United Nations Industrial Development Organization

An Industrial Approach

To

Natural Disaster Mitigation and Recovery

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I. INTRODUCTION

Each year, the Earth experiences countless natural events: 100,000 thunderstorms, 10,000 floods, thousands of earthquakes, wildfires, landslides and tornadoes and hundreds of volcanic eruptions, tropical cyclones and tsunamis.

In the past 20 years, these natural phenomena have killed perhaps 3 million people. About 1 billion have been adversely affected by natural disasters and have suffered homelessness, other devastating hardships, ill health and severe economic loss.

The international community has been generous in providing emergency relief to the victims of disasters, and its financial and human commitment has been increasing. But this action, concentrating on the immediate post-disaster phase, has not addressed the basic causes of the problem. Frequently not enough preventive action is being taken to reduce the vulnerability of human societies to damaging events. Although many natural events present the potential for loss of life and physical damage, the degree of vulnerability of a community can be reduced by coherent policy action.

A natural disaster can be defined as any disruption of the human ecology that exceeds the capacity of the community to function normally. A disaster is not the inevitable result of a natural hazard of great magnitude, and, conversely, a disaster can result from a natural hazard of relatively small magnitude. Thus a particular event may cause serious disruption in one community and require international assistance to restore the normal functioning of society. In another community, a similar event may cause relatively minor disruption that can be settled with routine emergency management procedures.

Whether a community is at risk of a natural disaster is a function of the nature and magnitude of the physical event, referred to as the hazard, and the vulnerability of the community to the hazard.

The vulnerability of a community is made up of the social factors that predispose the community to suffer the impacts of the hazard. For example, in an earthquake-prone region, dense population and social pressures to provide low-cost housing can lead to the construction of buildings that are unable to withstand an earthquake - despite the fact that earthquake-resistant structures are technically feasible and that policy makers are aware of the possibility and consequences of such an event.

Appropriate action taken by Governments and professional bodies and institutions can help to reduce the risk, thereby mitigating the disaster. A well conceived disaster management programme provides not only for mitigation and general preparedness but also includes planning for eventual relief and recovery operations in the event that a disaster should strike.

II. OVERVIEW OF NATURAL DISASTERS

Natural disasters result from inadequate planning, preparedness and prevention measures. Hazards lead to disasters when a community is ill prepared, is exposed unnecessarily, is unable to provide or use warning signals effectively, and is unable to mobilize a prompt and effective post-disaster recovery effort.

Earthquakes, by their localized intensity and present unpredictability, are among the most devastating disasters of natural origin. They have been responsible for the death of perhaps 1 million people in recent decades. Certain areas of the globe, such as the Pacific rim, the Mediterranean and the Balkan Regions are known to be particularly at risk, but other areas reportedly not affected in recent centuries may be struck by unexpected seismic activity.

Volcanic eruptions can also have devastating effects, and there are major historical and recent examples of cities left in ashes or buried in volcanically induced mudflows. Although major disasters are rare because most active volcanoes are remote from large population centres, the 1985 eruption of Nevado del Ruiz, Colombia, resulted in the loss of 22,000 lives. The potential for disasters remains significant, however, and mudflows induced by volcanic eruptions have caused major destruction.

Landslides are frequently caused by meteorological or seismological events that trigger the movements of unstable slopes. The instability is often exacerbated by the denuding of hills. Although the affected area is normally much smaller that in most of the other types of hazards, landslides are numerous and especially severe in densely populated areas, particularly in developing countries.

Tropical cyclones called hurricanes, typhoons and cyclones in different parts of the world, can have wind velocities approaching 350 kilometres per hour, rains exceeding 80 centimetres in just a few days, and storm surges of 8 metres covering hundreds of square kilometres. A single such storm can lead to more than 100,000 casualties. In addition to tropical cyclones, windstorms include localized tornadoes that can create wind speeds of 500 kilometres per hour, leaving a wide swath of destruction in their wake. Thunderstorms can cause localized high winds and heavy rainfall, leading to flash floods. World wide, wind-related disasters cause an annual average of 30,000 deaths.

Floods, which stem from the extreme rainfall of typhoons, cyclones and monsoons, are the principal cause of cyclical catastrophes in certain areas. Riverine flooding is caused by heavy rainfall, protracted snowmelt, or a combination of the two. Floods can also be caused or exacerbated by changes to the earth's surface from improper farming practices, deforestation, wildfires, urbanization and unwise interference with the natural environment. Global warming has the potential for raising sea levels, thus exacerbating coastal flooding. From 1980 to 1985, floods impacted on some 185 million people, with perhaps 20 million left homeless and about 30,000 dead.

Tsunamis, large oceanic waves usually generated by submarine earthquakes or volcanic eruptions, increase in amplitude as they advance towards the shore, where they become extremely damaging. Most countries along the Pacific rim and all the Pacific islands are vulnerable.

Wildfires, droughts and locust attacks represent a different category of natural disasters which can have devastating effects on agriculture and on the environment in general and cause widespread destruction and economic losses. They rarely have any major impact on physical structures and only with exceptions cause loss of lives except indirectly through hunger or malnutrition resulting from loss of crops.

III. HAZARD AND VULNERABILITY DETERMINES THE RISK

The understanding of how the occurrence of a natural hazard or an accident turns into a disaster enables planners to forecast likely situations where a disaster is possible. If there were no houses in the vicinity, an earthquake would be a harmless act of nature. The combination of houses (elements) and earthquake (hazard) makes the disaster possible. Some houses are more vulnerable to earthquake effects than others. Identifying which these are - the elements most at risk - helps to indicate the priorities for a comprehensive disaster planning and management.

The terms involved have been defined as follows:

> **Hazard** means the probability of occurrence, within a specific period of time in a given area, of a potentially damaging phenomenon such as earthquake, cyclone or flood expressed in terms of expected frequency as well as the magnitude of the phenomenon;
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> **Vulnerability** means the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss);
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> **Elements at risk** means the population, buildings and civil engineering works, economic activities, public services, utilities and infrastructure, etc. at risk in a given area;
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> **Specific risk** means the expected degree of loss to a specific category of elements due to a particular phenomenon and is a function of both hazard and vulnerability;
>
> **Risk** means the expected number of lives lost, persons injured or displaced, the damage to property and the disruption of economic activity due to a particular phenomenon and is, consequently, the product of specific risk and elements at risk.

IV. COMPREHENSIVE DISASTER MANAGEMENT

The worst effects of any disaster are the deaths and injuries caused to the population. The scale of disasters and the number of people they are capable of killing is the primary justification for mitigation. Understanding the way that people are killed and injured in disasters is a prerequisite for reducing casualties. Floods and earthquakes are the big killers worldwide, with storms and high winds less deadly but far more widespread. In earthquake over 75 % of fatalities are caused in building collapse. In floods deaths occur by drowning, mainly outdoors and in fast flowing currents or in turbulent water. Saving lives in earthquakes means quite clearly focusing on prevention of building collapse. Reducing fatalities from floods means limiting the exposure of people to rapid inundation - either by keeping them 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 manufacture. The company may not survive the loss. The people it employs may lose their 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. 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, labour, power and communications. This complex interdependency is extremely vulnerable to disruption by hazards affecting one link in the chain. Newly industrializing societies are the most vulnerable of all.

Comprehensive disaster management covers the total complex of activities aiming at reducing the damages resulting from a disaster. They can be grouped into four main phases which are related in time and function to all types of disasters as well as to each other:

- **Mitigation** covers any activity aimed at reducing the probability of a disaster and at reducing its harmful effects before it occurs. These are long-term activities including land use planning based on hazard assessment and strengthening of buildings through application of appropriate building codes and construction systems. In order to be effective disaster mitigation must be an integrated part of development planning.

- **Preparedness** activities are necessary to the extent that mitigation measures cannot prevent disasters. They include the establishment of warning systems, public awareness programmes and the planning of the emergency response operations including the stockpiling of supplies and food.

- **Response** activities are designed to provide emergency assistance to survivors including search and rescue operations, medical care, emergency shelter and eventual evacuation.

- **Recovery** from a natural disaster covers a wide range of activities including those required in the short term in order to re-establish basic life-support systems as well as long-term

rehabilitation programmes bringing all parts of the society back to normal or improved levels of quality and efficiency.

UNIDO has an important role to play in the context of overall disaster management within its mandate of industrial development. Its activities in this respect are focused on minimizing the damage and economic losses to the society and in particular to the building stock and to the industrial sector as a result of natural disasters and to ensure the optimum operation of the industry both before and after the disaster. UNIDO's involvement is focused at two of the four phases referred to above, i.e. disaster mitigation and disaster recovery.

V. DISASTER MITIGATION

A disastrous earthquake - one that kills more than 1,000 people - occurs somewhere in Southern Europe at least once every 11 years. Smaller earthquakes - ones that kill fewer people - happen almost every year. Most disastrous of all are the great earthquakes that kill tens of thousands of people and these occur sporadically and horrifically across the populated areas of Mediterranean and Southern Europe.

Each time the international community responds - sending aid, technical assistant and masterplans for reconstruction. The reconstruction after the Skopje earthquake in 1963 was a state-of-the art town plan by Kenzo Tonge - an exemplary international effort coordinated by United Nations. The reconstruction after the Kalamata earthquake in Greece 1986 provoked similar international reaction. The emergency operations that followed the Campania earthquake in Italy in 1980 involved coordinated bilateral aid from over 15 European countries, again involving the United Nations in the post-disaster logistics.

And yet the international memory is short. Once a disaster has faded from the headlines it ceases to be an international concern. The time between disasters is just long enough for the issue to drop in priority against all the other pressing issues of the day and to lose its urgency against all the other competing needs for resources.

As our understanding of such events improves, as our catalogue of historical occurrences becomes more complete and the patterns and cycles of hazard occurrence become clearer, it becomes harder to argue that any particular disaster was unexpected.

Public education and rising standards of expectations of protection levels in European society mean that disasters are much less tolerable. Disasters are no longer being accepted as 'Acts of God' - they are now being recognized as 'Omissions of Man'.

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 then 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. 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 decease was generally accepted because there was little alternative.

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, i.e. the systematic science of what happens in a disaster, shows that disasters are largely preventable.

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 each individual also has to act to protect itself. Just as public health depends on personal hygiene, so public protection depends on personal safety.

The situation at the present time is in many ways not unlike the period in the mid-nineteenth century, when the great public health programmes - piped water and sewage disposal - began to be implemented in the large cities. These depended on:

- a scientific understanding of the causes of disaster (in this case water-borne diseases)
- the availability of technical means to eliminate or mitigate the disaster, and a knowledge of the costs of protective measures
- a widespread public belief that disasters are not random, and that mitigation is possible
- the political will and opportunity to act

It can be expected that when these same four conditions are achieved, disaster protection schemes will begin to be implemented on a very much increased scale.

At the present time the first two of these conditions are already met, and the third - public belief in the possibility of mitigation - is steadily increasing as each successive disaster is shown to have been caused not by the natural phenomena, but by an avoidable failure of protection planning. As it already has in a number of communities, well organised pressure by those at risk, backed by the support of building professionals, can generate the political will to implement protection programmes. Indeed as the issues become more widely understood we can hope to see earthquake and other disaster protection programmes as a significant part of all urban and national development programmes.

1. Mitigation Action

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 that can employ to bring about change.

The range of techniques that an authority might consider in order to assemble an appropriate package for disaster mitigation can be classified into:

- Engineering and Construction
- Physical Planning
- Economic Planning
- Policy Guidance
- Public Response

a. Engineering and Construction

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 including flood control structures, dykes, levels and infiltration dams.

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 suction, impact, combustibility, flood resistance and other safety factors against known hazards. Building codes are the critical front line defence for achieving stronger engineered structures, including large private buildings, public sector buildings, infrastructure, transportation networks and industrial facilities.

Disaster-resistant building codes are however 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 checking and penalising 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 standard building codes.

A large number of the buildings likely to be affected in a disaster, and those most vulnerable to hazards are however 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 himself play a role in persuading his client to build to higher specification, but unless this is carried out within a general public awareness of the disaster risk and acceptance of the need for protection, he is unlikely to find many customers. Grant systems, preferably 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 from 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 structural care. Strengthening existing structures ('retrofit' protection) can be achieved through adding bracing, stiffening and new structural elements. 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 building new structures in their place that conform to building code safety requirements.

b. Physical Planning

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 centres. 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 design of service networks - roads, pipelines and cables - also needs careful locational 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.

c. Economic Planning

Equitable economic development is the key to disaster mitigation. A strong economy in which the benefits are shared throughout 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.

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 programme.

Some aspects of economic planning are directly relevant to reducing disaster risk. Diversification of economic activity is as important an economic principle as deconcentration 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 labour 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 rumour 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 population relocation. Property taxation can be used to penalize more vulnerable structures and structures built in less desirable locations. Grants and loans can be offered to assist owners upgrade their properties 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.

d. Policy Guidance

Disaster mitigation also requires certain organizational and procedural measures. The timescale over which a significant reduction can be achieved in the potential for disaster is long. Changes in physical planning, upgrading 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 means the acceptance of a consensus of opinion that efforts to reduce disaster risk are of continual importance.

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

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 are grossly under-resourced to carry out their job. Research, technical expertise and policy-making organizations are important resources for developing mitigation strategies both nationally and sub-nationally.

e. Public Response

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 general public 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 an everyday acknowledgement 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 being conscious even at a low level, that their choice of house, the placing of that bookcase or stove and the quality of construction of the garden wall around their children's play area all affect their own safety.

Awareness of risk locally is aided by reminders of past events: a bollard erected with markings 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 otherwise with a disruptive occurrence of the hazard, not the annihilation of the soap opera family through cataclysm.

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.

2. The Challenge

The greatest challenge for disaster protection today is to establish policies and strategies that can be sustained into the next century and beyond to offset the inexorable increases in disaster potential. Long term

administrative and social structures need to be established now so that protection becomes ingrained. Social attitudes have to be shaped so that each new generation builds ever stronger and safer within their hazardous environment.

The process of building structures and facilities, planning them, locating them and investing in them needs to incorporate disaster protection considerations as part of their normal ingredients. The investment needed to build an disaster-resistant environment must be established as part of the baseline costs - not seen as some additional cost or optional extra. This investment is part of the norms for social protection and is the necessary price of living in safety from the elemental forces of nature.

The doubling of the world's population over the next century entails a massive increase in the physical infrastructure and building stock of the globe. Much of this investment will be in the world's great earthquake, cyclone and flood zones. This massive investment and construction activity on an unprecedented scale must be carried out with earthquake safety as an integral part of it. The attitudes and procedures that will shape this future construction need to be established now. The laws, codes, investment standards and procedures established now will form the foundation of a safer future.

VI. DISASTER RECOVERY

Even the most comprehensive mitigation measures will not protect a community against considerable damage as a result of a major disaster. Economic considerations make it impossible or at least non viable to strengthen all older structures to a degree securing them against a projected disaster scenarios and, in most cases, also the majority of newer constructions will have been based on engineering solutions representing a compromise between disaster resistance and cost.

Just as there is an obvious need to prioritize disaster mitigation during the pre-disaster period in order to minimize the human and economic losses which the next disaster may cause, a clear requirement exists to organize the post-disaster recovery in a way which brings the community and all its activities back to normal in the most efficient way. A highly complex and multi-disciplinary task posing difficult problems of planning and resource allocation among the various sectors.

The disaster will have had a major impact not only on the physical fabric of the affected region including housing, commercial and public buildings and civil engineering structures, but also on the whole range of economic and social activities it harbours. Recovery after a major disaster therefore means much more than physical repair and reconstruction.

The restoration of the economic activities through the rehabilitation of the industrial manufacturing sector is another essential need of a disaster struck region. One among the many interrelated operations allowing the community to recover from its multiple losses, but an important prerequisite

to the overall progress of the recovery process. The revitalization of economic production leads to the regeneration of jobs and income and is a requirement for the re-establishment of lifestyles and repair of the social linkages of the community.

1. Industrial Rehabilitation

Any major disaster is likely to have inflicted direct damage on industrial buildings and equipment and auxiliary installations such as power generation equipment and maintenance facilities. Stores of raw materials and products will have been destroyed or damaged and files and documentation lost. In addition, the production of factories may be halted and the manufacture of goods stopped and the workforce is without a job.

Any related activity such as shops selling the products or factories still in production but dependant on semi-products no longer available are likely to suffer as a result of the shortfall in production. In a competitive market a factory or company temporarily prevented from trading due to disaster damage is likely to have its business taken by competitors. Employees with no or reduced income will have less to spend on goods and services and the local economy will suffer even further as a result.

Following a disaster during which damage to the industry as well as to the building mass as a whole has been severe, there will be a very important need for financial resources and services to bring about the full recovery and a necessity to set priorities and develop appropriate timetables. As soon as the immediate period of disaster relief is over there will be a strong public demand to restore the full level of economic activity inter alia in the manufacturing sector as quickly as possible.

Privately owned industries and, in particular, such having an adequate insurance coverage will probably start planning for the reconstruction very soon after the disaster, and they may be expected to implement their plans at their own speed and in accordance with their own priorities. Government owned plants as well as companies without adequate means to rebuild or repair their factories will depend to various extents on public rehabilitation plans and funding. Especially small and medium scale enterprises may find themselves unable to raise the necessary funds, and this may be the time for the Government to consider a certain intervention in the private sector.

Government intervention may take different forms including damage compensations, favourable credits, loan guarantees and commercial dispensations. It may also involve assistance in the establishment of commercial joint ventures and other investment promotion activities or in the identification and transfer of the most appropriate technologies. And it may caver active involvement in the establishment of industrial zones where backup services needed by small scale industries can be made available and where incentives in the form of grants, dispensations or technology support can be offered to private companies wishing to re-establish themselves in the area or to start up new activities. The setting up of industrial zones or the temporary designation of industrial areas in damaged communities as industrial incubators has proven a very effective way of accelerating recovery in some countries.

a. Technology upgrading

As an integral part of the reconstruction or rehabilitation process it may be well worth while to take the opportunity to introduce new or improved technologies to the factories affected. Replacing old equipment with new may in itself lead to a higher level of quality and productivity in the framework of the long term innovation programme of affected companies. But the major rehabilitation needs will often permit the companies to abandon old and redundant technologies or altogether and replace them with different or more modern production lines responding better to actual market requirements and changed economic conditions and priorities.

The easier availability of credit in the post disaster period and the potential for increasing plant profitability and competitiveness through the introduction of new technologies may make it highly attractive for private and public industries as well as for banks and other finance agencies to play an active role in the reconstruction process.

Additionally, the introduction of improved plant designs and equipment will most probably lead to savings of energy and to the installation of more environmentally friendly technologies and thereby make a positive contribution to the community also in this important respect.

b. Reconstruction Planning

The interdependency between the industrial sector and other sectors of the local and national economy both within and outside the disaster region makes reconstruction a complex process. Financial resources, manpower, equipment and materials will be of limited availability and there will be a need to weigh the needs of several competing sectors for these inputs against each other and to assign priorities.

Within the industrial sector itself a number of similar decisions on the phasing of the rehabilitation work and the allocation of resources will need to be taken. This must include an integration of private sector reconstruction with that of the public sector and the establishment of a set of priorities for how resources will be shared. It will take years to rebuild damaged industrial complexes and even longer to bring them back to full operation offering pre-disaster levels of production and job opportunities. Small scale, labour intensive production units require less time and fewer resources but often more government support to bring back to life.

Decisions have to be made on the sequence of reconstruction operations taking into consideration the objectives and needs of public authorities, industry owners (both public and private), representatives of the work-force and the market representatives and in full coordination between these parties. Together they will have to obtain as accurate as possible a picture of the total damage, the loss of production capacity and output and the economic impact on the local community and make a detailed assessment of the resources needed.

c. Techno-economic Options

Establishing the industrial rehabilitation plan requires a detailed consideration of technological options available, not only in terms of the solution to be selected for each individual plant but also in terms of the sequence of plant rehabilitation and new plant establishment in response to the needs of the community. It may in many cases be advisable to base decisions on techno-economic feasibility studies carried out on a plant by plant basis combined with socio economic cost benefit analyses in order to properly assess the relative merits of various scenarios.

It may be obvious from the start, or studies will reveal, that the rehabilitation of certain plants are unprofitable or unacceptable from environmental or other public interest points of view. Older factories for which local raw material reserves have been depleted or offering a product range for which the demand no longer exists would eventually have had to close anyway and should obviously not be reconstructed, especially if the damage suffered is significant. Similarly, any sound industrial planning for an earthquake prone area should ban hazardous chemical industries and other plants which would pose threats to the population or the environment in case of a future damaging disaster.

On the other hand, certain commodities will be badly needed during the recovery phase and should to the extent possible be produced locally. This applies especially to food and other basic daily necessities and, of course, to the building materials and other physical inputs to the reconstruction process itself. Such production types should, obviously, be given the highest priority in the first phase of industrial rehabilitation in order not to have to rely on the in any case overcharged transportation network for the provision of these bulky and/or heavy goods and to give local industries the advantage of the captive market.

The revitalization of the disaster-struck community will require the fast re-creation of jobs to provide a basis for the existence of the survivors and for the return of those who have left the scene of the disaster. Rapid establishment of labour intensive industries is a priority and the re-construction schedule must take this need into consideration. Retaining an un-occupied workforce on full pay is not economical but for the factories under reconstruction it is important that skilled staff and managers remain available for the plant once it reopens. Temporary employment of staff of damaged factories in general recovery activities is obvious as a first solution and desirable from the point of view of the community. Later on, the staff may participate in the reconstruction of the factory and in preparing it for start-up.

2. Physical Reconstruction

Within the overall context of the recovery operation following a damaging disaster the physical reconstruction of housing, schools, administrative, commercial and industrial buildings represents by far the most demanding task. In a severe earthquake the physical destruction close to the epicentre can be almost total. But also a significant part of the buildings still standing after the disaster will be so heavily damaged that they are

beyond repair, i.e. that repair will cost more than demolition and reconstruction.

a. Damage Assessment

The first step in the reconstruction programme is the damage assessment which is carried out building by building. The purpose is to determine if the building is safe to re-occupy and, if yes which repair or strengthening is required to restore it to its original state, if possible with additional constructional features increasing its resistance to future similar disasters, or if it needs to be demolished. Another purpose is to determine the reasons for the building's collapse or the failure of its structural elements in order to gain a better insight into their resistance for the benefit of future construction projects.

Conducted in this way, the inventory will provide most valuable information required for the elaboration of up-dated building codes for the hazard prone area. It will also, in conjunction with geological data and other relevant information on the geographical distribution of the physical damages, help planners to revise the micro-zoning of the area indicating which building types it will be safe to construct in which locations. Since this work can be time consuming and the community is eager to see a speedy start of the reconstruction it is often better to launch the reconstruction programme at the earliest possible date on the basis of a set of 'better safe than sorry' emergency codes and micro-zoning, and then to relax the requirements once all studies have been completed.

A complete and detailed inventory of the damages forms the essential basis for a reconstruction programme geared to a rehabilitation of the physical environment in line with the needs of the community and offering a balanced compromise between safety and cost. However, of equal importance is the availability of a local construction industry supplied by a broad range of building material manufacturing units. The smooth co-operation of both within the affected community is a prerequisite for successful and cost-effective reconstruction.

b. The Construction Industry

After a disaster there is a tendency to make extensive use of out-of-town contractors, government construction agencies and even international contractors brought in connection with foreign recovery aid. Although the volume of construction required over a relatively short period of time exceeds the normal capacity of the local construction industry, there are significant disadvantages to this approach, the most important being that local builders and contractors can suffer long term damage by being excluded from the work.

The construction sector is an important part of the local economy and funds and investing in new building stock through local contractors and craftsmen who to a large extent will spend their earnings in the local community and using local materials and labour as far as possible is an effective way of reviving the local economy. It should be kept in mind that there will be a need for the local construction industry to be even more effective after the reconstruction than before given the expectations raised

by the higher standard of construction performed during this time. Assistance to the contractors and to small scale builders in technological and management fields or in the form of financial support, possibly through joint ventures with larger companies from other parts of the country, will help to strengthen their capabilities to cope with both present and future demands.

Experience shows that the post-disaster reconstruction period is the ideal time to introduce improved construction techniques and more disaster resistant structural details since everybody is well motivated having the effects of the past disaster in fresh memory. The policy adopted for the reconstruction phase should therefore include measures to introduce improved standards of construction to all companies and individuals active in the local construction sector. The aim should be to ensure that not only the buildings constructed during the reconstruction phase per se but also future construction project will be designed to higher safety standards than before the disaster.

c. The Building Materials Industry

Most building materials are heavy and bulky and expensive to transport over long distances. To bring them to a construction site over long distances increases their cost considerably especially considering the low production cost per unit of weight for the most basic materials. The use of locally produced materials in a post-disaster reconstruction therefore not only is an effective way of maximizing the usefulness of the capital investment for the revitalization of the local economy. It is at the same time the most direct way of reducing the construction cost.

Evidently, the demand for building materials during a major reconstruction will be much larger than during normal times and will most likely exceed the capacity of the production units existing in the area. And since the industry is closely linked to locally available raw materials there is a natural limit to the types and quantities of building materials which local producers will be able to supply. But in most cases there is never the less, significant scope for expanding local production to allow it to cater for a large proportion of the need for basic materials.

Planning for the reconstruction should include an integrated plan for building materials covering the projected needs of all sectors including housing, schools, hospitals, public administration, industry and commercial buildings as well as roads, dams, bridges and other civil engineering structures. This global assessment of the materials needed will emerge from the damage analysis and the tentative reconstruction programme.

The plan should also include an inventory of the existing building materials industry in the region covering the capacity and production range of each production unit and the level of damage sustained and the need for rehabilitation of each of them. It should incorporate information on the availability of raw materials in the area and provide indications of which additional plants could be established and on the scope for expansion and diversification of the production of existing plants. Finally, the plan should conclude in a set of proposals for which materials could be locally produced, which could be supplied by manufacturers elsewhere in the country and which would need to be imported.

One of the main criteria for recommending the rehabilitation of a local production unit or the establishment of a new one must, apart from the demand for its production as documented by the need assessment, be the economic viability of the plant. This viability must be evaluated both at the plant level in terms of an economic cost-benefit analysis or feasibility study and at the level of the national economy comparing the cost of the products delivered at the building site with the cost of comparable products produced at different locations or using different technologies.

In principle, there is no difference between presenting and selecting building materials manufacturing projects for promotion in the context of a post-disaster reconstruction scenario and in an ordinary non-disaster related situation. The quality of the product and the economic viability of the investment has to be right no matter the circumstances. In practice, the substantially different demand structure of a post-disaster recovery programme imposes special conditions on the building material industries being established or expanded to serve it.

First of all, the huge initial demand will eventually fall back to the level normal for the region which means that a part of the production capacity no longer will be required - at least not until the next strike of a similar disaster. Secondly, there will be considerable public pressure to initiate the reconstruction, especially of housing, with minimum delay which means that the industry should be in a position to supply the materials at equally short notice. And thirdly, selfhelp construction will play a more important part than under normal circumstances, especially in respect of repair of only slightly to moderately damaged buildings.

Small scale manufactures seem to offer the solution to most of the problems raised by the post-disaster recovery situation. They are relatively uncomplicated in terms of technology and can be quickly established requiring only a modest investment cost. They are labour intensive, can be established very close to the consumer or to the raw material source or both. They are flexible in terms of output thanks to the possibility of adding or closing down one or several low capacity production lines and they permit the experimentation with new technologies without disrupting overall production to any appreciable extent, and by being close to the consumers they can much more easily than larger industries adapt themselves to changing demands.

VII. INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION

The United Nations General Assembly by its Resolution 42/169 adopted by its 42. session declared the 1990's as the International Decade for Natural Disaster Reduction (IDNDR). The objective of the Decade is "to reduce through concerted international action, especially in developing countries, the loss of life, property damage, and social and economic disruption caused by natural disasters.

The Decade is the first concerted attempt on a global scale to reduce the impacts of natural hazards. It aims to achieve this reduction by developing an integrated approach to the reduction of disasters' impacts on

human life and on property. It could include action designed to stimulate and encourage improvements in data gathering, more widespread application of forecasting and warming technology, improved techniques for disaster preparedness, changes in public attitudes towards disaster reduction and increased community participation, training and education of an increased number of technicians and specialists, coordinated research, and like measures through programmes and projects at the international, regional, national and local levels.

The Decade mainly addresses the rapidly acting natural hazards - earthquakes, tsunamis, volcanic eruptions, landslides, avalanches, tropical cyclones and other windstorms, floods and wildfires - as well as those impacts of drought and locust infestations that are amenable to the approaches being developed for rapid-onset events. The relative prevalence of these hazards and the possibility of new hazards arising from environmental change also merit consideration.

By chance or by design, disaster reduction has so far been event based; the Decade will promote an integrated approach to natural disasters by applying knowledge gained about one type of disaster to benefit those affected by others.

Much of the knowledge needed to reduce suffering and property losses induced by disasters already exists, but, in many cases, difficulties have arisen in applying this knowledge to protect both people at risk and the vulnerable places where they live.

The Decade offers an opportunity for the United Nations to demonstrate its catalytic ability to bring together the diversity of skills, resources and groups needed to stem the losses from natural disasters. Its system of organizations are uniquely placed to play a leading role in the Decade through their expertise in social, health, economic and technical sectors, including disaster management and mitigation. This role stems from the organizations' global and regional structure, their general and specialized interests in many fields and their various operational activities in areas of concern.

Organizations of the United Nations system, both individually and collectively, have operational and programme management capabilities that can be applied to the Decade. Through field, regional and headquarters operations, the organizations of the United Nations system are aware of the needs of disaster-prone developing countries and are important participants in development activities. With such representation, they can encourage disaster awareness in the development programmes of individual nations.

The United Nations and its system of organizations are well placed to serve as a primary agent for the exchange and dissemination of information concerning natural disaster reduction. Through its information centres network, it reaches the opinion-forming media in both developing and industrialized countries. Moreover, United Nations specialized agencies have extensive contacts with Scientific and technological institutions as well as with health services, many of which will be active in the Decade. The United Nations, therefore, can amass data about the plans and activities of all Governments, organizations and institutions taking part in efforts to reduce the loss of life, property damage and social and economic disruption caused by natural disasters.

VIII. THE ROLE OF THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

As the specialized agency responsible for co-ordination of industrial activities within the United Nations system, UNIDO has developed a variety of unique programmes to bring technical assistance, investment, training, information, technology and industrial planning to the doorstep of the developing countries. At the same time, it helps bridge the interests of donors and recipients by promoting industrial co-operation between North and South.

Within the Organization's broad mandate of fostering industrial development and co-operation, the UNIDO Constitution calls for promotion of "harmonious and balanced" industrialization by harnessing the joint strength of the public, co-operative and private sectors.

This unique blend gives UNIDO a distinct advantage by allowing it to draw on a broad spectrum of industrial co-operation to benefit both developing and developed countries. It means closer interaction with industry, making state-of-the-art expertise more readily available to countries of the South and allowing participating companies to work more closely with them.

Since its creation in 1966, UNIDO has carried out more than 11,000 projects in 160 countries, providing experts, equipment and fellowships often otherwise inaccessible to many third-world nations. This assistance encompasses numerous applications, entailing modern methods of industrial production, programming and planning, as well as the establishment and strengthening of industrial institutions. It also involves the development, adaptation and transfer of technology and industrial training. On a rough estimate, out of UNIDO's present technical co-operation activities, programmes amounting to some 30 million dollars are directly or indirectly related to the production and use of building materials and to the promotion of a wide range of construction technologies including disaster resistant building techniques.

While concentrating on individual projects, the Organization at the same time, has adopted an approach to developing specific sectors vital to industrial development as a whole or to the improvement of the quality of life.

Such efforts include meetings which focus on the technical, economic and social aspects of industrial technologies or industrialization strategies and an extensive publication programme. Policy recommendations from such meetings, for example have emphasized the possibilities for international cooperation in promoting disaster resistant construction or called attention to the enormous potential for improving the low-cost housing situation through increased promotion of local building materials.

In the field of industry related disaster mitigation the Organization has a clear mandate and an important role to play in respect of strengthening industrial installations to withstand natural disasters as well as to rehabilitate industries which have suffered various degrees of destruction during such disasters.

This, especially is receiving considerable attention as one of UNIDO's most required contributions to post disaster recovery. In particular the post disaster rehabilitation programme aiming at the earliest possible re-start of

industries producing essential goods or services needed for the post disaster recovery period is receiving much attention and a plan has been elaborated for the establishment of a "disaster rehabilitation fund" to be available without delay to initiate the first phase of industrial rehabilitation following a natural disaster.

This programme covers a wide range of industrial sectors including food industries and small scale manufacturing units offering a large number of job opportunities at short delay. Most important in this context is the building materials and construction industry in view of the fact that in most cases the major problem faced by disaster stricken communities is the rehabilitation of destroyed or damaged buildings and civil engineering structures.