, sea walls along coasts may keep high water levels out of flood plains. Water regulation (slowing up the rate at which water is discharged from catchment areas) can be achieved through construction of reservoirs, increasing vegetation cover to slow down run-off, and building sluice systems. Dredging deeper river channels and constructing alternative drainage routes (new river channels, pipe systems) may prevent river overload. Storm drains in towns assist drainage rate. Beaches, dune belts, breakwaters also reduce power of tidal surges.

Onset and warning

Flooding may happen gradually, building up depth over several hours, or suddenly with the breach of retaining walls. Heavy prolonged precipitation may warn of coming river flood or urban drainage overload. High tides with high winds may indicate chance of coastal flooding some hours before it occurs. Evacuation may be possible with suitable monitoring and warning system in place. Tsunamis arrive hours or minutes after earthquake.

Elements most at risk

Anything sited in flood plains. Earth buildings or masonry with water-soluble mortar. Buildings with shallow foundations or weak resistance to lateral loads or impact. Basements or underground buildings. Utilities: sewerage, power, water supply. Machinery and electronics including industry and communications equipment. Food stocks. Cultural artifacts. Confined/ penned livestock and agriculture. Fishing boats and other maritime industries.

Main mitigation strategies

Land-use control and locations planning to avoid potential flood plain being the site of vulnerable elements. Engineering of structures in floodplain to withstand flood forces and design for elevated floor levels. Seepage-resistance infrastructure.

Community participation

Sedimentation clearance, dike construction. Awareness of flood plain. Houses constructed to be flood resistant (water-resistant materials, strong foundations). Farming practices to be flood-compatible. Awareness of deforestation. Living practices reflect awareness: storage and sleeping areas high off ground. Flood evacuation preparedness, boats and rescue equipment.

EARTHQUAKES

Mechanism of destruction

Vibrational energy transmitted through the earth's surface from depth. Vibration causes damage and collapse of structures, which in turn may kill and injure occupants. Vibration may also cause landslides, liquifaction, rockfalls and other ground failures, damaging settlements in the vicinity. Vibration may also trigger multiple fires, industrial or transportation accidents and may trigger floods through failure of dams and other flood retaining embankments.

Parameters of severity

Magnitude scales (Richter, Seismic Moment) indicate the amount of energy release at the epicenter–the size of an area affected by an earthquake is roughly related to the amount of energy released. Intensity scales (Modified Mercalli, MSK) indicate severity of ground shaking at a location–severity of shaking is also related to magnitude of energy release, distance away from epicenter of the earthquake and local soil conditions.

Causes

Energy release by geophysical adjustments deep in the earth along faults formed in the earth's crust. Tectonic processes of continental drift. Local geomorphology shifts. Volcanic activity.

Hazard assessment and mapping techniques

Past occurrence of earthquakes and accurate logging of their size and effects: tendency for earthquakes to recur in the same areas over the centuries. Identification of seismic fault systems and seismic source regions. In rare cases it may be possible to identify individual causative faults. Quantification of probability of experiencing various strengths of ground motion at a site in terms of return period (average time between events) for an intensity.

Potential for reducing hazard

None.

Onset and warning

Sudden. Not currently possible to predict short-term earthquake occurrence with any accuracy.

Elements most at risk

Dense collections of weak buildings with high occupancy. Non-engineered buildings constructed by the householder: earth, rubble stone and unreinforced masonry buildings. Buildings with heavy roofs. Older structures with little lateral strength, poor quality buildings or buildings with construction defects. Tall buildings from distant earthquakes, and buildings built on loose soils. Structures sited on weak slopes. Infrastructure above ground or buried in deformable soils. Industrial and chemical plants also present secondary risks.

Main mitigation strategies

Engineering of structures to withstand vibration forces. Seismic building codes. Enforcement of compliance with building code requirements and encouragement of higher standards of construction quality. Construction of important public sector buildings to high standards of engineering design. Strengthening of important existing buildings known to be vulnerable. Location planning to reduce urban densities on geological areas known to amplify ground vibrations. Insurance. Seismic zonation and land-use regulations.

Community participation

Construction of earthquake-resistant buildings and desire to live in houses safe from seismic forces. Awareness of earthquake risk. Activities and day-to-day arrangements of building contents carried out bearing in mind possibility of ground shaking. Sources of naked flames, dangerous appliances etc. made stable and safe. Knowledge of what to do in the event of an earthquake occurrence; participation in earthquake drills, practices, public awareness programs. Community action groups for civil protection: fire-fighting and first aid training. Preparation of fire extinguishers, excavation tools and other civil protection equipment. Contingency plans for training family members at the family level.

VOLCANIC ERUPTION

Mechanism of destruction

Gradual or explosive eruption, ejecting hot ashes, pyroclastic flows, gases and dust. Blast pressures may destroy structures, forests and infrastructure close to the volcano and noxious gases may kill. Hot ash falls for many kilometers around the volcano, burning and burying settlements. Dust may carry for long distances, and fall as a pollutant on other settlements further away. Molten lava is released from the volcanic crater and may flow for many kilometers before solidifying. The heat of lava will burn most things in its path. Snow-capped volcanoes suffer ice-melt causing debris flows and landslides that can bury buildings. A volcanic eruption may alter the regional weather patterns, and destroy local ecology. Volcanoes may also cause ground upheaval during their formation.

Parameters of severity

Volume of material ejected. Explosiveness and duration of eruption, radius of fall-out, depth of ash deposit.

Causes

Ejection of magma from deep in the earth, associated with mantle convection currents. Tectonic processes of continental drift and plate formation.

Hazard assessment and mapping techniques

Identification of active volcanoes. Volcanoes readily identifiable by their topographical and geological characteristics. Activity rates from historical records and geological analysis. Seismic observation can determine whether a volcano is active.

Potential for reducing hazard

Lava flows and debris flows may be channelled, dammed and diverted away from settlements to some extent, by engineering works.

Onset and warning

Eruption may be gradual or explosive. Seismic and geochemical monitoring, tiltmenters, and mudflow detectors may be able to detect build up of pressure over the hours and days preceding eruption. Mud flow detection, geotechnical monitors and tiltemeters are some of the monitoring strategies available. Evacuation of population away from volcano environs is often possible.

Elements most at risk

Anything close to the volcano. Combustible roofs or buildings. Water supplies vulnerable to dust fall-out. Weak buildings may collapse under ash loads. Crops and livestock are at risk.

Main mitigation strategies

Location planning to avoid areas close to volcano slopes being used for important activities. Avoidance of likely lava-flow channels. Promotion of fire-resistant structures. Engineering of structures to withstand additional weight of ash deposit.

Community participation

Awareness of volcano risk. Identification of danger zones. Preparedness for evacuation. Fire-fighting skills. Taking shelter in strong, fire-resistant buildings.

■ LAND INSTABILITIES

Mechanism of destruction

Landslides destroy structures, roads, pipes and cables either by the ground moving out form beneath them or by burying them. Gradual ground movement causes tilted, unusable buildings. Cracks in the ground split foundations and rupture buried utilities. Sudden slope failures can take the ground out from under settlements and throw them down hillsides. **Rockfalls** cause destruction from fragmentation of exposed rock faces into boulders that roll down and collide into structures and settlements. **Debris flows** in softer soils, slurry material, man-made spoil heaps and soils with high water content flow like a liquid, filling valleys, burying settlements, blocking rivers (possibly causing floods) and blocking roads. **Liquefaction** of soils on flat land under strong vibrations in earthquakes is the sudden loss of the strength of soils to support structures that stand on it. Soils effectively turn temporarily to liquid allowing structures to sink or fall over.

Parameters of severity

Volume of material dislodged (m^3), area buried or affected, velocity (cm/day), boulder sizes.

Causes

Gravitational forces imposed on sloping soils exceed the shear strength of soils that hold them in position. High water content makes soil heavier, increasing the load, and decreasing shear strength. With these conditions heavy rainfalls or flooding make landslides more likely to happen. The angle of slope at which soils are stable is a physical property of the soil. Steep cuttings through some types of soils makes them unstable. Triggering of the collapse of unstable soils can be caused by almost any minor event: storms, minor ground tremors or man-made actions. Liquefaction is caused by earthquake vibrations through loose soils, usually with high water content.

Hazard assessment and mapping techniques

Identification of previous landslides or ground failures by geotechnical survey. Identification of probability of triggering events such as earthquakes. Mapping of soil types (surface geology) and slope angles (topographic contouring). Mapping of water tables, hydrology and drainage. Identification of artificial land fill, man-made mounds, garbage pits, slag heaps. Investigation into the probability of triggering events, especially earthquakes.

Potential for reducing hazard

Landslide risk for a slope reduced by shallower slope angles (excavating top layer to cut back slope), increasing drainage (both deep drainage and surface run-off) and engineering works (pilling, ground anchors, retaining walls). Shallower angles for embankments and cuttings, terracing slopes and forestation can prevent loss of surface material to depth of root penetration. Debris flows can be directed into specially constructed channels if they are expected. Rockfall protection barriers (trenches, slit dams, vegetation barriers) can protect settlements.

Onset and warning

Most landslides occur gradually at rates of a few centimeters an hour. Sudden failures can occur without warning. Rockfalls are sudden but noisy. Debris flows sudden, but precursory trickles of material may give a few minutes of warning if population is prepared.

Elements most at risk

Settlements built on steep slopes and softer soils or along cliff tops. Settlements built at the base of steep slopes, on alluvial outwash fans or at the mouth of streams emerging from mountain valleys. Roads and other communication lines through mountain areas. Masonry buildings. Buildings with weak foundations. Large structures without monolithic foundations. Buried utilities, brittle pipes.

Main mitigation strategies

Location planning to avoid hazardous areas being used for settlements or as sites for important structures. In come cases relocation may be considered. Reduce hazards where possible. Engineering of structures to withstand or accommodate potential ground movement. Piled foundations to protect against Liquefaction. Monolithic foundations to avoid differential settlements. Flexible buried utilities. Relocation of existing settlements or infrastructure may be considered.

Community participation

Recognizing land instability potential and identifying active landslides. Avoidance of siting houses in hazardous locations. Construction of strong foundations for structures. Compaction of ground locally. Slope stabilization through terracing and forestra. Rockfall barriers (trees and earth banking).

■ STRONG WINDS

(typhoons, hurricanes, cyclones, tropical storms and tornados)

Mechanism of destruction

Pressure and suction from wind pressure, buffeting for hours at a time. Strong wind loads imposed on a structure may cause it to collapse, particularly after many cycles of load reversals. More common damage is building and non-structural elements (roof sheets, cladding, chimneys) blown loose. Wind-borne debris causes damage and injury. High winds cause stormy seas that can sink ships and pound shorelines. Many storms bring heavy rains. Extreme low air pressure at the center of a tornado is very destructive and houses may explode on contact.

Parameters of severity

Velocity of wind. Wind scales (e.g. Beaufort) gale severity scale. Local hurricane/typhoon scales.

Causes

Winds generated by pressure differences in weather systems. Strongest winds generated in tropics around severe low pressure systems several hundreds of kilometers diameter (cyclones) known as typhoons in the Pacific and as hurricanes in Americas and elsewhere. Extreme low pressure pockets of much narrower diameter generate rapidly twisting winds in tornados.

Hazard assessment and mapping techniques

Meteorological records of wind speeds and direction at weather stations gives probability of high winds in any region. Local factors of topography, vegetation and urbanization may affect microclimate. Past records of cyclone and tornado paths give common patterns of occurrence for damaging wind systems.

Potential for reducing hazard

None. Cloud seeding may dissipate rain content.

Onset and warning

Tornados may strike suddenly but most strong winds build up strength over a number of hours. Low pressure systems and tropical storm development can be detected hours or days before damaging winds affect populations. Satellite tracking can help follow move ment of tropical storms and project likely path. The movements of weather systems are however, complex and still difficult to predict with accuracy.

Elements most at risk

Lightweight structures and timber housing. Informal housing sectors and shanty settlements. Roofs and cladding. Loose or poorly attached building elements, sheets and boards. Trees, fences, signs etc. Telegraph poles, pylons and high-level cables. Fishing boats or other maritime industries.

Main mitigation strategies

Engineering of structures to withstand wind forces. Wind load requirements in building codes. Wind safety requirements for non-structural elements. Good construction practices. Micro-climatic siting of key facilities, e.g. in lee of hillsides. Planting of windbreaks, planning of forestry areas upwind of towns. Provision of wind-safety buildings (e.g. strong village halls) for community shelter in vulnerable settlements.

Community participation

Construction of wind-resistant or easily rebuilt houses. Securing fixing of elements that could blow away and cause damage or injury elsewhere, e.g. metal sheeting, fences, signs. Preparedness for storm action. Taking shelter in strong, wind-resistant buildings. Protection measures for boats, building contents or other possessions at risk.

TECHNOLOGICAL HAZARDS

Mechanism of destruction

Explosions cause loss of life, injury and destruction of buildings and infrastructure; transportation accidents kill and injure passengers and crew, and may release hazardous and polluting substances; industrial fires can achieve very high temperatures and affect large areas; hazardous substances released into the air or water can travel long distances and cause contamination of air, water supply land, crops and livestock making areas uninhabitable for humans; wildlife is destroyed, and ecological systems disrupted. Large-scale disasters can threaten the stability of the global ecology.

Parameters of severity

Quantity of hazardous substances released; temperature of fire; extent of explosion destruction; area of contamination of air, sea, groundwater; local intensity of contamination (parts per million, Becquerels/liter for radio-activity).

Causes

Fire; failures of plant safety design; incorrect plant operating procedures; failures of plant components; accidental impact; arson and sabotage; earthquakes.

Hazard assessment and mapping techniques

Inventories and maps of storage locations of toxic/ hazardous substances and their characteristics; common transportation routes for dangerous substances; maps of possible zone of contamination and contamination intensity in the event of a release of any given size; traffic corridors and historical accident records for transportation hazard areas;

Potential for reducing hazard

Improved safety standards in plant and equipment design; anticipation of possible hazards in plant design; fail-safe design and operating procedures; dispersal of hazardous materials; legislation; preparedness planning

Onset and warning

Rapid (minutes or hours) or sudden (no warning); industrial plant design should incorporate monitoring and warning systems for fire, component failure and build-up of dangerous conditions; release of pollutants may be slow enough for warning and evacuation of plant operatives and public; explosions can in some cases be anticipated.

Elements most at risk

Industrial plant or vehicle and its employees or crew; passengers or residents of nearby settlements; adjacent buildings; livestock/crops in the vicinity of the plant (up to hundreds of kilometers in the case of large-scale releases of airborne pollutants and radioactive materials); regional water supply and hydrology; fauna and flora.

Main mitigation strategies

Reduce or eliminate hazard by the means listed above; improve fire-resistance by use of fire-resistant materials, building fire barriers, smoke extraction; improving detectors and warning systems; preparedness planning-improve firefighting and pollution dispersal capabilities, and emergency relief and evacuation planning for plant employees and nearby settlements, (crew and passengers in the case of vehicles). Initiate on-site and off-site safety plans, conduct drills in conjunction with local fire departments. Improve capabilities of civil defense and emergency authorities. Limit or reduce storage capacity of dangerous or flamable chemicals.

Community participation

Action to monitor pollution levels, to ensure inspection and enforcement of existing safety standards and to improve safety legislation. Prepare evacuation plans.

■ DROUGHT AND DESERTIFICATION

Mechanisms of destruction

Lack of water affects health of crops, trees, livestock, humans: land becomes subject to erosion and flooding; effects are gradual but if not checked, crops and trees and livestock die, people lose livelihood, are forced to move, and may starve if aid is not provided: then buildings and infrastructure are abandoned and decay and cultural artifacts are lost.

Parameters of severity

Rainfall level, rainfall deficit (mm), period of drought; extent of loss of soil cover, extent of desert climatic zone.

Causes

Drought mainly caused by short-term periodic fluctuations in rainfall level; possibly by long-term climatic changes; desertification caused by loss of vegetation and subsequent land erosion caused by combination of drought, overgrazing and poor land management.

Hazard assessment and mapping techniques

Rainfall map indicating areas of desert and semi-desert climatic conditions; mapping of erosion rates desertification.

Potential for reducing hazard

Drought is uncontrollable; desertification can be reduced by improved land management practices, forest management, infiltration dams, irrigation and range management (control of land use and animal grazing patterns).

Onset and warning

Slow onset, period of years, many warnings by rainfall levels, river, well and reservoir levels, human and animal health indicators. Onset of severe drought, causes death of livestock, rise in infant mortality, migration.

Elements most at risk

Crops and forests; human and animal health, all economic activities dependent on continuous water supply; entire human settlements if drought is prolonged.

Main mitigation strategies

Water rationing; conserving or replacing failing water supply by watershed management, construction of dams, pipelines or aqueducts; conserving soil and reducing erosion rates by checking dams, levelling, planting, herd management; reducing firewood cutting by improved fuel stoves, introduction of flexible farming and cropping patterns; population control; education and training programs.

Community participation

Construction of check dams, reservoirs, wells, water tanks, planting and afforestation; changing cropping patterns; introducing water conservation policies; changing livestock management practices; development of alternative non-agricultural industries;

PART 1 SUMMARY

introduction to mitigation concepts

- The essential first step in any mitigation strategy is to understand the nature of the hazards which may be faced.
- The list of hazards and their order of importance is different for each country and region, and may even vary from village to village. Existing studies and mapping may help to identify the most significant hazards in any one area.
- Understanding each hazard requires comprehension of:
  - its causes
  - its geographical distribution, magnitude or severity, and probable frequency of occurrence
  - the physical mechanisms of destruction
  - the elements and activities most vulnerable to destruction
  - the possible economic and social consequences of the disaster
- Mitigation involves not only saving lives and injury and reducing property losses, but also reducing the adverse consequences of natural hazards to economic activities and social institutions.
- Where resources for mitigation are limited, they should be targeted where they will be most effective-on the most vulnerable elements and in support of existing community level activities.
- Vulnerability assessment is a crucial aspect of planning effective mitigation. Vulnerability implies both susceptibility to physical and economic damage and lack of resources for rapid recovery.
- To reduce physical vulnerability weak elements may be protected or strengthened. To reduce the vulnerability of social institutions and economic activities, infrastructure may need to be modified or strengthened or institutional arrangements modified.

ANSWER *(from page 12)*

In order to determine the areas where mitigation activities will be most effective one must know what the elements at risk are, where they are located and the vulnerability of these elements to

PART **2**

ACTIONS TO REDUCE RISK

This part of the module illustrates the difference between passive and active methods of risk reduction as well as five basic types of measures available for use in planning mitigation programs:

- *Engineering and construction measures*
- *Physical planning measures*
- *Economic measures*
- *Management and institutional measures*
- *Societal measures*

Reducing hazard vs reducing vulnerability

Protection against threats can be achieved by removing the causes of the threat, (reducing the hazard) or by reducing the effects of the threat if it occurs (reducing the vulnerability of elements at risk).

For most types of natural disaster, it is impossible to prevent the actual geological or meteorological process from occurring: volcanos erupt, earthquakes occur, cyclones and wind storms rage. The focus of mitigation policies against these hazards is primarily on reducing the vulnerability of elements that are likely to be affected. Some natural hazards can be reduced in certain circumstances. The construction of levees along the banks of certain rivers reduces the chance of them flooding the surrounding areas, for example, and it is possible to prevent known landslides and rockfalls from developing further by stabilizing land pressures, constructing retaining walls and improving drainage of slopes. The destructive agents of some natural hazards can be contained by engineering works or diverted away from important elements in channels and excavations. In some cases tree planting can be an effective way of either reducing the potential for floods and mudslides or to slow desertification. The potential for reducing the hazard level is given in each of the hazard profiles.

Obviously, preventing industrial accidents from occurring in the first place is the best method of mitigating future industrial disasters. Fire prevention, chemical spillage, technological and transportation accidents are all hazards that are essentially preventable. In man-made risks of disaster the focus of disaster mitigation is in reducing or preventing the hazards from occurring. Engineering system safety is an important part of reducing risks form industrial hazards. A growing body of knowledge form the experience of long-established industries is applicable to the newly-industrializing regions.

Tools, powers and budgets

From the hazard profiles and the descriptions of actions that may be possible to reduce their effects, it is evident that protection is complex and needs to be built up through a range of activities undertaken at the same time. Protection cannot be simply provided by any single authority or agency. A government cannot provide housing that is wind-resistant for every citizen in cyclone-prone areas. Governments can and do, however, influence individuals towards protecting themselves and the rest of the community. Governments can employ a wide range of tools and use their powers in many ways to influence the safety of the community. Legislative powers, administrative functions, spending and project initiation are all tools they can employ to bring about change. Powers of persuasion are sometimes classified into two types: Passive and Active. These are summarized below.

Passive mitigation measures

Authorities prevent undesired actions through controls and penalties by:

- Requirement to conform with design codes
- Checking compliance of controls on-site
- Imposing court proceedings, fines, closure orders on offenders
- Control of land use
- Denial of utilities and infrastructure to areas where development is undesired
- Compulsory insurance

Requirements of passive control systems

a. An existing and enforceable system of control
b. Acceptance by the affected community of the objectives and the authority imposing the controls
c. The economic capability of the affected community to comply with the regulations.

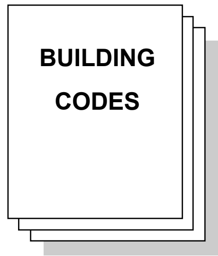
Active mitigation measures

Authorities promote desired actions through incentives like:

- Planning control dispensations
- Training and education
- Economic assistance (grants and preferential loans)
- Subsidies on safety equipment, safer building materials, etc.
- Provision of facilities: safer buildings, refuge points, storage
- Public information dissemination and awareness raising
- Promotion of voluntary insurance
- Creation of community organizations

Active Programs

a. Aim to create a self-perpetuating safety culture in areas of weak authority or poor ability to comply with existing controls.
b. Require large budgets, skilled manpower and extensive administration.
c. Are useful in areas of low income, rural areas or elsewhere where there is no external jurisdiction over land use or building activity.



Safety standards, construction codes and building regulations form part of the normal apparatus that government use to help a community protect itself. One of the simplest measures for national authorities to take is to pass legislation for a national building code that requries new buildings and infrastructures to be resistant to the various hazard prevalent in that country. Some 40 earthquake-prone countries currently have seismic building codes for new construction. However, codes themselves are likely to have little effect unless the building designers are aware of them and understand them, and unless the community considers them necessary, and unless they are enforced by competent administrators.

The multiplicity of hazards and the different ways of reducing their various effects on the elements at risk is further compounded by the type of community powers and budgets available to the decision-makers. There is no standard solution to mitigating a disaster risk. The construction of large scale engineering projects in Japan and other high-income countries to give protection against floods and volcanic debris flows, is not appropriate to mitigating similar hazards in developing countries. The enforcement of town planning regulations, and what is considered an acceptable level of interference by an authority on individual's right to build, varies considerably from one country to another, it varies from rural to urban situations and from one community and culture to the next.

The prohibition of building houses on hazardous slopes may seem sensible but is unenforceable in cities where economic pressures to locate on such locations outstrip concerns of illegality. The right of a municipal engineer to inspect the seismic resistance of a building under construction may be accepted in major cities of a country but would be objected to in the more remote villages of the same province.

Q. A distinction is made in the text between passive and active mitigation measures. What are the arguments for using active measures over passive ones?

Does this hold true for your community and the hazards that you expect might occur there?

A. ______________________________

There is no standard solution to mitigating a disaster risk.

Opportunities for community-based mitigation actions should always be sought in developing a comprehensive mitigation strategy.

Community-based mitigation

It has been argued1 that governments and large development agencies tend to adopt a "top-down" approach to disaster mitigation planning whereby the intended beneficiaries are provided with solutions designed for them by planners rather than selected for themselves. Such "top-down" approaches tend to emphasize physical mitigation measures rather than social changes to build up the resources of the vulnerable groups. They rarely achieve their goals because they act on symptoms not causes, and fail to respond to the real needs and demands of the people. Ultimately they undermine the community's own ability to protect itself.

An alternative approach is to develop mitigation policies in consultation with local community groups using techniques and actions which they can organize themselves and manage with limited outside technical assistance. Such community-based mitigation programs are considered more likely to result in actions which are a response to people's real needs, and to contribute to the development of the community, its consciousness of the hazards it faces and its ability to protect itself in the future, even though technically the means may be less effective than larger-scale mitigation programs. They will also tend to maximize the use of local resources, including labor, materials and organization.

Community-based mitigation strategies tend to maximize the use of local resources; materials, labor and management.

River defenses being built by local community-based organizations in Rimac Valley, Peru

Maskrey, 1989.

Applying such community-based policies depends on several factors– the existence of active concerned local community groups and agencies able to provide technical assistance and support at an appropriate level, for example, are crucial to success.

Nevertheless, opportunities for community-based mitigation actions should always be sought in developing a comprehensive mitigation strategy. They will certainly be cheaper and may be more successful than alternative larger-scale programs.

The menu of mitigation actions

The techniques or measures that an authority might consider in assembling an appropriate package for disaster mitigation can be classified as:

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

Engineering and construction measures

Engineering measures are of two types. Those that result in stronger individual structures that are more resistant to hazards, and those that create structures whose function is primarily disaster protection-flood control structures, dikes, levees, infiltration dams, etc.

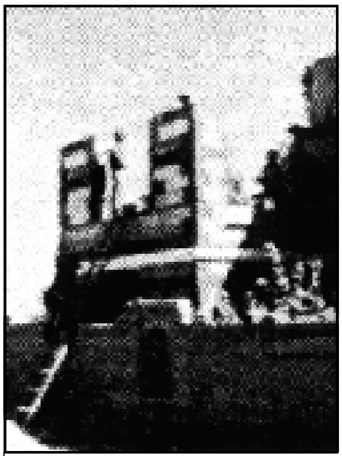
Actions of the first type are mainly actions on individual buildings and structures and are sometimes referred to as "hardening" facilities against hazard forces. Improving the design and construction of buildings, agricultural structures, infrastructure and other facilities can be achieved in a number of ways. Design standards, building codes and performance specifications are important for facilities designed by engineers. Engineering design against the various hazards may include design for vibration, lateral loads, load surcharges, wind loads, impact, combustibility, flood resistance and other safety factors. Building codes are the critical front line defense for achieving stronger engineered structures, including large private buildings, public sector buildings, infrastructure, transportation networks and industrial facilities.

Disaster-resistance based building codes are unlikely to result in stronger buildings unless the engineers who have to implement the code accept its importance and endorse its use, understand the code and the design criteria required of them and unless the code is fully enforced by authorities through checking and penalizing designs that do not comply. A code has to fit into an environment prepared to receive it. Part of the measures necessary to achieve the "engineering" mitigation measures may include increased levels of training for engineers and designers, explanatory manuals to interpret the code requirements and the establishment of an effective administration to check code compliance in practice: the recruitment of ten new municipal engineers to enforce an existing code may have more effect in increasing construction quality in a city than proposing higher standards in building codes.

A large number of the buildings likely to be affected in a disaster, and those most vulnerable to hazards are not designed by engineers and will be unaffected by safety standards established in the building codes. These are houses, workshops, storerooms and agricultural buildings built by the owners themselves or by craftsmen or building contractors to their own designs. In many countries these non-engineered buildings make up a large percentage of the total building stock. The "engineering" measures that are needed to improve the disaster-resistance of non-engineered structures involve the education of builders in practical construction techniques. The resistance of houses to cyclone winds is ultimately dependent on how well the roofing sheets are nailed down, and the quality of the joints in the building frame and its attachment to the ground. Training techniques to teach builders the practicalities of disaster resistant construction are now well understood and form part of the menu of mitigation actions available to the disaster manager.

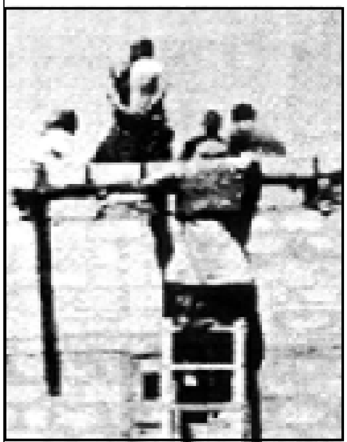
Persuading owners and communities to build safer, more disaster-resistant structures and to pay the additional costs involved is required to make builder training effective. The building contractor may play a role in persuading the client to build to higher specifications, but unless this is carried out within a general public awareness of the disaster risk and acceptance of the need for protection, the contractor is unlikely to find many customers. Grant systems, preferential loans and supply of building materials have also been used as incentives to help improve the hazard-resistance of non-engineered buildings. Legalizing land ownership and giving tenants protective rights also encourages people to upgrade building stock with security of tenure and a stake in their own future.

Apart form new buildings, the existing building stock also may need to be "hardened" against future hazard impacts. The vulnerability of existing buildings can be reduced to some degree by regular maintenance and



Code enforcement by inspection of structures under construction is an important element of maintaining a strong building stock in hazard-prone areas.

Municipal inspection, Dharan, Yemen Arab Republic



Training of builders in hazard-resistant construction techniques is best carried out through practical exercises and advice on-site.

Yemen earthquake reconstruction builder training project

ANSWER (from page 23)

Although they may cost more to initiate, active measures may produce better results in some communities because they:

- tend to promote a self-perpetuating safety culture
- do not rely on the economic capability of the affected community

The cost of adding strength to an existing building tends to be more expensive (and disruptive) than making new building design stronger, so strengthening is unlikely to be an economic option for the large majority of the building stock; for average buildings, with relatively short life expectancies (10 to 50 years), it may be better to take a long-term view of building stock upgrading, waiting until buildings come naturally to the end of their useful lives, demolishing them and buildings new structures in their place that conform to building code safety requirements.

Important existing buildings can be strengthened to reduce their vulnerability to hazards:

Retrofit earthquake-resistant strengthening in Mexico City, Court Tribunal Building

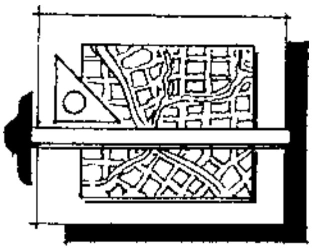
For special structures, critical facilities or historic buildings with long expected life spans, retrofit strengthening techniques are now well established and a considerable amount of expertise has been developed in this field, though these are generally too costly to be useful in development projects.

The engineering of large-scale flood control and water-supply measures is complex, lengthy and capital-intensive; and their construction frequently has adverse consequences for those they are intended to protect, for example some people may be forced off their land, land-use patterns may be changed and other adverse effects felt. Experience has shown that small-scale flood control measures which can be managed by community-based organizations can be effective in risk mitigation while simultaneously achieving other development goals. They tend to make use of local materials, labor and management resources to build on traditional mitigation knowledge rather than replacing it, and to enhance the community's own self-reliance rather than undermining it. Such measures can play an important role in disaster-mitigation within integrated agricultural or rural development projects.

Physical planning measures

Many hazards are localized with their likely effects confined to specific known areas: Floods affect flood plains, landslides affect steep soft slopes, etc. The effects can be greatly reduced if it is possible to avoid the hazardous areas being used for settlements or as sites for important structures. Most urban masterplans involving land use zoning probably already attempt to separate hazardous industrial activities from major population centers. Urban planning needs to integrate awareness of natural hazards and disaster risk mitigation into the normal processes of planning the development of a city.

Location of public sector facilities is easier to control than private sector location or land use. The careful location of public sector facilities can itself play an important role in reducing the vulnerability of a settlement–schools, hospitals, emergency facilities and major infrastructural elements like water pumping stations, electrical power transformers and telephone exchanges represent a significant proportion of the functioning of a town. An important principle is *deconcentration* of elements at risk: services provided by one central facility are always more at risk than those provided by several smaller facilities. The collapse of the central telephone exchange in the Mexico City earthquake of 1985 cut communications in the city completely. In the reconstruction, the central exchange was replaced by a number of mini exchanges in different locations around the city to make the telephone system less vulnerable. The same principle applies equally to hospitals and schools, for example as it does to power stations and water treatment plants.



The principle of deconcentration also applies to population densities in a city: a denser concentration of people will always have more disaster potential than if they are more dispersed. Where building densities can be controlled the urban masterplan should reflect the spatial distribution of hazard severity levels in its zoning for permitted densities of development. Indirect control of densities is sometimes possible through simpler methods such as using wide roads, height limitations and road layouts that limit the size of plots available for development. Creation of park lands reduces urban densities, and also provides space in the city, greenery, allows drainage to decrease flood risk, provides refuge areas for the population in the event of urban fires and may provide space for emergency facilities in the event of a disaster.

At a regional level, the concentration of population growth and industrial development in a centralized city is generally less desirable than a decentralized pattern of secondary towns, satellite centers and development spread over a broader region.

Services provided by one central facility are always more at risk than those provided by several smaller facilities.

The design of service networks-roads, pipelines, and cables also needs careful planning to reduce risk of failure. Long lengths of supply line are at risk if they are cut at any point. Networks that interconnect and allow more than one route to any point are less vulnerable to local failures provided that individual sections can be isolated when necessary. Vehicle access to a specific point is less likely to be cut by a road blockage in a circular road system than in a radial one.

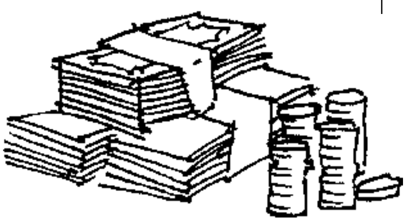
Urban planners may also be able to reduce risks by changing the use of a vulnerable building being used for an important function-a school in a weak building could be moved to a stronger building and the weak building used for a less important function, like storage.

It is often private sector land use, the informal sectors and shanty towns that pose the highest risks of disaster.

The location of public sector facilities is easier to control than those in the private sector. In many rapidly developing cities, the control of private sector land use through urban masterplanning and development permissions is almost impossible. It is often private sector land use, the informal sectors and shanty towns that pose the highest risks of disaster. Flood plains and steep slopes are often the marginal lands that are available to the lower-income communities and the most vulnerable social groups. The economic pressures that drive these groups, first to the city for jobs and opportunity, and second to the marginal lands to live, need to be fully understood as the context for reducing their risk. Prohibition or measures to clear settlers from hazardous areas are unlikely to be successful for long if the background pressures are not addressed. Some indirect measures may be effective, such as making safer land available, or making alternative locations more attractive. This may be through better provision of income sources, access to public transport and better service provision. Deterring further development in unoccupied areas by declaring areas clearly as hazard zones, denying services, reducing accessibility and limiting availability of building materials may also be effective. Ultimately, however, it is only when the local community recognizes the true extent of the hazard and accepts that the risk outweighs the benefit to them of being in that location that they will locate elsewhere or protect themselves in other ways.

Economic measures

Equitable economic development is the key to disaster mitigation. A strong economy in which the benefits are shared throughout the society is the best protection against a future disaster. A strong economy means more money to spend on stronger buildings and larger financial reserves to cope with future losses. The interdependency between Disasters and Development is the subject of another module in this training course.



Mitigation measures that help the community reduce future economic losses, help members withstand losses and improve their ability to recover after loss and measures that make it possible for communities to afford higher levels of safety are important elements of an overall mitigation program.

A strong economy in which the benefits are shared throughout the society is the best protection against a future disaster.

Inevitably it is those who have least that, proportionally, lose most in a disaster. The weakest members of the economy have few economic reserves. If they lose their house or their animals they have no means of recovering them. They are unlikely to have insurance or access to credit and can quickly become destitute. Large scale drought or flood disasters in rural areas can result in an acceleration of urbanization in the region and possibly increased risks as families with their livelihoods destroyed migrate to the towns in search of better opportunities. The destruction of industries and loss of jobs and incomes may well make recovery of the region a long and slow process or make it more vulnerable to a future disaster. Reconstruction plans often extend generous loans to victims to aid their recovery but a family without an income has little prospect of making repayments and is therefore unable to benefit.

Economic development is likely to be the main objective of any regional planner or national government agency, regardless of disaster mitigation objectives. The processes of economic development are complex and beyond the direct focus of this training course, however, disaster mitigation should be seen as a part of the process of economic development.

A single industry (or single-crop) economy is always more vulnerable than an economy made up of many different activities.

Some aspects of economic planning are directly relevant to reducing disaster risk. Diversification of economic activity is as important an economic principle as deconcentration is in physical planning. A single industry (or single-crop) economy is always more vulnerable than an economy made up of many different activities. The linkages between different sectors of an economy-the transportation of goods, the flow of information, the labor market-may be more vulnerable to disruption from a disaster than the physical infrastructure that is the means of production. Tourism as an economic sector is extremely vulnerable to disaster, or even the rumor of a potential disaster. The reliance of industry and the economy on infrastructure-the roads, transportation networks, power, telephone services etc., means that a high priority should be placed on protecting these facilities: the consequential losses of failure are costly to the whole community.

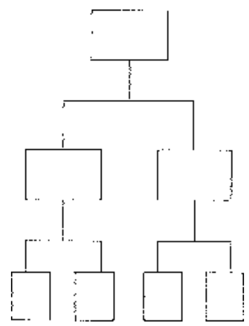
Economic incentives and penalties are an important part of the powers of any authority. Grants, loans, taxes, tax concessions and fines can be used to influence the decisions people make to reduce disaster-related risks. Industrial location is commonly influenced by government incentives which can be used to attract industry to safer locations or to act as a focus for and loans can be offered to assist owners to upgrade their property and make buildings more disaster resistant.

In industrialized countries, insurance is one of the major economic protection devices. If the risk of economic loss is spread widely over a large number of premium payers, the loss is safely dissipated. Commercial insurance is expensive and its viability is determined by accurate calculation of risk. With only a small number of premium payers, premiums remain high and are prohibitive to potential policy holders. The more widespread policy holding becomes, the lower the premiums are and the more widespread insurance use is likely to be. Encouragement of people to protect themselves through insurance ensures that a level of protection is built up. Compulsory insurance schemes have not been successful and national governments rarely have the financial resources to dedicate to disaster insurance guarantees, although many countries build up a disaster reconstruction fund through general taxation. Disaster insurance is high-risk finance and only multi-national insurance companies can gather the resources to cover the losses of any sizeable disaster. It is unlikely to be available to protect poorer or rural communities and their disaster-protection investments unless backed by a large development agency.

The institutionalization of disaster mitigation requires a consensus of opinion that efforts to reduce disaster risk are of continual importance.

Management and institutional measures

Disaster mitigation also requires certain organizational and procedural measures. The time span over which a significant reduction can be achieved in the potential for disaster is long. Changes in physical planning, upgranding structures and changes in the characteristics of building stock are processes that take decades. The objectives and policies that guide the mitigation processes have to be sustained over a number of years, and have to survive the changes in political administration that are likely to happen within that time, the changes in budgetary priorities and policies on other matters. The institutionalization of disaster mitigation requires a consensus of opinion that efforts to reduce disaster risk are of continual importance.



Education, training and professional competence, and political will, are necessary aspects of institutionalizing disaster mitigation. The professional training of engineers, planners, economists, social scientist and other managers to include hazards and risk reduction within their normal area of competence is gradually becoming common. Increasing the exposure of these groups to international expertise and transfer of technology in disaster mitigation is an important part of building capability in the affected country.

Information management and personnel training forms a major part of mitigation activities

Staff of Disaster Preparedness Center, Federal District of Mexico

Information is a critical element in planning for disaster mitigation, but there are many hazard-prone countries where the basic meteorological and geological observatories to monitor hazards have not been established or do not have the resources to carry out their job. Research, technical expertise and policy-making organizations are important resources for developing mitigation strategies both nationally and locally.

Administrative and organizational powers for disaster mitigation include the checking procedures and planning powers to realize mitigation plans, consultation procedures and representation of the community in mitigation decisions and management of the implementation of mitigation activities.

Community-based mitigation requires the strengthening of the capability of local institutions to formulate plans, to manage local protection measures and to negotiate with government to provide assistance.

A workshop for community leaders in Rimac Valley, Peru, organized by a local NGO in 1985.

Source: Maskrey 1989

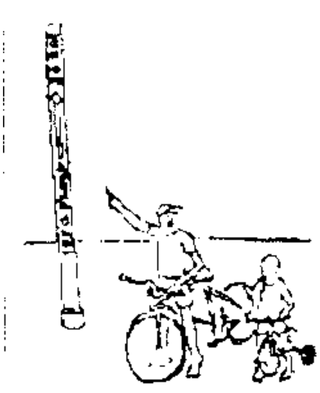
Additional staff resources and organizational structure may be needed to implement mitigation plans. Some countries have established Ministries of Civil Protection or sub-departments whose responsibilities are disaster management and the development of protection measures. It may not be necessary to establish an autonomous unit for disaster mitigation, and it is often argued that disaster mitigation is better integrated within existing activities than carried out as a separate exercise. An administration that carries policy through to implementation is essential.

At the local level, community-based mitigation requires the strengthening of the capability of the local institutions to carry out local protection measures-such training and support can often be carried out most effectively by national or international NGOs.

Societal measures

The mitigation of disasters will only come about when there is a consensus that it is desirable, feasible and affordable. In many places, the individual hazards that threaten are not recognized, the steps that people can take to protect themselves are not known and the demand of the community to have themselves protected is not forthcoming. Mitigation planning should aim to develop a disaster “safety culture” in which the people are fully aware of the hazards they face, protect themselves as fully as they can and fully support efforts made on their behalf to protect them.

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. Education should attempt to familiarize and de-sensationalize. Everyone who lives in a hazard-prone area should understand hazards as a fact of life. Information about hazards should be part of the standard curriculum of children at school and be part of everyday information sources, with occasional mentions of them in stories, TV soap operas, newspapers and other common media. The objective is to develop and everyday acknowledgment of hazard safety where people take conscious, automatic precautions through being aware of, but not terrified of, the possibility of hazard occurrence. Their understanding should include being aware of what to do in the event, and a sense that their choice of house, the placement of that bookcase or stove and the quality of construction of the garden wall around their children’s area all affect their own safety.



Awareness of risk locally is aided by reminders of past events: a bollard erected with marking to show the high water mark of past floods; the ruins of a building preserved as a monument to a past earthquake.

It is also important to de-sensationalize hazards. Most occurrences of hazards are not disastrous. Reporting only catastrophic hazards causes fear and fatalism: "If an earthquake lays waste a town, what difference does it make where I put my bookcase?». The treatment of fictional hazards in the media should be aimed at showing how a household copes or doesn’t cope with a disruptive occurrence of the hazard, not the annihilation of the soap opera family through cataclysm.

Societal awareness is important for disaster mitigation. Drills and public participation in practices can maintain awareness.

Simulated evacuation of General Hospital Balbuena during a disaster, Mexico City

Involvement of the community in mitigation planning processes may involve public meetings and consultations, public inquiries and full discussion of decisions in the normal political forum.

Further awareness is developed through drills, practice emergencies and anniversary remembrances. In hospitals, schools and large buildings it is often common to have evacuation practices to rehearse what the occupants should do in the event of fire, earthquake or other hazard. In schools children may practice earthquake drills by getting under desks. This reinforces awareness and develops behavioral responses.

In some countries, the anniversary of a major disaster is remembered as Disaster Awareness Day-1 September in Japan, 20 September in Mexico, and the month of April in California, USA. On this day drills are performed, ceremonies and activities held to promote disaster mitigation. The United Nations General Assembly in its adoption of the International Decade for Natural Disaster Reduction (Resolution 44/236,22 December 1989) designated the second Wednesday of October as an International Day for Natural Disaster Reduction which may be an opportunity for many other countries to carry out disaster awareness activities.

The objective is to develop an everyday acknowledgment of hazard safety where people take conscious, automatic precautions through being aware of, but not terrified of, the possibility of hazard occurrence.

Disaster awareness can be promoted through national days or months dedicated to hazard-related exercises. California's Earthquake Preparedness Month in April 1989 involved exercises for business, schools, government and emergency services.

Q. Five types of measures were discussed as being available for planners to use as tools for designing a mitigation program. What are they? Which of these measures are available to you through your office or position?

A. ______________________________

PART 2 SUMMARY

ACTIONS TO REDUCE RISK

- For most of the risks associated with natural hazards, there is little or no opportunity to reduce the hazard. In these cases the focus of mitigation policies must be on reducing the vulnerability of the elements and activities at risk.
- For technological and human-made hazards, reducing the hazard is, however, likely to be the most effective mitigation strategy.
- Actions by planning or development authorities to reduce vulnerability can broadly be classified into two types-active and passive measures.
- Active measures are those in which the authorities promote desired actions by offering incentives-these are often associated with development programs in areas of low income.
- Passive measures are those in which the authorities prevent undesired actions by using controls and penalties-these actions are usually more appropriate for well-established local authorities in areas with higher incomes.
- Community-based mitigation actions are likely to be responsive to people's real needs, to mobilize local resources and use local materials and contribute to the long-term development of the community, though in engineering terms they may be less effective than larger-scale capital-intensive alternatives.
- The range of mitigation actions which might be considered can include the following:
  - engineering and construction
  - physical planning
  - economic measures
  - management and institutional measures
  - societal measures
- Engineering measures range form large-scale engineering works to strengthening individual buildings and small-scale community-based projects. Codes of practice for disaster protection are unlikely to be effective unless they are accepted and understood by the community. Training of local builders in techniques to incorporate better protection into traditional structures-buildings, roads, embankments-is likely to be an essential component of such measures.
- Careful location of new facilities-particularly community facilities such as schools, hospitals and infrastructure plays an important role in reducing settlement vulnerability: in urban areas, deconcentration of elements especially at risk is an important principle.

ANSWER (from page 31)

The five types of mitigation measures discussed in the text are:

- engineering and construction measures
- physical planning measures
- economic measures
- management and institutional measures
- societal measures

- The 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 the 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.
- Building disaster-protection takes time. It needs to be supported by a program of education, training and institution building to provide the professional knowledge and competence required.
- Mitigation 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 and of the community as a whole.

NOTES

PART 3

MITIGATION STRATEGIES

This part of the module discusses the factors affecting mitigation strategies including:

- *economic conditions and policies*
- *political realities*
- *timing of mitigation activities*
- *social/community capabilities*

Aims and methods

The aim of a mitigation strategy is to reduce losses in the event of a future occurrence of a hazard. The primary aim is to reduce the risk of death and injury to the population. Secondary aims include reducing damage and economic losses inflicted on public sector infrastructure and reducing private sector losses in as far as they are likely to affect the community as whole. The objectives are likely to include encouragement for people to protect themselves as far as possible.

Any mitigation strategy is likely to include a range of measures from the menu of actions outlined in Part 2. A set of actions that includes some engineering measures, some spatial planning, and a degree of economic, management and societal inputs will be needed to bring about effective mitigation. A mitigation program that concentrates solely on any one of these five aspects will be unbalanced and is unlikely to achieve its aims.

A mitigation strategy has to be designed for its proposed application. Disaster mitigation programs carried out in the Philippines are unlikely to be directly transferrable to Peru. There are few standard solutions. Some individual elements and techniques of mitigation will be transferrable-compulsory purchase techniques for widening roads in dense urban areas that have been used in Peru may be of interest to the planners in the Philippines-but the full range of measures needed to reduce disaster potential for an individual application is likely to be unique. In each country the range of hazards faced are likely to be different. The types of infrastructure, houses and other elements at risk will have their own characteristics. The types of actions that are possible including the legislative framework, the social attitude to the problem and the budget that is available will specify what constitutes an effective mitigation program.

Economics of mitigation

Perhaps the greatest difference likely to be encountered between the various countries served by UNDP and DHA, and between the various societies threatened by disasters, is the budgetary constraints on spending for mitigation. The Japanese Government spends over $2 billion a year on disaster mitigation and preparedness. This is more than the total annual government revenue of half the world's nations.

Mitigation investment has to be seen in terms of the price of protecting existing and future infrastructure.

In most of the developing nations threatened by disaster, capital for investment is at a premium. Investment in agricultural irrigation projects or in industrial manufacturing capability has a demonstrable effect in increasing economic output. Investing in disaster mitigation is likely to mean fewer resources left for irrigation projects, industry and hospitals. And yet not spending on disaster mitigation means that the investment in irrigation projects, industry and hospitals will be wasted if they are destroyed in a future occurrence of a hazard. The spending of a few percent extra on a new facility to build it a little stronger and protect it against a future threat is usually seen as prudent. Mitigation investment has to be seen in terms of the price of protecting existing and future infrastructure.

The level of investment that is justified to protect society, its economic activities and its built environment is a matter of political decision making, and the economics of risk. Choosing an appropriate level of safety for building codes, for example, is a matter of considerable debate in the engineering profession. The cost of providing safety is considerable and the stronger a building is, the more it costs. Structural resilience standards written into code requirements in United States, where GNP per capita is about $20,000 may not be directly applicable in countries with income levels of $1,000 GNP per capita, but the attitude to safety that the code espouses is applicable. Appropriate levels of investment in safety need to be defined for each country.

The nature of political administrations means that projects that result in tangible or demonstrable outputs within the lifetime of the administration (two, three, four years) are preferred.

Decision making on appropriate levels of investment in disaster mitigation depends on how likely the hazard is to occur, and what would be the impact of the hazard if it does occur. The assessment of risk and use of vulnerability evaluation in decision-making is covered in the module on *Vulnerability and Risk Assessment.*

The costs and benefits of alternative investment strategies need to be carefully evaluated. In a number of evaluations of disaster mitigation projects, it has been demonstrated that well-targeted investment will repay itself several times in the event of a disaster in reduced levels of direct damage cost. It will also have the additional benefits of saving life and reducing consequential losses to the economy and the costs of emergency operation. The use of a systematic framework of risk assessment to establish which hazards are most likely to occur and the probable effects will help define the priorities of a mitigation program-whether to build flood protection barriers or to establish a public information campaign for cyclone-resistant housing, for example.

Practicalities of mitigation

Successful mitigation entails a number of fundamental changes in the attitudes of the people at risk, in the processes of creating and modifying the physical environment and in the physical layout of a community. These changes take time.

The nature of political administrations requires that projects resulting in tangible or demonstrable outputs within the lifetime of the administration (two, three, four years) are preferred. Many visible elements of mitigation can be achieved within that time span; engineering projects for hazard mitigation, building strengthening, changing the use of vulnerable structures, widening streets, for example, but these alone are unlikely to result in a sustainable reduction in risk. A balance of both immediately visible outputs and long term, sustainable benefits is needed.

Financial incentive schemes to reduce disaster risk requires a considerable government budget for disaster mitigation. The scale of the problem faced in trying to combat a large-scale hazard like earthquakes or tropical storms is the geographical extent of the zone at risk and the number of elements at risk in the region. Programs for housing upgrading, hazard education or community action is likely to involve millions of households. The resources necessary to accomplish this may be considerable.

There is no standard solution to mitigating a disaster risk.

Opportunities for mitigation: post-disaster implementation

Occasionally mitigation projects are prompted by predictions and studies of the likely consequences of hazards but in many cases implementation of mitigation comes about mainly in the aftermath of disaster. Rebuilding what has been destroyed and a recognition that the damage was avoidable can generate protection against a future disaster. Public support for mitigation action is strong with the visible evidence and recent memory of the disaster, or the knowledge of a disaster elsewhere.

Q. It is argued that the best time to implement a disaster mitigation program is in the aftermath of a disaster. Why is this so?
Even though the aftermath of a disaster is fertile ground for mitigation activities, there are some possible drawbacks as well, What are they?

A.

Hazard-specific programs tend to follow the occurrence of a particular hazard irrespective of the multi-hazard needs: A cyclone disaster tends to lead to cyclone mitigation, even if flood risk is higher.

The best opportunity to implement a disaster mitigation program is in the immediate aftermath of a disaster.

The experiences of the disaster, the reconstruction and the mitigation measures it engenders should be exported with relevant adaptations to the places that need it most.

For most hazards, mitigation projects tend to focus on the reconstruction area, even if other areas are more at risk: An area damaged by an earthquake is likely to be targeted for immediate mitigation measures despite the fact that the next earthquake may be unlikely to strike the same place, but is more likely to occur elsewhere in the region. This may not be true for some hazard types especially floods which tend to reoccur in the same locations.

The fact remains that reconstruction activities with large amounts of investment being put into the area and the opportunities for change represent significant opportunities to carry out mitigation. The techniques learned and the expertise developed will be applicable elsewhere in the country. It is important that the mitigation actions are promoted as far as possible beyond the reconstruction area to other areas at risk from similar hazards, and that mitigation encompasses all the hazards likely to be encountered. The experiences of the disaster, the reconstruction and the mitigation measures it engenders should be exported with relevant adaptations to the places that need it most.

Empowerment and community-based mitigation

Successful mitigation practices must involve collaboration between the local community and larger-scale development agencies. The local community must be aware of the risk and concerned to take action to prevent it: in this they may need technical assistance, material assistance and help in building their own capabilities. These forms of assistance may not be available in which case they need to be provided by external agencies. One of the most effective ways in which such an agency can help promote community protection is by enabling communities to formulate their own project proposals and negotiate with government and the larger development agencies (or government agencies) for the necessary government actions and the material assistance they need. This is especially true for technologically based engineering projects, such as large embankments, spillways, and diversion works. For example construction of community defenses based solely on hand-labor and local materials alone may result in poor disaster defenses. But local labor supplemented by heavy machinery, and local materials bonded by factory-made materials (e.g. cement or wire mesh) provided from external sources can result in lasting defenses which the local community will be able to trust and maintain in the long term. Similarly a community-based mitigation program may need government action to provide land for safer resettlement of the most vulnerable, which can most effectively be determined by the community itself.

The empowerment of the community created by achieving such goals and obtaining assistance from government agencies is likely to be a lasting development benefit.

The empowerment of the local community acquired through negotiating assistance from government agencies can be a lasting development benefit.

A government bulldozer cleans debris from a mud-flow in the Rimac Valley according to plans drawn up by PREDES in consultation with the local community.

ANSWER (form page 47)

The time immediately following a disaster is a good time to initiate disaster mitigation programs due to the fact that:

- public support is strongest immediately after a disaster
- the community is involved in active reconstruction
- international or local aid may be focused on the community

Even with these advantages there may be some problems associated with mitigation measures that are based on reaction to a recent disaster. Mitigation measures may be based exclusively on the recent hazard type even though other hazards may be more likely to strike next. Mitigation may be focused on the area worst affected by the disaster even though other areas may actually be more at risk.

PART 3 SUMMARY

MITIGATION STRATEGIES

- Mitigation strategies will in many cases be incorporated as an element of larger scale development programs; any successful strategy should include a range of measures from the menu of possible actions. The appropriate mix will be different for each location and type of hazard.
- The selection of an appropriate strategy should be guided by evaluating and considering the costs and benefits (in terms of future losses saved) of a range of possible measures.
- To obtain political acceptability, a mitigation strategy may need to contain a mixture of immediately visible improvements and of less visible but long-term sustainable benefits.
- Mitigation strategies are much easier to implement in the immediate aftermath of a disaster or near-disaster; awareness of the impact of similar natural hazards elsewhere can also assist in obtaining public and political support for disaster protection.
- Mitigation strategies developed during disaster reconstruction should encompass all the hazards likely to be encountered in the future and promoted as far as possible beyond the reconstruction areas to other areas at risk from similar hazards.
- Empower the local community by promoting planning and management of its own defenses and obtaining outside assistance only where needed.

PART 4

IMPLEMENTING ORGANIZATIONS

This part of the module discusses some of the organizations involved in the implementation of mitigation programs and outlines the policy goals of UNDP and DHA regarding disaster mitigation. The methods of achieving these goals are:

- *institution building*
- *dissemination of information*
- *the international exchange of information*
- *the IDNDR campaign*

Building up skills and institutions

Disasters are an international problem. The scale of a major disaster often exceeds the capabilities and resources of a national government. The international community is usually quick and generous in its response. Protection from disasters is similarly an international concern. Disasters are, with a few notable exceptions, infrequent and a country is unlikely to have regular experience or to have built up expertise in dealing with all of the wide range of hazards it is likely to experience. That ***expertise is available*** on an international level. Countries that have recently experienced a volcanic eruption may be best placed to assist another country anticipating volcanic activity, for example. International organizations are important vehicles for facilitating international exchanges of expertise and developing an international approach to disaster mitigation. Some of the important actors are DHA, UNDP, NGOs and regional organizations.

DHA

One of the most important long-term, sustainable aspects of disaster mitigation is the development of skills and technical capacitation in-country. Professional development and a pool of expertise in disaster mitigation techniques will allow longer term development of the issue. Helping to build national institutions and formal structures that will perpetuate the mitigation program is an important element of the UN's initiative in providing disaster management assistance. In a number of countries, the response to any individual disaster is to set up a special disaster committee to handle the emergency. At the end of the emergency of reconstruction, the committee or government department has the advantage of retaining these skills and experiences. This allows some emphasis to be switched from post-disaster assistance to pre-disaster preparedness.

Institutions which gather and analyze information are fundamental to the development of the skills required in any nation to reduce its risk against future disaster. Examples of institutions that would make up a national

Helping to build national institutions and formal structures that will perpetuate the mitigation program is an important element of the UN's initiative in providing disaster management assistance

technical capability could include:

- Meteorological observatory
- Seismological observatory
- Volcanology institution
- Hydraulics and hydrology laboratories
- Engineering council
- Industrial safety inspectorate
- Chamber of architects
- Institution of urban and regional planners
- University departments
- Research institutions
- Associations of economists, geographers, social scientists
- National standards committee

The hazard observatories are the first requirements for a national capability in hazard defense. Often these institutions have few resources and are perceived as low priority or as esoteric research institutes. Equipment needs may be critical. Observatories need networks of sophisticated instrumentation maintained in the field, and are likely to need advanced computing facilities and software to analyze results. Training of technicians and staff members in developments in instrumentation and scientific methods may be important. The output of the various professional institutions is often highly technical and there is a need to persuade technical specialists to present their findings in simplified forms, comprehensible to laymen and to professionals in other disciplines-the interdisciplinary interfaces are important in developing an integrated mitigation program.

The regional context: a problem shared

Countries with similar hazards, similar building stocks and with similar cultural backgrounds may benefit considerably form sharing experiences in disaster mitigation. Encouraging international linkages at a regional level helps to pool disaster expertise.

This has been successfully developed in regional disaster mitigation projects such as the Balkan seismic risk project involving Albania, Bulgaria, Greece, Romania, Turkey and Yugoslavia (UNESCO), and in the South East Asian disaster construction project (UNIDO). The OAS (Organization of American States) also provides cooperation in natural hazard management to its member states through its Department of Regional Development.

Regional cooperation projects may also extend to joint mitigation measures, particularly regional hazard assessment for large scale hazards like cyclones and earthquakes, regional warning stations, such as the tsunami warning network around the Pacific rim, and even financial defenses, like the regional disaster fund established by a consortium of island nations in the South Pacific Bureau for Economic Cooperation.

International exchange of expertise

A wide range of mitigation actions are available. Some have been successfully implemented in one location and the experience may be useful to others. Others may have been unsuccessful and the lessons from the failure are also important to other communities considering similar plans. Lessons of one country's building upgrading program to reduce earthquake risk may be of considerable interest to a large number of other countries. Techniques developed in another country for community involvement in flood protection may be directly usable in another.

The science of disaster mitigation is still at an early state of development and many techniques are being implemented or experimented with independently. The connection and transfer of experience from one location to another will help the implementation of effective mitigation techniques.

The rapidly developing science of hazard assessment; the earth sciences, meteorology, instrumentation advances and detection and prediction techniques are an important part of the international sharing of knowledge. Training, international scholarships, conference support, knowledge transfer in all its various forms is an important part of developing disaster mitigation expertise.

The role of DHA and other UN bodies in facilitating international exchange of expertise is summarized in Annex 1.

Supporting decision-making: external specialists

The formulation of a disaster mitigation strategy-deciding whether floods are more important than cyclones, what emphasis should be given to raising public awareness as against strengthening key facilities, what type of management an administrative structure is most appropriate to implement the project-has to be made by the community affected. International assistance can best help those decisions to be made by increasing the capability and expertise of the decision-makers.

Decision-support and technology transfer is offered by a number of United Nations agencies that execute technical cooperation projects. Technical cooperation projects provide international consultants, training and focused activities in a number of areas. Profiles of a number of United Nations agencies that are commonly involved in disaster mitigation projects are given in Annex 1. The types of projects they run, their focus and mandates are different for each agency, but areas of overlap exist and many of the large projects have input from several agencies, through inter-agency agreements. Sample projects are given to illustrate past experience of agencies, and the types of projects that can be expected of them.

Knowledge dissemination

Dissemination of knowledge internationally is an important function of both UNDP and DHA: Individual case studies of projects, manuals, literature compendiums and text books are part of a growing body of literature published by the United Nations and are recognized as primary sources of information for disaster mitigation. The authority of the United Nations tends to make such publications widely regarded and their relative ease of availability means that United Nations documents have lead the science of disaster mitigation. A major role for DHA and for UNDP offices is to disseminate United Nations publications as broadly as possible in-country and to ensure that any disaster mitigation project carried out in-country is published and disseminated as widely as possible.

A list of available UN publications is presented in the bibliography at the end of this module.

International decade for natural disaster reduction

The adoption of the 1990s as the International Decade for Natural Disaster Reduction was carried by the United Nations General Assembly in *Resolution 44/236,* 22 December, 1989. The objective of the decade is to reduce loss of life, property damage and social and economic disruption caused by natural disasters. At a national level, the IDNDR resolution calls for all governments to formulate national disaster mitigation programs, integrating a range of economic, land use and insurance policies into their national development programs.

The United Nations system is urged to accord priority to natural disaster preparedness, prevention, relief and short-term recovery, including economic damage risk assessment in their operational activities.

Disaster mitigation in UNDP country programming

In keeping with the aims of the International Decade for Natural Disaster Reduction, the *UNDP/UNDRO Disaster Management Manual* outlines the policy goals of UNDP and DHA as:

- to strengthen the abilities of societies to avoid, or protect themselves, their property and means of livelihood, from natural hazards.
- to ensure that programs and projects funded by UNDP do not exacerbate the potential adverse effects of natural hazards, nor increase the risk of disaster, but rather lead to an avoidance of disaster or a lessening of adverse effects.
- to encourage the integration of disaster prevention, mitigation and preparedness measures in planning and budgetary processes related to development in all sectors.
- to facilitate exchanges between disaster-prone countries of experience, knowledge and skills related to disaster management.

The country programming exercise offers an opportunity for UNDP to assess its potential contribution to assist governments to develop their institutional capacity in disaster management. This should include both:

- mitigation projects in risk assessment or disaster preparedness in areas of especially high risk *and*
- incorporating mitigation into other development projects within the country program.

UNDP Resident Representatives are expected to consider the possibilities for promoting appropriate disaster prevention, mitigation and preparedness measures during the regular country programming process and in the planning of post-disaster rehabilitation and reconstruction assistance. This requires a risk assessment study (see module on *Vulnerability and Risk Assessment*) which should be formulated in consultation with DHA and the UN Disaster Management Team.

The UNDP/UNDRO *Disaster Management Manual* lists the following aspects with which the Resident Representatives should be familiar in order to assess the priorities which should be given to disaster management aspects, the need for specific disaster management projects and the extent to which risk mitigation measures should be incorporated into other sector.

The manual also gives detailed guidance on how to include disaster mitigation considerations into the formulation and appraisal of projects.

■ ASPECTS OF DISASTER MITIGATION

Initial phases of the UNDP Country Programming Exercise

Past disasters

- past experience with disasters-losses suffered (notably those which could have been mitigated or avoided through prevention, mitigation and preparedness measures), early warning and disaster response strengths and weaknesses

The possibility of future disasters

- the natural hazards to which the country is subject, and their frequency, intensity, duration and location
- the elements at risk; i.e. the populations, physical property, the socio-economic, agricultural and cultural resources and programs at risk from these hazards
- the degree of vulnerability of these elements at risk to the hazards
- the total losses which can be expected as a function of hazard, risk, and vulnerability

National resources and capabilities

- the legislative, legal, policy and regulatory (e.g. land use, building codes) framework
- the extent to which disaster management considerations are explicitly integrated in national development planning and budgetary processes
- the scope and quality of national, regional and sub-regional disaster preparedness plans
- the extent of public awareness, education, and responsiveness
- the character and quality of disaster-specific organizational structures, resources, and procedure
- government policies or practices in disaster prevention, mitigation and preparedness-especially with respect to agricultural policies, building regulations, land-use planning, transport, regional development, social security support, forestry, water resources
- aspects of Government policy directly or indirectly contributing to the occupation of disaster-prone areas
- government policies or practices directly or indirectly exacerbating the vulnerability of communities occupying disaster-prone areas
- policy shifts needed to reduce the vulnerability-increasing effects of existing government policy
- national or external resources needed to reduce risk and vulnerability

Bringing about improvements:

- external technical assistance needed and available notably within the country program
- training and awareness raising at the government level

PART 4 SUMMARY

DISASTER MITIGATION AND THE UNITED NATIONS

- The policy goals of UNDP/DHA include specific attention to strengthening the ability of societies to protect themselves from natural hazards.
- The UNDP Country Programming exercise offers and opportunity for UNDP to assess its potential contribution to governments to help them develop their capacity for disaster management.
- Such assistance may include specific disaster mitigation projects but should also include incorporating disaster mitigation into projects in other sectors.
- Disasters are an international problem. DHA and UNDP are important vehicles for facilitating international exchanges and developing an international approach to disaster mitigation.
- A key UN role is to help build the national institutions which will perpetuate the mitigation program.
- For hazards of regional impact, such as earthquakes and drought, regional cooperation projects can be valuable in building warning systems and sharing regional experience and expertise.
- Knowledge in the field of disaster mitigation is developing rapidly. UN funding is a vital means of bringing to developing countries the new knowledge-both of the hazards and the means of combatting them that can make implementation programs more effective.

ANNEX 1

Profile of selected United Nations Agencies and their activities in disaster mitigation

UN DHA

UNESCO

UNCHS (Habitat)

UNIDO

UNEP

■ UN DHA

United Nations Department of Humanitarian Affairs

DHA

Palais des Nations ■ CH-1211 Geneva ■ 10 Switzerland
Tel: (+4122) 917 1234 Fax: (+4122) 917 0023 Telex: 414242 DHA CH

UNDRO, the predecessor to **UN DHA** was established in 1971 to mobilize and coordinate international emergency relief to areas struck by disaster. In 1991 it was reorganized as the Geneva office of the United Nations Department of Humanitarian Affairs. This office is also charged with promoting disaster preparedness and prevention measures in nations and regions at risk. The main focus of its activities in mitigation (disaster prevention and preparedness) is to promote the study of risks and their reduction as well as emergency planning for natural disasters through such means as collection and dissemination of information on relevant scientific and technological developments. Divisions in DHA-Geneva consist of the Relief Co-ordination Branch, the Disaster Mitigation Branch which is part of the International Decade for Natural Disaster Reduction (IDNDR), and the Information and Disaster Data Systems Management.

Technical assistance in disaster mitigation

UN DHA is encouraging national authorities to make disaster preparedness an integral part of national planning. Technical assistance is provided to countries on request. Assistance in mitigation planning has been provided to

- Afghanistan
- Algeria
- Armenia
- Caribbean
- Colombia
- Cyprus
- Ecuador
- Egypt
- Guinea
- Haiti
- Indonesia
- Iran
- Madagascar
- Mauritius
- Namibia
- Nepal
- Paraguay
- Peru
- Philippines
- Saudi Arabia and Somalia
- Tunisia and others

Past projects in disaster mitigation

Activities in cooperation with regional inter-government organizations include:

- 1986 establishment and subsequent development of a regional training center for Disaster Management at the Asian Institute of Technology, Bangkok
- Training activities for the Pan Caribbean Project on disaster mitigation
- National training projects in Colombia, Ecuador, Indonesia, Nepal etc.
- Mediterranean Seismic Risk Project

UNESCO

United Nations Educational, Scientific and Cultural Organization

7, place de Fontenoy ■ 75700 París ■ Francia
Tel: 45 68 3910 Fax: Télex: 204461 París

UNESCO has been engaged since 1960 in the assessment and mitigation of risks from natural hazards of geological origin (earthquakes, tsunamis, volcanic eruptions and landslides) and contributes to the study of hazards of hydrometeorological origin (storms, floods, prolonged droughts, desertification and avalanches). UNESCO undertakes a Natural Hazards subprogram in the science sector of its activities within which most of its work on disaster mitigation is carried out. Other associated work, such as the protection of educational buildings and of cultural monuments is implemented through its Educational and Cultural Sectors. The relatively small budget available to the Natural Hazards subprogram has been successful in mobilizing extra budgetary operational projects in most parts of the world. UNESCO became, in 1965, the organization through which international cooperation in tsunami warning was formally initiated, and set up the International Tsunami Information Center, based in Honolulu.

Past projects

Intergovernmental Meetings on Seismology and Earthquake Engineering (1964), Assessment and Mitigation of Earthquake Risk (1976) which began much of the research and application of earthquake protection.

Establishment of specialized centers

International Seismological Center, United Kingdom

Regional Seismological Center for South America(CERESIS) Peru, 1968

International Institute of Seismology and Earthquake Engineering, Japan, 1963

Institute of Earthquake Engineering and Engineering Seismology, Yugoslavia, 1965

Initiation of regional project initiatives

Regional Seismological Network in Southeast Asia, 1973

Earthquake Risk Reduction in Balkan Region 1970-76, 1980-84, 1988-

Program for Assessment and Mitigation of Earthquake Risk in the Arab Region (PAMERAR)

National project initiatives

Flood Forecasting in Rio de Janeiro, Brazil and Andes Valleys and Cuzco area, Peru

National Seismological Observatory Network, Romania 1979

Strong-Motion Telemetry Network in Beijing Region, China 1981

Modernization and Reinforcement of Seismological Services, Vietnam, 1987

Seismic Microzonation Study in El Asnam region, Algeria 1983

Protection & preservation of cultural heritage

Post disaster missions to many countries to advise on repair and future protection, including floods in Florence and land subsidence in Venice, Italy, Restoration of earthquake damaged monuments, Burma 1981, Protection against flooding of Moenjadoro, Pakistan 1974

Studies and publications

Cause and Prevention of landslides and publication of guidelines on landslides hazards zonation

World Catalogue of Very Large Floods

Flood Flow Computation

■ UNCHS (HABITAT)

United Nations Center for Human Settlements

PO Box 30030 ■ Nairobi ■ Kenya
Tel: (+254-2) 333930 Fax: (+254-2) 520-724 Télex: 22996

UNHCS (Habitat) is the organization within the United Nations system charged with the specific responsibility of promoting human settlements development world-wide through the execution of human settlements technical cooperation projects. Since its establishment in 1978, UNHCS has undertaken a number of pre and post disaster mitigation projects. Of the approximately 250 projects in over 100 countries currently being supported by Habitat, over 30 of them focus on disaster mitigation in human settlements or incorporate disaster-mitigation aspects in development projects.

Pre- and post-disaster planning

The impacts of natural and man-made disasters on human settlements can be reduced to a large extent through appropriate pre-disaster and post-disaster planning. UNHCS (Habitat) had broad experience in the design and implementation of disaster-mitigation programs concerned with a variety of the most common natural disasters which affect human settlements-both their built and natural environments. Within the framework of these programs UNHCS (Habitat) has worked closely with national institution to develop innovative methodologies of hazard and vulnerability analysis to determine risk levels and to assist in the preparation and implementation of plans to attenuate the effects of such events in the future. Designs for more resistant structures, as well as comprehensive strategies for post-disaster reconstruction have been developed in a number of countries. UNHCS (Habitat) is also in the forefront of promoting the incorporation of natural-disaster mitigation concepts in urban planning and management.

Past Projects

- Earthquake reconstruction advisory mission, Philippines, 1990
- Reconstruction and earthquake mitigation, Iran, 1990
- Reconstruction of flood damaged areas, Punjab, Pakistan, 1990
- Earthquake Reconstruction and rehabilitation programs, Nepal, 1988
- Reconstruction of rural housing after floods, Bangladesh, 1988
- Seismic Mitigation in the planning of the historic center of Mexico City, 1985
- Hurricane rehabilitation and disaster-prevention program, Turks and Cacos Islands, 1985
- Disaster prevention and rehabilitation after typhoon, Vietnam, 1985
- Post-earthquake rural housing, Yemen, 1982
- Reconstruction of Lamu, Kenya after fire, 1982
- Hurricane-resistant housing, Domenica, 1980
- Reconstruction of human settlements in Algeria, 1980
- Physical development plan and master plans for region of Montenegro, Yugoslavia, 1979

UNIDO

United Nations Industrial Development Organization

Viena International Center ■ PO Box 300 ■ A-1400 Viena ■ Austria
Tel: (+43-1) 211-310 Fax: (+43-1) 232-156 Télex: 135612 UNO A

UNIDO was established in 1967 to promote and accelerate industialization in developing countries. UNIDO exists to promote international cooperation in industrialization and to provide technical assistance at the request of governments, to help acquire practical know-how in a broad range of industrial activities.

UNIDO has been involved in the field of disaster mitigation since 1979, within the overall context of promotion and strengthening of the construction industry, and has a mandate for the protection of industrial facilities in hazard-prone areas and in promoting industrial safety to reduce technological hazards to the population.

UNIDO provides technical assistance in the reconstruction and recovery following major disasters, including the rehabilitation of industrial sectors, revitalization of building material manufacture and the construction industry for reconstruction. Emergency Industrial assistance program of UNIDO includes activity after disasters in Jamaica, Mexico, Sudan, Bangladesh and Soviet Armenia.

UNIDO coordinates a program aimed at reducing the risks of natural disasters by increasing the awareness and know-how of government agencies and research institutions of participating countries in construction techniques for increasing the structural resistance of buildings to earthquakes, cyclones and floods and by strengthening their capability to formulate and implement policies and practical measures aimed at mitigating natural disasters.

Past projects

- Building Construction Under Seismic Conditions in the Balkan Regions, including Seismic Design Codes, Design and Construction of a range of building types and Repair and Strengthening of buildings, 1979
- A Seismic Construction Strengthening and Repair of Buildings, Mexico 1985
- Rubber Base Isolation for Protecting Buildings from the Effect of Earthquakes, Malaysia, 1982
- Interregional Demonstration on Base Isolation for Seismic Construction USA, 1986
- Participation in Seismic Risk Reduction in the Mediterranean Region, 1987
- Regional Policy Seminar on Natural Disaster Resistant Housing, Beijing, China 1990

■ UNEP

United Nations Environmental Program

P.O. Box 30552 ■ Nairobi ■ Kenya
Tel: (+254-2) 333930/520600 Fax: (+254-2) 520711 Télex: 22068 UNEP KE

UNEP has been described as the environmental conscience of the UN system. As such its primary function is not to do, but to motivate and inspire, to raise the level of environmental action and awareness on all levels of society, worldwide and to coordinate the environmental work of all the UN's organizations and agencies. UNEP's main tool within the UN system is the System-wide Medium-term Environmental Program (SWMTEP) - a six- year plan for action across the board of United Nations activities. SWMTEP gives the UN system the chance to streamline or expand existing programs and to identify what still needs to be done. The plan is coordinated through the UN Administrative Committee on Coordination. During 1988, UNEP cooperated on 63 projects with other UN agencies and bodies and on 123 projects with intergovernmental and non-governmental organizations.

Environmental concerns of UNEP

- The ozone layer
- Climate
- Waste and waste disposal
- Marine environment
- Water and water supply
- Land degradation
- Forests
- Biological diversity
- Industry and industrial pollution
- Energy efficiency and pollution
- Settlements, health and population expansion
- Chemical hazards

ANNEX 2

ACRONYMS

DHA	Department of Humanitarian Affairs
ECA	Economic Commission for Africa
IDNDR	International Decade for Natural Disaster Reduction
NGO	Non-Governmental Organization
OAU	Organization of African Unity
OAS	Organization of American States
UNCHS	United Nations Center for Human Settlements
UNDP	United Nations Development Programme
UNDRO	United Nations Disaster Relief Organization (now DHA-Geneva)
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization

ANNEX 3

ADDITIONAL READING

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Young, Lincoln. "Mitigating Disaster in Agriculture, University of Reading Agricultural Extension and Rural Development Center." Bulletin. (October 1984), pp. 8-12.

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Vol. 3. Seismological Aspects [F/S]
Vol. 4. Meteorological Aspects[F/S]
Vol. 5. Land Use Aspects [E/F/S]
Vol. 6. Aspects Relatifs a la Constuction et Genie Civil [F]
Vol. 7. Economic Aspects [E/F/S]
Vol. 8. Sanitation Aspects [E/F/S]
Vol. 9. Legal Aspects[E/F/S]
Vol.10 Public Information Aspects [E/F/S]
Vol.11. Preparedness Aspects [E]
Vol.12. Social and Sociological Aspects

Guidelines for Disaster Prevention [E: English, F: French, S: Spanish]

Vol. 1 Pre-Disaster Physical Planning on Human Settlements [E/F/S]
Vol. 2 Building Measures for Minimizing the Impact of Disaster[E/F/S]
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Working Group B	Vulnerability and Seismic Hazard
Working Group C	Seismic Risk Assessment and Development of Model Code for Seismic Design
Working Group D	Dynamic Behavior of Soils, Soil Amplification and Soil-Structure Interaction
Working Group E	Dynamic Behavior of Structures and Structural Components

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Vol.2. Design and Construction of Prefabricated Reinforced Concrete Building Systems

Vol.3. Design and Construction of Stone and Brick Masonry Buildings

Vol.4. Post-Earthquake Damage Evaluation and Strength Assessment of Building under Seismic Conditions

Vol.5. Repair and Strengthening of Reinforced Concrete, Stone and Brick Masonry Buildings

Vol.6. Repair and Strengthening of Historical Monuments and Buildings in Urban Nuclei

Vol.7. Seismic Design Codes of the Balkan Region

Agency: UNCHS, available UNCHS (Habitat), Nairobi

Human Settlements and Natural Disasters, publication prepared by Habitat (1989)

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GLOSSARY

This glossary lists the disaster management terms as used in the *UNDP/UNDRO Disaster Management* Manual. Different usages which UNDP and other users of this manual might encounter in other documents are mentioned in the definitions as necessary.

Assessment

(Post-disaster) (sometimes Damage and Needs Assessment)

The process of determining the impact of a disaster of events on a society, the needs for immediate, emergency measures to save and sustain the lives of survivors, and the possibilities for expediting recovery and development.

Assessment is an interdisciplinary process undertaken in phases and involving on-the-sport surveys and the collation, evaluation and interpretation of information from various sources concerning both direct and indirect losses, short- and long-term effects. It involves determining not only what has happened and what assistance might be needed, but also defining objectives and how relevant assistance can actually be provided to the victims. It requires attention to both short-term needs and long-term implications.

Disaster

The occurrence of a sudden or major misfortune which disrupts the basic fabric and normal functioning of a society (or community). An event or series of events which gives rise to casualties and / or damage or loss of property, infrastructure, essential services or means of livelihood on a scale which is beyond the normal capacity of the affected communities to cope with unaided.

Disaster is sometimes also used to describe a catastrophic situation in which the normal patterns of life (or eco-systems) have been disrupted and extraordinary, emergency interventions are required to save and preserve human lives and / or the environment. Disasters are frequently categorized according to their perceived causes and speed of impact. [See: Sudden natural disasters; Slow-onset disasters; Technological disasters; Human-made disasters]

Disaster management

A collective term encompassing all aspects of planning for and responding to disasters, including both pre- and post-disaster activities. It refers to the management of both the risks and the consequences of disasters.

Disaster mitigation

A collective term used to encompass all activities undertaken in anticipation of the occurrence of a potentially disasterous event, including preparedness and long-term risk reduction measures.

The process of planning and implementing measures to reduce the risks associated with known natural and man-made hazards and to deal with disasters which do occur. Strategies and specific measures are designed on the basis of risk assessments and political decisions concerning the levels of risk which are considered to be acceptable and the resources to be allocated (by the national and sub-national authorities and external donors).

Mitigation has been used by some institutions/ authors in a narrower sense, excluding preparedness. It has occasionally been defined to include post-disaster response, then being equivalent to disaster management, as defined in this glossary.

Disaster preparedness

Measures that ensure the readiness and ability of a society to (a) forecast and take precautionary measures in advance of an imminent threat (in cases where advance warnings are possible), and (b) respond to and cope with the effects of a disaster by organizing and delivering timely and effective rescue, relief and other appropriate post-disaster assistance.

Preparedness involves the development and regular testing of warning systems (linked to forecasting systems) and plans for evacuation or other measures to be taken during a disaster alert period to minimize potential loss of life and physical damage; the education and training of officials and the population at risk; the establishment of policies, standards, organizational arrangements and operational plans to be applied following a disaster impact; the securing of resources (possibly including the stockpiling of supplies and the earmarking of funds); and the training of intervention teams. It must be supported by enabling legislation.

Hazard

(or hazardous phenomenon or event)

A rare or extreme event in the natural or man-made environment that adversely affects human life, property or activity to the extent of causing disaster.

A hazard is a natural or man-made phenomenon which may cause physical damage, economic losses, or threaten human life and well-being if it occurs in an area of human settlement agricultural, or industrial activity.

Note, however, that in engineering, the term is used in a more specific, mathematical sense to mean the probability of the occurrence, within a specified period of time and a given area, of a particular, potentially damaging phenomenon of a given severity/intensity.

Hazard assessment

(Sometimes Hazard Analysis/Evaluation)

The process of estimating, for defined areas, the probabilities of the occurrence of potentially-damaging phenomenon of given magnitudes within a specified period of time.

Hazard assessment involves analysis of formal and informal historical records, and skilled interpretation of existing topographical, geological, geomorphological, hydrological, and land-use maps.

Hazard mapping

The process of establishing geographically where and to what extent particular phenomena are likely to pose a threat to people, property, infrastructure, and economic activities.

Hazard mapping represents the result of hazard assessment on a map, showing the frequency/probability of occurrences of various magnitudes or durations.

Human-made disasters

Disasters or emergency situations of which the principal, direct causes are identifiable human actions, deliberate or otherwise. Apart from "technological disasters," this mainly involves situations in which civilian populations suffer casualties, losses of property, basic services, and means of livelihood as a result of war, civil strife, or other conflict.

In many cases, people are forced to leave their homes, giving rise to congregations of refugees or externally or internally displaced persons.

Human-made hazard

A condition which may have disastrous consequences for a society. It derives from technological processes, human interactions with the environment, or relationships within and between communities.

Natural hazard

Natural phenomena which occur in proximity and pose threat to people, structures or economic assets and may cause disaster. They are caused by biological, geological, seismic, hydrological, or meteorological conditions or processes in the natural environment.

Risk

For engineering purposes, risk is defined as the expected losses (lives lost, persons injured, damage to property, and disruption of economic activity) caused by a particular phenomenon. Risk is a function of the probability of particular occurrences and the losses each would cause. Other analysts use the term to mean the probability of a disaster occurring and resulting in a particular level of loss.

A societal element is said to be "at risk", or "vulnerable", when it is exposed to known disaster hazards and is likely to be adversely affected by the impact of those hazards if and when they occur. The communities, structures, services, or activities concerned are described as "elements at risk."

Risk assessment **(sometimes risk analysis)**

The process of determining the nature and scale of the losses (due to disasters) which can be anticipated in particular areas during a specified time period.

Risk assessment involves an analysis and combination of both theoretical and empirical data concerning: the probabilities of known disaster hazards of particular force or intensities occurring in each area (“hazard mapping”); and the losses (both physical and functional) expected to result to each element at risk in each area from the impact of each potential disaster hazard (“vulnerability analysis” and “ expected loss estimation”).

Risk mapping

The presentation of the results of risk assessment on a map, showing the levels of expected losses which can be anticipated in specific areas, during a particular time period, as a result of particular disaster hazards.

Slow-onset disasters

(Sometimes Creeping Disasters or Slow-onset Emergencies)

Situations in which the ability of people to acquire food and other necessities of life slowly declines to a point where survival is ultimately jeopardized. Such situations are typically brought on or precipitated by drought, crop failure, pest diseases, or other forms of “ecological” disaster, or neglect.

If detected early enough, remedial action can be taken to prevent excessive human distress or suffering occurring. However, if neglected, the result can be widespread destitution and suffering, and a need for emergency humanitarianism assistance as in the aftermath of sudden disasters.

Sudden natural disasters

Sudden calamities caused by natural phenomena such as earthquakes, floods, tropical storms, or volcanic eruptions. They strike with little or no warning an have an immediate adverse impact on human populations, activities, and economic systems.

Technological disasters

Situations in which large numbers of people, property, infrastructure, or economic activity are directly and adversely affected by major industrial accidents, severe pollution incidents, nuclear accidents, air crashes (in populated areas), major fires, or explosions.

Vulnerability

The extent to which a community, structure, service, or geographic area is likely to be damaged or disrupted by the impact of a particular disaster hazard, on account of their nature, construction, and proximity to hazardous terrain or a disaster-prone area.

For engineering purposes, vulnerability is a mathematical function defined as the degree of loss to a given element at risk, or set of such elements, expected to result from the impact of a disaster hazard of a given magnitude. It is specific to a particular type of structure, and expressed on a scale of 0 “high,” “medium,” and “low” or explicit statements concerning the disruption likely to be suffered.

Vulnerability analysis

The process of estimating the vulnerability to potential disaster hazards of specified elements at risk.

For engineering purposes, vulnerability analysis involves the analysis of theoretical and empirical data concerning the effects of particular phenomena on particular types of structures.

For more general socio-economic purposes, it involves consideration of all significant elements in society, including physical, social and economic considerations (both short- and long-term), and the extent to which essential services (and traditional and local coping mechanisms) are able to continue functioning.