THE ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

The OECD is a forum where Members come together to discuss critical issues, opportunities and policy options and to arrive at harmonised approaches through consensus. Established in 1960, it is the successor to the Organisation for European Economic Co-operation, created in 1948 to help with the revitalisation of war-torn economies of Western Europe. Since its origin, the OECD has promoted democratic, pluralistic institutions and market-oriented policies which aim:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral non-discriminatory basis in accordance with international obligations.

Current Member countries of the OECD are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities participates in OECD work.

THE DEVELOPMENT ASSISTANCE COMMITTEE (DAC)

The Development Assistance Committee (DAC) is a specialised committee of the OECD, whose Members have agreed to secure the expansion of the total volume of resources made available to developing countries and to improve aid effectiveness. Created in 1960, the Committee undertakes periodic peer reviews that critically analyse aid programmes. Members also consult on broader aspects of development policy encompassing a range of economic, financial, trade, environmental and structural issues.

The DAC is the principal international forum where bilateral donors adjust the pattern of their aid in light of changing priorities and new perspectives on the development process. In 1989 the DAC created a Working Party on environment to strengthen the contribution of aid policies and programmes to sustainable development.

As of 1994, the Members of the Development Assistance Committee are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, the United States and the Commission of the European Communities.

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List of Acronyms

AOSIS	Alliance of Small Island States.
CGIAR	Consultative Group on International Agricultural Research.
CRED	Centre for Research on the Epidemiology of Disasters, University of Louvain, Belgium.
DAC	Development Assistance Committee of the OECD.
DHA	See UNDHA.
ECHO	European Community Humanitarian Office.
EM-DAT	Disaster Events Database, University of Louvain, Belgium.
FAO	Food and Agriculture Organisation of the United Nations.
IDNDR	International Decade for Natural Disaster Reduction of the United Nations.
MM	Modified Mercalli scale of seismic intensity.
MSK	Medvedev-Sponheuer-Karnik scale of seismic intensity.
NGO	Non-governmental organisation.
OFDA	Office of United States Foreign Disaster Assistance.
SAR	Search and Rescue teams.
UNDHA	United Nations Department of Humanitarian Affairs (formerly UNDRO).
UNDP	United Nations Development Programme.
UNDRO	The former United Nations Disaster Relief Organisation (see UNDHA).
UNSSO	United Nations Sudano-Sahelian Office.
WHO	World Health Organisation. of the United Nations.
WFP	World Food Programme of the United Nations.
WMO	World Meteorological Organisation of the United Nations.

GUIDELINES ON DISASTER MITIGATION

Introduction

Natural hazards are an integral part of the environment in which we live. Extreme atmospheric, hydrological and geophysical events may occur at any time in various parts of the world and, in those economies and societies which are vulnerable to their effects, the events frequently become disasters involving substantial loss of life and social and economic disruption. Many developing countries are particularly prone to one or more of these types of extreme events (see Maps in Annex 1). In addition, principally as a result of their poverty, developing countries are especially vulnerable to natural hazards. Hazard events which would cause limited damage and few casualties in a rich country often cause extensive damage and substantial loss of life in a developing country context. Thus natural disasters usually occur with greater severity in developing countries and claim a higher death toll. One recent estimate is that 95 per cent of all disaster-related deaths occur in developing countries. Disasters also often have a significant negative impact upon the economies and development prospects of developing countries because of the destruction of public and private capital, the disruption of production and trade and the diversion of scarce resources to relief and rehabilitation efforts. In some countries where pre-existing social tensions render them highly vulnerable, natural hazards can exacerbate such tensions and lead to political instability and civil strife.

Whilst a strong correlation exists between per capita income and a country's vulnerability to natural hazards, economic growth *per se* does not automatically reduce the level of vulnerability, and vulnerability may actually increase during early stages of development. Developed countries are less vulnerable because they have invested in both *structural and non-structural measures* to mitigate the impact of the natural hazards they face. Whilst developing countries can expect to remain vulnerable to hazards, their level of vulnerability can be substantially reduced by the adoption of a selection of the mitigation measures developed and in common use in more developed countries. The selection and adaptation, where necessary, of the particular measures to be introduced or implemented needs to be carefully considered in relation to the type and severity of the natural hazards likely to occur and the anticipated impacts upon the developing country's society and economy. Whilst such measures will not prevent the occurrence of extreme events, they should reduce the frequency and severity of the resultant disasters. The measures undertaken need not detract from investments in productive sectors of the economy

and may often complement and enhance such investments by protecting them from damage and destruction and reducing the scale of resource diversion when disasters do occur.

DAC Members have an important role to play in assisting developing countries to enhance their capacity to cope with natural hazards for the following reasons:

- Many DAC member countries possess considerable knowledge and expertise on natural hazards and how to cope with them, both in relation to their own countries and in relation to developing countries. Whilst measures appropriate in developed countries may not always be directly transferrable to developing countries, it would appear that much greater use could be made of such capacities by aid agencies in mitigating natural disasters and in strengthening the scientific and institutional capacities within developing countries.
- By virtue of the resources available through their aid programmes DAC Members can encourage and assist the adoption of measures to mitigate the effect of disasters by the public and private sectors within developing countries. Whereas developing country governments are frequently preoccupied with short-term considerations and have difficulty in devoting adequate attention to natural hazards whose occurrence is unpredictable, donor organisations are sometimes better placed to take a longer-term perspective.
- The performance of aid programmes of DAC Members can be negatively affected by natural hazards. Even in countries which are known to be particularly prone to certain natural hazards, many aid agencies fail to take sufficient account of the risks posed by such hazards in their design of projects and programmes. More careful consideration of natural hazards by donor organisations in the design of projects and programmes is likely to enhance their overall performance.
- When disasters occur in developing countries, aid agencies often respond with sizeable allocations of relief and rehabilitation assistance. Frequently, such responses are resourced from funds which would otherwise have been expended on regular development activities. In many cases the scale of the post-disaster needs could have been reduced if more attention and support had been given to measures designed to reduce the impact of the disaster prior to its occurrence.

These guidelines are intended to increase awareness among those involved in designing and implementing development co-operation programmes of the threats posed by natural hazards and of the range of measures that may be adopted so as to reduce their impacts on developing countries. They are aimed at officials responsible for aid policy and those responsible for administering aid programmes in countries which are exposed to a range of natural hazards and which are

particularly vulnerable. They assume no prior specialist knowledge in the natural hazard and disaster field.

The 1990s has been designated as the International Decade for Natural Disaster Reduction (IDNDR) by the UN General Assembly through Resolution 42/169 of 1988, in an effort to reduce the impact of disasters on development. The goals of the Decade are to:

- improve each country's ability to mitigate the effects of natural disasters;
- devise guidelines and strategies for applying existing knowledge;
- foster scientific and engineering endeavours to reduce loss of life and property;
- disseminate existing and new information about the assessment, prediction, prevention and mitigation of natural disasters;
- promote programmes of technical assistance and technology transfer, demonstration projects and education and training tailored to specific hazards and locations.

National IDNDR Committees have been established in many developing countries and DAC Member states, and under the umbrella of IDNDR a number of disaster mitigation initiatives and activities are taking place. It is hoped that these guidelines will further the goals of the Decade, by increasing awareness among DAC Members of potential approaches to disaster mitigation and by increasing their ability to exploit the opportunities presented by IDNDR.

Terms and concepts

A ***natural hazard*** is a natural phenomenon that is potentially damaging. A natural hazard is not necessarily the event itself but the implied risk to a population because of the potential occurrence of that event. It is therefore a probabilistic concept[1]. Some areas of the world are significantly more prone to natural hazards than others. For instance, earthquake hazards are effectively limited to known geographic zones of seismic activity. Similarly, coastal zones in the tropics are significantly more prone to cyclone hazards than inland areas in the upper latitudes (see Maps in Annex 1).

Many natural hazard events do not result in disasters. For instance, a community which has adapted itself to cope with storms through reinforced buildings, food production systems which can cope with storms, and systems to warn the population to stay indoors may be inconvenienced by a storm but is unlikely to experience substantial damage or casualties. Thus some communities are more vulnerable to the effects of natural hazards than others. Those which are more vulnerable will experience more damage, disruption and casualties. *A **natural disaster** may therefore be seen as the impact of a natural hazard upon a population or area which is vulnerable to such impacts and where the impacts result in substantial damage, disruption and casualties*[2]. The concept of vulnerability is therefore central to the definition of disasters. Vulnerability is a term which is

frequently misused but essentially ***vulnerability*** *concerns the propensity of a society to experience substantial damage disruption and casualties as a result of a hazard.*

Disaster mitigation *concerns those measures taken to reduce the damage, disruption and casualties caused by disasters.* Though it is sometimes difficult to draw the line between measures intended to modify the hazard and measures to reduce a society's vulnerability to the hazard, disaster mitigation, which is the concern of these guidelines, is essentially about the means by which vulnerability may be reduced. Mitigation is therefore a broad notion and incorporates two other terms which are often used in the literature, namely ***disaster prevention****, which concerns those measures aimed at impeding the occurrence of a hazard event and/ or preventing such an event causing damage, disruption and casualties, and* ***disaster preparedness****, which concerns those measures which enable societies to respond rapidly to disasters.*

A distinction is often made between *'man-made' or* ***'human-caused' disasters*** *such as armed conflict or chemical accidents* and ***natural disasters*** *which are the product of natural hazards such as drought, cyclones and floods*. The distinction between natural and human-caused disasters has long been regarded by some as artificial, and the distinction has become increasingly difficult to maintain over recent decades. In part, this is due to the strength and complexity of the human influence upon natural processes. For instance, natural flood events within a river catchment may be exacerbated by alterations in the run-off characteristics within the catchment as a result of urban expansion or the replacement of forested areas with grazing areas. Embankments constructed alongside the lower reaches of a river to prevent flooding may break and the violence of the resultant flooding may create a disaster from what would otherwise have remained a hazard. The distinction between natural and human-caused is also difficult to maintain because of the substantial grey area between what may be regarded as 'purely' natural disasters and 'purely' human-caused disasters. For instance, in Africa conflict and drought during the 1980s have frequently exacerbated the effects of each other, leading to the development of famines. So intertwined are the effects that it is often not possible to separate them. Non-violent human actions may also cause disasters. Thus famines have occurred in areas which did not suffer reductions in crop production but where onerous systems of rural taxation have reduced the amount of food which farmers could retain for their own consumption.

Despite the inherent difficulties in distinguishing between natural and human-caused disasters, the focus of these guidelines is upon the mitigation of natural disasters. Such a focus is not intended to divert attention from conflict which, as shown in Annex 3, is responsible for a death toll several times larger than all the natural disasters combined. Though there are considerable similarities between the mechanisms by which the international community may provide humanitarian **relief** in response to conflict and in response to natural disasters, the similarities between the **mitigation** of conflict and the mitigation of natural disasters are substantially less. The mitigation of conflict is largely a matter of diplomacy, intelligence information, and interventions designed to preserve, make or enforce peace. Such matters are primarily the preserve of the diplomatic and

defence departments of DAC Member governments rather than of development co-operation. In contrast, the mitigation of natural disasters is essentially about structural measures, such as the construction of river embankments and strengthening buildings, and non-structural measures such as land-use zoning, building codes, insurance systems and public awareness-raising. There is, of course, an overlap between the two in terms of vulnerability. The factors which make a particular population vulnerable to the effects of conflict, such as poverty and lack of social cohesion, are the same as those which make them vulnerable to the effects of a natural hazard.

Within the category of natural disasters, a commonly used distinction is that between ***sudden-impact*** *and* ***slow-impact disasters***, sometimes referred to as sudden and slow-onset disasters. Sudden-impact disasters are those which occur with little or no warning and have an immediate impact, whilst with slow-impact disasters there is a warning period of days or weeks before they begin to have a significant impact upon human activity. Earthquakes, cyclones, floods and volcano eruptions are often included in the sudden-impact category, while droughts are in the slow-impact category. For instance, rainfall monitoring may reveal a reduction in rainfall (ie. a meteorological drought) in the middle of a crop production cycle, ie. several weeks before the (reduced) harvest. In contrast, an earthquake may occur without warning causing widespread devastation within minutes. As might be expected, however, such a distinction is problematic. Few disasters occur with no warning whatsoever, and improved monitoring techniques and the greater use of monitoring systems are constantly increasing the length and accuracy of warnings. For instance, the monitoring of rainfall, snowmelt and river levels within the catchment areas of river systems can provide flood warnings hours or even days ahead of the event. Seismic monitoring can provide warnings of increased pressure within rock formations likely to result in earthquakes, though it has to be said that the occasions on which such monitoring has resulted in accurate predictions of the timing and intensity of earthquake events have been comparatively rare. Similarly, the development and migration of tropical cyclones may be monitored and reasonably accurate warnings given of their course and intensity. Despite the increasingly blurred distinction between sudden and slow-impact disasters, the categorisation continues to be widely used.

Though as much a natural hazard as a cyclone or an earthquake, drought, as a classic slow-impact phenomenon, is often regarded ambiguously in the natural disaster literature. It is not uncommon for reports on natural disasters to omit drought or to treat it in a cursory manner, despite the evidence that droughts are responsible for more deaths and often have a greater economic impact than other types of natural disaster (see Annexes 1 and 3). Factors which appear to contribute to this underrating of the importance of the hazard posed by drought include:

- sudden-impact disasters which cause sudden damage in geographically concentrated areas have greater visual and emotional effect;
- the organisational arrangements in relation to sudden-impact disasters are often different from those relating to drought[3];

— disaster terminology does not always comfortably fit slow-impact disasters — for instance a **relief** response to reduced rainfall may also serve to **mitigate** its effects;

— the development of the 'organising theme' of food security over the last decade has contributed to a separation of the intellectual approaches to drought from those to the sudden-impact disasters.

Whilst recognising the special characteristics of the drought hazard, *these guidelines include drought.*

Hazard and Vulnerability Assessments play a crucial function in disaster mitigation. The objective of ***hazard assessments*** (sometimes referred to as risk assessments) is to provide information in a probabilistic form on the nature, severity and frequency of all the potential hazards for all areas of a country. The information used to undertake such assessments are generally scientific data on previous hazard events, topographical, geological, hydrological and meteorological maps, historical records, local folklore, and specially designed surveys. An effective way of presenting hazard assessments is by hazard maps which show the variations in probability of hazard events of a given level of severity, eg. the probability of a 50 per cent reduction in annual rainfall or the probability of a river flood exceeding a level of x metres. The level and sophistication of such assessments will naturally vary depending on the perceptions of the risks and the level of available resources. Some countries may already possess such maps, though they may need updating to take account of recent hazard events or periods without such events. In others it will be necessary to compile such maps from raw data, or even to initiate systems to collect such information, for instance in the case of potentially hazardous rivers for which there are no existing hydrological records.

Vulnerability assessments should indicate the vulnerability of physical structures and of the society to the hazards indicated by the hazard assessment. *Physical vulnerability assessments* involve the assessment of the ability of structures to withstand hazards of different strengths and intensities. Much of the technical information and measures upon which such assessments would be based is already available, if not within the country itself then in other countries. For instance, the ability of buildings of different types of construction to withstand earthquakes of different levels of intensity or winds of different strengths has been much studied by architects not only in developed countries, but also in a number of developing countries. Assessment of the vulnerability of lifeline structures and services (roads, railways, telecommunications, hospitals, schools, water supply, sewage, etc.) should be given priority within the assessment as it is crucial that these services continue to function if not during, then certainly in the period immediately following a severe hazard event.

Societal vulnerability assessments involve the assessment of the ability of the livelihood systems and social structures to withstand the shocks and stresses caused by natural hazards. The notion that societal vulnerability to hazards can be assessed and expressed in a scalar form (high, medium, low) is a recent development and the current techniques for undertaking such assessments are unsophisticated. Whilst poverty is potentially an important factor, it is by no means the dominant factor.

Poor societies which have succeeded in adapting to regular hazards are often less vulnerable to the effects of such hazards than wealthier societies that have failed to make the necessary adaptations.

Societal vulnerability depends largely upon the nature of livelihood systems in an area. If a community or group within the population is dependent on one type of system which is itself vulnerable, then that community or group will be highly vulnerable. If, however, the community or group is involved in a number of different livelihood systems (e.g. mixed arable/pastoral farming supplemented by remitted income from household members in trading and service employment in the local city or working abroad), its risks will be spread and it will most likely be judged to be less vulnerable. A critical component of an assessment of societal vulnerability is therefore the identification of livelihood systems, their relative importance to different groups within society and some estimation of the vulnerability of those systems to the risks indicated by the hazard assessment.

Societal vulnerability is not simply a question of economic vulnerability. Some societies are more cohesive and better able to organise themselves to cope with periods of shock and stress. Though this is a neglected field of study and cross-cultural measures are not available, social development specialists or anthropologists who are familiar with the country should be able to judge a society's approximate ability to cope with disasters.

As with hazard assessments, vulnerability assessments **may** be presented in map form. However, care should be taken, as societal vulnerability may vary strongly between social groups and classes. The field in which societal vulnerability mapping is furthest developed is that of food security. Societal vulnerability is, of course, constantly changing and it will be necessary for such assessments to be undertaken on a regular basis, at least every five years or so.

Organisational and procedural arrangements with aid agencies

Context

Disaster mitigation is currently not well integrated within donor aid programmes. Why this should be the case is not entirely clear but a key factor is likely to be the view, which was widely shared among developing country governments and donor officials for much of the last three decades, that disasters represent a temporary distraction from efforts directed towards the overall goal of raising living standards. The persistence of linear notions of development evolved during the 1950s and 1960s, a lack of appreciation of the inherently dynamic nature of environmental systems, and a lack of understanding of the economic consequences of disasters were probably largely responsible for an approach which treated disasters as something separate from the development process.

Organisational arrangements for dealing with disasters within donor organisations may reflect, but at the same time exacerbate, this tendency to regard disasters as something separate from development. Because of the requirement for speed in responding to many natural disasters, most donor organisations have

developed special organisational arrangements and administrative procedures for managing their response. Often, these have involved the creation of specialist emergency/disaster offices with rapid procurement and transportation procedures, close links with the national armed services, the Red Cross Movement, the UN Department of Humanitarian Affairs and NGOs specialising in relief. Because of the high political and media profile of emergency aid, such offices often report directly to the Minister responsible for the Aid Programme. Whilst such arrangements are often highly effective in relation to **disaster response**, the separation of relief concerns from mainstream development concerns may have served to limit the evolution of **disaster mitigation** to specific mitigation projects rather than the full integration of such concerns within the aid programmes of DAC Member states.

Whatever the balance of factors contributing to the poor integration of disaster mitigation in the past, there is now a growing appreciation among aid agencies of the need for aid programmes to take fuller account of disaster mitigation concerns. The shift in attitudes to environmental concerns has led to a greater awareness of the dynamic nature of environmental systems and the variability which may, on occasion, be extreme. Though analysis of the economic impacts of disasters remains relatively unsophisticated, there is an increased appreciation of the potential scale of the economic impacts. Since the African food crisis of the mid-1980s aid agencies have also been increasing their expenditures on disaster relief such that this category now represents a not insignificant proportion of the overall Official Development Assistance (ODA) of DAC Members. As a result of these two factors **a balanced mitigation and relief approach to disasters** appears, in many instances, to represent a more efficient use of scarce resources than a generous relief response *per se*. The designation of the 1990s as the International Decade for Natural Disaster Reduction has helped increase awareness that a greater emphasis on mitigation is desirable.

Disaster mitigation considerations should be integrated within the planning and allocation procedures of DAC Member states at both the macro level and in relation to individual programmes and projects. Central to the approach at both levels are Hazard and Vulnerability Assessments which should be prepared for all developing countries.

The objectives of such assessments should be to:

- identify those countries which are particularly prone to disasters and vulnerable to their impacts;
- provide aid agencies with an objective basis for the estimation of the risks posed to particular projects and programmes within a country so that account may be taken of such risks in project appraisal and design;
- provide aid agencies with an objective basis for the estimation of the costs and benefits of specific disaster mitigation activities.

Rather than DAC Members undertaking such assessments individually, it is desirable that they are undertaken on a multilateral basis using standardised methods and thereby facilitating inter-country comparisons. Because of the UN Department of Humanitarian Affairs' mandate to encourage disaster mitigation

activities and the work already undertaken in this field by its predecessor agency (UNDRO), it is logical that the DHA should be supported in further developing the methodology for Hazard and Vulnerability Assessments and in undertaking such assessments for all developing countries. DAC Members could support such a programme of activities through the provision of technical assistance as well as funding.

Country strategies

Country Strategy Papers which are regularly prepared for individual developing countries by most aid agencies offer an effective means of integrating disaster mitigation considerations into aid and investment programmes at the macro level. Country Strategy Papers should include the main points arising from the available Hazard and Vulnerability Assessments and, in the case of particularly hazard-prone and vulnerable countries, indicate how such considerations are accounted for within the proposed strategy.

At the level of individual programmes and projects there is a range of mechanisms by which disaster mitigation considerations may be integrated into the process of project identification, appraisal and design.

Project identification

Many aid agencies already undertake some form of risk assessment as part of their project identification process. Indeed, an examination of the potential risks to a project form an integral part of the logical framework method. However, the 'risks' identified are often of a political, economic or project management nature rather than natural hazards. Even where natural hazards are identified as potential risks, the assessment of the risks they pose may not be comprehensive or based on a full, scientific assessment of the potential hazards. The availability of a Hazard and Vulnerability Assessment would facilitate the inclusion of disaster mitigation considerations at the project identification stage. Where Hazard and Vulnerability Assessments are available, aid agencies should incorporate them into the assessment of potential risks to projects.

Project appraisal/design

Through the various methods of appraising projects (ie. technical, financial, economic, social/distributional and environmental) aid agencies already undertake risk assessments, though these may not directly consider natural hazards.

In countries which are particularly disaster-prone most **technical appraisals** may already take account of the risks posed by such hazards as earthquakes or high winds in the design for built structures and the specifications to be used. Such practice may reflect the existence of local building codes or, where none exist, the awareness on the part of those undertaking the technical appraisal of the hazard

risks. If an aid agency is using local building codes as the basis for the appraisal and design of structures, then it is desirable that an assessment of the building codes should be carried out to determine their appropriateness in relation to natural hazards. In the case of 'life-line' services and structures (roads, railways, telecommunications, major dams, domestic water supplies, irrigation systems, electricity supplies, sewage systems, government offices, emergency services facilities, hospitals, schools and other community buildings) there is a strong case for the use of more rigorous building specifications to ensure that such services and structures survive severe hazard events, thereby facilitating both the relief and recovery efforts. For instance, whilst local building codes may be designed with the objective of withstanding hazard events with a 1-in-20-year probability, 'lifeline' services and structures might be designed to withstand a 1-in-50-year event.

Whilst technical appraisals of projects frequently take account of the risks posed by natural hazards, such risks are often not directly addressed by the other methods used in project appraisal. For instance, as part of the *economic appraisal* of projects, aid agencies often use sensitivity analysis or risk analysis methods. However, the potential risks and threats often include variability in input and output prices during the life of the project rather than natural hazards *per se*. *Environmental assessments* undertaken as part of the appraisal process invariably focus on the impact of the project upon the environment rather than on the potential environmental impacts upon the project.

Once a Hazard and Vulnerability Assessment is available for the country or area in which the project is to be implemented, both the economic and environmental appraisals should consider the risks posed by natural hazards[4]. Quantification of the risks for use in economic appraisals may prove problematic because of the difficulty of placing values on the likely losses of a hazard event of a given magnitude. Nevertheless, such estimations should be attempted. With the more extensive use of such assessments by aid agencies it may be expected that the techniques and accuracy of estimations will improve over time.

Organisational arrangements

The creation of separate emergency/disaster offices was identified earlier as a possible factor contributing to the limited integration of disaster mitigation considerations in the aid programmes. If the mechanisms suggested above for the integration of disaster mitigation into development programmes are adopted, the continued separation of the response function from the mitigation function may not be a significant problem. However, responsibility for overseeing the implementation of the above mechanisms will need to be clearly identified[5].

Staff training and awareness-raising

Because of their limited experience of contact with disaster-related matters, personnel involved in the administration of DAC Members' development programmes may benefit from training designed to increase their understanding of

disaster types and impacts, the integration of disaster management considerations within development programmes, and the preparation and use of Hazard and Vulnerability Assessments.

Disaster mitigation at the country level: approaches

Familiarisation with existing and planned mitigation activities

For donor officials unfamiliar with the institutions involved in disaster mitigation and the various activities that may already have been undertaken in a country, it is important that they undergo a process of familiarisation. Because of the multi-disciplinary nature of disaster mitigation and the various levels at which it may be undertaken, it is often difficult to discover the full range of disaster mitigation activities being carried out or planned in a country.

In most developing countries there are likely to be a range of sources of information on existing and planned disaster mitigation activities, namely, the UN, the government, the National IDNDR Committee, other donor organisations and multilateral lending institutions, insurance companies, national and regional research and training institutions, and the local Red Cross/Crescent and other NGOs.

UN: The UNDP and, if present, the UN Department of Humanitarian Affairs will be important sources of information, particularly for sudden-impact natural disasters[6]. Additional information on drought and food security activities may need to be sought from FAO and WFP representatives. The Disaster Management Training Programme has been developed jointly by UNDP/DHA since 1990 and training programmes involving UN and government officials are likely to have already been run in many developing countries.

Government: Many developing country governments have sections responsible for disaster relief affairs which are also nominally responsible for disaster mitigation matters. In some countries responsibility for disaster mitigation matters may be located within a civil defence context.

National IDNDR Committee: As part of the IDNDR, many developing countries have established National IDNDR Committees involving representatives of the government, universities, private sector companies and the voluntary sector. Because of the breadth of institutions and perspectives represented on such committees and their regular meetings, the National IDNDR Committee may be a particularly useful source of information.

Other donor organisations and multilateral lending institutions: Some bilateral donor organisations and multilateral lending institutions may already be undertaking or planning disaster mitigation activities. These activities may form a component of larger projects and the disaster mitigation element may not be apparent from the project title. The Asian Development Bank has been particularly active in the field of disaster mitigation over the last five years and is currently involved in a range of projects with a substantial or major mitigation component. Enquiries channelled through existing donor co-ordination mechanisms within the

country may be directly useful and may also serve to raise awareness of disaster mitigation activities within the donor community.

Insurance companies: In some developing countries local and international insurance companies have substantial operations, on the basis of which they have developed a good knowledge of hazard risks and mitigation activities within the private sector.

National and regional disaster training institutions: Several developing countries have developed specialist local research and training capacities in disaster management and related subjects, located either within local universities or run as separate institutions. Countries without such a local capacity may be served by one of the regional training facilities developed in Asia (the Asian Disaster Preparedness Centre in Bangkok) and the Americas (the Pan American Health Organisation in Washington). Such centres may provide useful information complementary to that which may be available locally.

Red Cross/Crescent Societies and other NGOs: As well as playing an important role in relief operations at the local level, many Red Cross/Crescent Societies and other NGOs are involved in disaster mitigation activities and may provide useful sources of information.

The co-ordination and timing of new mitigation activities

Given the range of institutions and organisations with an interest and/or involvement in disaster mitigation, effective co-ordination is particularly important. Donors should therefore support local co-ordination mechanisms and ensure that they are kept informed of any planned initiatives. In many countries separate co-ordination mechanisms have developed for development and disaster relief. In seeking to support co-ordination it may prove necessary for donors to use co-ordination mechanisms other than those relating to development activities. Because of the range of institutions and organisations potentially involved, donors should seek to co-ordinate their activities not just with the government, UN agencies, multilateral lending institutions and other bilateral donors, but more broadly among the research and training community, the private sector and the NGO community.

Many observers have noted that disasters offer a 'window of opportunity' for the introduction of new mitigation activities as a result of the greatly heightened awareness of the threat posed by disasters among the government, donors and the public, and also because mitigation considerations may be incorporated within the post-disaster reconstruction and rehabilitation activities. Whilst a number of ambitious and innovative mitigation programmes have been introduced in the wake of a disaster[7], post-disaster 'windows' may not be the most beneficial way for a donor to be initiated into mitigation activities. The time-pressured and sometimes chaotic, context of a post-disaster situation increases the possibility that new initiatives will not be adequately planned or co-ordinated. The slackening of awareness and interest in disaster mitigation in the period after the disaster may lead to the adoption of approaches which may not prove sustainable in the longer

term. Ideally, therefore, donors should not await a disaster before taking an active interest in disaster mitigation issues.

Strengthening of national policy and mitigation-related institutions

Some countries already have co-ordinated disaster mitigation policies and procedures in place. However, in many countries efforts are more often directed at policies and procedures in relation to disaster relief rather than disaster mitigation, and consequently mitigation is approached in an *ad hoc*, poorly co-ordinated fashion. In developing such policies and procedures it is preferable to have an organisational structure with clearly allocated responsibilities and lines of authority. There are no clear rules as to how countries can best initiate a process of devising policies and procedures for disaster mitigation and no blueprints of the ideal organisational structure. Each country should devise approaches and organisational structures appropriate to its own circumstances, such as national disaster plans. In many situations it may be preferable to build upon existing institutions rather than create new ones. The examination of approaches adopted by neighbouring countries is one way of helping countries decide what is best suited in their case.

As part of the IDNDR some governments are reviewing their policies and organisational arrangements with regard to disaster mitigation. Donors should seek to encourage the initiation of such reviews and to support them in countries where they are under way.

Regardless of the organisational structures and approaches adopted, it is possible for donors to identify those agencies which play a key role in disaster mitigation and to seek ways in which they can be supported, perhaps through financial support or the provision of technical assistance. For instance, support could be provided to the departments responsible for monitoring and warning of potential hazards (meteorology, geology, water authority, etc.) and those responsible for the development and enforcement of building codes and land-use zoning in urban areas or particularly hazardous areas.

Local research capacity in the field of disaster mitigation could also benefit from donor support. In the field of food security donors already support efforts to develop drought-resistant crop strains either on a bilateral or a multilateral basis through the CGIAR system. In particularly drought-prone countries, such efforts may warrant additional support. Similarly, in earthquake- or cyclone-prone areas the strengthening of research institutions developing improved construction techniques could be beneficial. DAC Members with particular capacity in relation to research on earthquake- or cyclone-resistant designs could encourage closer institutional linkages or ‘twinning’ arrangements between domestic institutions and developing country research institutions.

Given the ‘infancy’ of the methodology for societal vulnerability assessment, the encouragement of local social science research capacity in this area offers another opportunity where donor support could be beneficial. Once again this could

involve institutional 'twinning' arrangements with research institutions in DAC Member states.

A key institutional issue in relation to disasters is that of maintaining capacity between disasters. A cycle is apparent in many institutional contexts in which disasters and their aftermath are periods of heightened awareness and activity. Those institutions involved in the response and in mitigation measures are given greater recognition and support and should use these periods to correct errors of the past, so that society can enjoy a greater level of security than before the disasters. In the absence of subsequent disasters, such institutions often experience a falling-off process with the more dynamic staff moving to more interesting job opportunities and the level of resourcing being gradually reduced in real terms as the government gives higher priority to other, more immediate concerns. By the time the next disaster strikes the institutional capacity is significantly reduced. The same also applies to those agencies responsible for mitigation measures. Indeed, a disaster may reveal the poor performance of departments responsible for mitigation, such as enforcing building codes, and the impacts of the disaster may be greater as a result. Donors should be aware of this process and seek to ensure that the institutional capacity is maintained, and even strengthened, between disasters, particularly when public expenditure reviews are under way.

Encouraging disaster mitigation in the private sector

In developing countries disaster mitigation is often perceived to be the primary responsibility of the public sector rather than the private sector. State agencies, often with substantial support from multilateral and bilateral donors, and NGOs invariably shoulder the major share of the burden of providing relief and recovery assistance in disaster-affected areas. This statist bias has been rightly criticised[8]. In undertaking disaster mitigation activities, donors ought actively to encourage the involvement of the private sector, both formal and informal. Private sector investors should be made fully aware, through either general or targeted awareness campaigns, of the risks involved in locating in particularly hazardous locations and, where possible, offered incentives to locate elsewhere. Businesses likely to experience certain hazards should be encouraged, again perhaps using incentives, to strengthen their buildings to reduce their vulnerability to high winds and flooding. Builders, whether sizeable formal sector companies or small, informal sector concerns, should be offered training programmes to encourage the use of appropriate construction techniques. Potentially, the private insurance sector has an important role to play in encouraging disaster mitigation practices and in providing post-disaster recovery assistance (see p. 19). The involvement of representatives of the formal and informal private sectors in committees or Task Forces established to encourage disaster mitigation efforts is desirable.

The availability of credit at uninflated rates of interest in the immediate aftermath of a disaster can play a key role in facilitating a rapid recovery and may prevent poorer households from having to borrow from local moneylenders at inflated rates of interest, possibly causing long-term indebtedness. The Grameen

Bank in Bangladesh has made an important contribution to the recovery efforts of poor households living in highly disaster-prone environments, following the floods and cyclones which regularly affect large areas of the country. The encouragement of banks and lending institutions to increase their coverage of hazard-prone communities as well as ensuring that they are able to operate effectively in the immediate aftermath of disasters, may be an effective form of mitigation as well as recovery.

The role of NGOs and community-based organisations

Community-based organisations, whether in rural or urban contexts, have a key role to play in disaster mitigation efforts. Such organisations can raise awareness of the hazard risks at the local level and mobilise the community or groups within it to take steps to reduce their vulnerability either through local structural measures, and by pressing for central government involvement in larger structural measures or through the development and introduction of adaptive or preparedness measures. The range of activities that can be undertaken by motivated community organisations is very broad and includes water harvesting schemes in drought-prone areas, local flood or landslide prevention measures, housing improvement and strengthening schemes, grain banks, credit schemes to fund small-scale mitigation or recovery measures, etc. There are numerous instances of such schemes developing spontaneously, without external support.

Many international and local NGOs were initially formed in response to a particular disaster, and though they often concentrate on development activities, they frequently play an important role in the delivery of relief resources at the local level. Through their involvement in relief programmes and their ability to support community-based organisations, NGOs also have an important role to play in disaster mitigation efforts. Assisting community-based organisations with small grants, providing technical advice and exchanging information between community-based organisations facing similar hazards are all activities in which many NGOs are already involved. NGOs are often well-placed to test, develop and disseminate innovations which may substantially reduce vulnerability at the community or household level. Donors could support NGOs involved in such activities and/or encourage other NGOs to become involved. Representatives of these NGOs should be encouraged to participate in any committees or Task Forces which are established.

Supporting an expansion of insurance cover

Insurance programmes are designed to spread the financial losses resulting from hazards beyond those who suffer such losses, be they individuals, private companies, or governments. Compensation for the insured loss, if undertaken promptly after a disaster, offers an effective mechanism for providing financial assistance to surviving participants in the programme, enabling them to rebuild their homes and businesses, perhaps more rapidly than those reliant upon other

sources of support. Potentially, therefore, insurance programmes offer an alternative mechanism to rehabilitation programmes implemented by government agencies and NGOs. With sufficient 'coverage' (i.e. proportion of the population in a given area participating in a programme) insurance programmes also offer a potentially powerful method for promoting better disaster mitigation practices, through the mechanism of offering reduced premiums to those adopting hazard-resistance measures.

At a national level the degree of insurance cover correlates strongly with GDP. The average ratio of premiums to GDP in the United States, Canada, Japan and Western Europe was 5.6 per cent in 1986 whereas for 88 developing countries during the 1984-86 period it was 1.7 per cent[9]. Insured losses as a proportion of total losses are, as might be expected, substantially higher in the more developed countries. For instance, insured losses represented only 4 per cent of total losses due to Hurricane Fifi which affected Honduras in 1974 compared with 60 per cent in the case of Hurricane Tracy which affected Australia in the same year.

Market failure, i.e. lack of effective demand for insurance cover, is largely responsible for the low insurance coverage in low-income countries. Though a peasant's crop or a shanty dweller's shelter may represent a significant proportion of their capital, their low income prevents the purchase of insurance cover, to insure against the risks of drought, flooding, wind damage, etc., to their capital. From the perspective of the insurance companies, the administrative costs of providing insurance cover to large numbers of resource-poor households, many of whom will lack legal collateral, makes the majority of households in low-income countries commercially unattractive. Where the value of both the capital and output enables the taking out of insurance cover, this is done, eg. medium and large-scale manufacturing enterprises and export crops are often covered against natural disasters in many low-income countries. However, another factor which may contribute to the low insurance cover in developing countries is the restricted nature of the insurance sector in many countries. For instance, in some countries the insurance sector is nationalised and foreign companies are prevented from operating, and in some, branches and subsidiaries of foreign insurance companies are excluded whilst in others foreign-owned companies are limited in the classes of insurance they are authorised to write. Encouraging increased competition in the insurance sector may help to reduce premiums and increase coverage.

Through financial incentives and/or state participation in the provision of insurance cover, not only private insurance companies but also community-based and co-operative insurance programmes may be set up, expanded or encouraged to introduce new schemes extending coverage into geographical areas and human activities that had previously been regarded as unprofitable. For instance, many Asian countries now operate crop insurance schemes, often with substantial participation by state agencies. However, crop insurance presents particular technical and administrative difficulties and the administrative costs are invariably high. In addition, a high degree of state involvement may not be desirable. There is strong evidence that publicly-owned crop insurance schemes have often proved not to be a cost-effective instrument for assisting farmers. The removal of constraints

on commercial insurers which serve to limit the efficiency of the operations may be the most appropriate role for governments in this area.

Insurance schemes may be devised which cover particular groups of vulnerable countries. For instance, the creation of an International Insurance Pooling System to provide financial insurance against the consequences of sea level rise as part of the Framework Convention on Climate Change has been proposed by the Alliance of Small Island States (AOSIS).

Disaster mitigation at the country level: specific techniques

A broad range of approaches and techniques is available for reducing the risks posed by particular hazards or for mitigating their effects. The options range from measures to reduce the risk posed by the hazard (for instance, through flood prevention measures) to measures designed to reduce physical and societal vulnerability to the hazard through regulatory and incentive measures, direct investment in vulnerability-reducing measures and public awareness and training measures.

Early warning systems

Early warning systems can greatly contribute to mitigating the effects of disasters by enabling the affected groups to take appropriate counter-measures. The early warning system consists of three major phases, which are: the detection of the signs of impending disasters; the analysis of these signs; the provision of information to potentially affected groups. Provision for each of these phases is important.

Land-use zoning

Land-use zoning can be used to prevent certain land uses in areas which are particularly hazard-prone. The approach involves the identification of areas facing particular levels of risk as part of macro and micro level hazard assessments. Certain types of land use may then be prevented in those areas through national or local legislation or prohibitions. Thus, agriculture but not residential or industrial uses may be allowed on the most hazardous floodplains, slopes prone to landslides, or land on either side of known active faults. However, in many developing countries land-use zoning practices are subject to problems of being influenced by vested interests and the lack of capacity to enforce zoning regulations.

Building codes

Building codes establish standards of building design and construction which are intended to improve the quality of new construction so that it is able to resist particular hazards. Many countries which are prone to earthquakes and cyclones

have developed such codes. The level at which they are set needs to be established with reference to notions of 'acceptable risk' and ideally in consultation with builders, architects and the public. Codes which add substantially to the costs of building may either severely retard construction activity in a region or, alternatively, may be widely ignored. Codes need to be understandable to builders and may need to be accompanied by builder training and education programmes. As with land-use zoning methods, building codes are open to problems of enforcement. These may arise from the lack of enforcement capacity and/or the fact that enforcement officials may be open to influence and corruption. For instance, contractors may 'buy' building approval certificates rather than incur the additional construction costs involved in adhering to the codes.

Incentives

A wide range of incentive techniques may be used to encourage a desirable mitigation practice. For instance, in earthquake- or cyclone-prone areas grants may be given to supplement funds of firms or households to strengthen their existing buildings or to incorporate certain design features during the construction phase. If the majority of households or businesses in a hazard-prone area pay tax or participate in an (obligatory) insurance programme, then their taxes or premiums may be reduced if they undertake certain measures such as using drought-resistant crop varieties in drought-prone areas or securely tying down roofs in cyclone-prone areas.

Free or subsidised provision of assets

Households and communities may be provided with assets which reduce their vulnerability either free of charge or at subsidised rates. Examples of such assets are community cyclone shelters, the drilling of deep boreholes to reduce the risk of a community's water source drying-up during a drought or a programme of land preparation for water harvesting with the community making some form of contribution.

Public awareness raising and training

Public campaigns to raise awareness of the hazards facing the population and how their effects might be mitigated can make an important contribution to overall disaster mitigation efforts. Such campaigns may be tied into campaigns advising people how to respond and cope when hazard events do occur. Training may take different forms and be targeted on different groups. For instance, training might be provided for government officials on how to integrate mitigation concerns into the development planning process. Builders might be provided with training on strengthening features to be included during the design and construction process.

Mitigation plans

To facilitate the selection of the most appropriate approaches and techniques to be used a given context *it is essential that the selection be based upon objective assessments of the hazards and the vulnerability of the population to the effects of those hazards*. Since there are various disaster mitigation techniques, as mentioned above, the choice of the most efficient and effective method depends upon the likely risk of disasters in the area concerned and its socio-economic situation. It is, therefore, important for efficient disaster mitigation enforcement to devise an appropriate mitigation plan taking regional characteristics into consideration, and to implement the plan systematically.

Notes

1. The UN definition is: the probability of occurrence, within a specific period of time in a given area, of a potentially damaging natural phenomenon (UNDRO, 1991).
2. The UN definition is: the impact of a natural event upon a vulnerable community resulting in disruption, damage and casualties which cannot be relieved by the unaided capacity of locally mobilised resources (UNDRO, 1991). This definition restricts itself to natural disasters. The definition also incorporates the notion of the capacity of local resources, however defined, being exceeded and requiring assistance from outside the affected area.
3. For instance, within the UN system the role of UNDRO in relation to drought was ambiguous throughout its 20-year history, as desertification and food security were the primary concern of the FAO, WFP and UNSSO. Some bilateral donor organisations administer food aid separately from the sections responsible for disaster response, and consequently drought is often perceived as being the concern of the sections providing food aid.
4. Alternatively the project appraisal process could include a separate treatment of the risks posed to the project as indicated by the Hazard and Vulnerability Assessment.
5. It is interesting to note that whilst the United States recently brought its Office of Foreign Disaster Assistance within the USAID administrative structure, in part to strengthen the linkages between relief and development, the EC created a Humanitarian Office (ECHO) separate from the two Directorates responsible for the administration of its development co-operation programmes.
6. The predecessor of the Department of Humanitarian Affairs was the UN Disaster Relief Organisation (UNDRO) which was created in 1971 and was for two decades the focal point within the UN system for disaster mitigation concerns. UNDRO undertook numerous disaster mitigation studies and projects. Though often somewhat mechanistic in their approach and peripheral to mainstream aid and investment activities, many of these studies remain relevant and potentially useful.
7. Two notable examples are the Bangladesh Flood Action Plan initiated after the 1987 and 1988 floods and the housing reconstruction programme in Mexico City following the 1985 earthquake (Kreimer and Echeverria in Kreimer and Munasinghe, 1991).
8. Andre Natsios, former Director of the Office of US Foreign Disaster Assistance has written ‘So long as this [disaster mitigation] is a highly specialised, arcane discipline, separate from the work of business managers, financiers, insurance actuaries, and

construction superintendents, it will be ineffective, misunderstood, or, worse, irrelevant.' (Natsios, in Kreimer and Munasinghe, 1991).

9. UNCTAD, 1990.

Annex 1

Natural Hazards and Disasters: Types and Characteristics

Drought

A drought is a temporary reduction in water or moisture availability to significantly below the normal or expected amount for a specified period. Periods of unusual dryness are a normal feature of climate and weather systems in all countries, including those generally regarded as being wet and cold as well as the arid and semi-arid areas of the tropics normally associated with the term drought.

Within the literature differentiation is frequently made between *meteorological drought* (involving a reduction in rainfall), *hydrological drought* (involving a reduction in water resources whether from rivers, snowmelt, groundwater or underground aquifers), *agricultural drought* (involving moisture availability falling below the optimum amount required by a crop during its growth cycle resulting in impaired growth and reduced yields)[1], and socio-economic drought (relating the supply and demand of some economic good or service to the occurrence of meteorological, hydrological and agricultural drought). Such definitional differences reflect the different disciplinary perspectives on drought and the numerous and complex ways in which human activity is related to water and moisture availability. Because of these complexities, variations in perspective, and the fact that droughts are temporary phenomenons occurring within climate and weather systems which are themselves constantly changing, droughts are particularly difficult to define in a way that governments and donor organisations would find operationally useful. Standardised definitions cannot take account of the wide variations in vulnerability to drought arising from the substantial variations in physical, economic and social conditions between areas and countries. Because of the lack of a standardised definition a map of drought hazards is not available and the map used in this report instead shows areas of high inter-annual rainfall variability.

In the absence of standardised, operationally useful definitions, it is important that those involved in drought-preparedness and mitigation activities have a common understanding of what constitutes a drought and the provisos that should be made explicit when using the term.

The identification and analysis of drought is particularly sensitive to the time periods employed. For instance, a moisture deficiency of as little as two weeks during a critical stage of crop growth may, in rainfed areas, significantly reduce yields, particularly if the soil moisture retention capacity is low and the period without rain coincides with a period of high temperature. Thus aggregate annual or even monthly rainfall totals may 'hide' significant drought events. For this reason it is now standard practice among meteorologists and agro-meteorologists to measure rainfall in 10-day periods or dekads. Similarly, given the long-term variability of rainfall in different areas, the period selected as the basis for 'normal' rainfall may determine whether a rainfall reduction qualifies as a drought. For instance, the World Meteorological Organization employs a 30-year meteorological base period standard, the current one being the period 1961-90, whereas prior to 1991 the base period used was 1931-60. The West African Sahel experienced a comparatively 'wet' period during the 1940s and 1950s, but since the mid-1960s has been experiencing an increasingly dry rainfall regime. In this context what might have been considered a drought year using the 1931-60 base period may now (since 1991) be considered to be an average year.

The vulnerability of a population to drought and the effects of drought are determined by a wide range of factors. Populations utilising comparatively reliable water sources (such as underground aquifers or snowmelt) for agricultural, industrial and domestic purposes are substantially less vulnerable than populations relying predominantly on rainfed sources in arid and semi-arid areas where rainfall is highly variable. Its reliance upon rainfed agricultural production renders much of Africa particularly vulnerable to the effects of drought. Whilst 55 per cent of total agricultural production in India is from the irrigated sector, the proportion for sub-Saharan Africa is only 4 per cent. Vulnerability to drought may also vary significantly within those areas dependent upon rainfed farming systems. The moisture retention characteristics of the predominant soil type in an area will affect the length of time a crop may survive between falls of rain without its growth being affected. The moisture retention capacity of sandy soils is generally significantly lower than that of clay soils. Crop growth characteristics and moisture requirements vary significantly. For instance, most varieties of sorghum and millet are often more 'drought-resistant' than many maize varieties which are in turn more drought-resistant than many varieties of wheat. Areas where farmers switch from more drought-resistant varieties to less resistant varieties (as a result of changes in food preference or variations in producer price) can therefore substantially increase their vulnerability to drought. Farmers may adapt to an intermittent start to a wet season by replanting either with the same variety or with another variety with different moisture requirements. The familiarity of farmers with such methods of *adaptive behaviour*, or their ability to utilise such methods, may vary significantly between different areas.

Whilst some populations may be able to cope with two or more years of successive drought and reduced harvests without substantial external assistance thanks to e.g. micro-credit programmes and seed co-operatives, others may be so vulnerable that external assistance is required from the end of the growing season during the first year of drought. In some areas landless agricultural labourers and

other groups whose income is directly and immediately dependent upon the normal progression of the growing season may be affected even before the growing season has ended.

Drought mitigation measures may range from increasing the security of water supplies through water storage schemes (such as dams or micro-level water-harvesting schemes), increasing the proportion of food production which is irrigated, increasing the efficiency with which available water sources are utilised, introducing or ensuring the retention of crop varieties which are drought-resistant, encouraging the greater use of adaptive strategies by farmers, to diversifying the sources of employment and income in an area into activities which are less vulnerable to the effects of drought.

The monitoring of rainfall, water levels in rivers and aquifers and the depth of snow (in areas where snowmelt is an important source of water) can give warning of imminent or developing droughts. Virtually all countries have functioning rainfall monitoring systems, though in some areas these may have become less effective as a result of lack of investment or conflict causing the breakdown of recording and reporting systems. Advances in remote sensing mean that satellites can be used to provide information on approximate rainfall in areas not adequately covered by rainfall monitoring systems, and also on the greenness of vegetation in an area. However, it is important that the results of remote sensing systems are regularly 'ground-truthed', ie. corroborated and complemented by ground-based assessments.

Famines

Famine may be defined as widespread and substantially increased morbidity and mortality and other serious consequences resulting from a sequence of processes and events that reduce food availability or food entitlements (after Downing, 1990). Such increased morbidity and mortality may occur without populations congregating around feeding centres, as occurred in northern Ethiopia in the 1984-5 famine. Widespread starvation can occur behind closed doors in people's homes and in agriculturally productive areas and may therefore be difficult for outside observers to recognise.

Until comparatively recently it was generally believed that famines were caused by a decline in food availability resulting from a reduction in food production through adverse weather (droughts, cyclones, torrential rainfall, high winds, floods, etc.), disease/pest infestation, the appropriation of farmer's produce by local authorities, by conflict or through a cutting-off of traditional sources of supply. However, there has been a growing realisation over recent decades that famines can occur in areas where overall food availability has not declined. In such situations famines may be the result of a reduction in the ability of the population or groups within the population to acquire food (i.e. their 'entitlements'), for instance, as a result of loss of income or a sudden rise in the price of food relative to their income and assets.

The ability of some countries to produce substantial agricultural surpluses, plus advances in transport and communications technology and international collaboration mean that famines are now preventable. For a famine to occur in the second half of the twentieth century implies that, in addition to the strictly causal factors, the failure of national governments or the international community to act to prevent or mitigate the famine has to be included as a 'causal' factor. Indeed, many of the greatest famines this century were in part caused by the interests of the affected population being subsumed beneath that of a higher goal or principle[2]. Conflict has frequently been an important contributory cause of famines. Conflict may affect food availability and/or reduce 'entitlements' through the direct destruction of life, property, food, animals and crops; the abandonment of land and other productive resources; and the disruption of commerce, freedom of movement, employment opportunities and the option of employing particular 'coping mechanisms' (see below). Warring parties often prevent relief food from reaching areas controlled by their opponents, even if it is intended for civilians and being carried by the UN and other recognised humanitarian relief agencies.

Faced by the threat of famine, households within the affected population will invariably utilise a wide range of responses to preserve themselves and their livelihoods. Commonly employed responses or '*coping mechanisms*' include going into debt, altering consumption patterns such as switching to less preferred foods, gathering locally available 'wild foods', selling off assets (land, furniture, jewellery, cooking utensils) to raise cash, and migrating to relief camps or out of the affected area. The particular mechanisms adopted vary widely as a result of the particular causal factors involved, the nature of the local food production and consumption systems, cultural factors, the nature of the households affected, local market conditions and the presence/absence of relief programmes. Knowledge of such coping mechanisms can be of use not only in the design of relief interventions, but possibly also in the design of programmes intended to prevent famines developing or to mitigate their impact. Coping mechanisms are therefore the subject of increasing research, though this remains at a comparatively early stage.

Over the last two decades the concept of *food security* has emerged as an organising theme in considering the relationship between food production, distribution and consumption. It is now employed by governments, UN agencies and donor organisations. The most widely used definition of food security is that used by the World Bank ie. access by all people at all times to enough food for an active, healthy life. Differentiation is often made between chronic and transitory food insecurity, with famine being an extreme form of the latter. The principal measures for maintaining food security during periods of transitory food insecurity are: price stabilisation; food subsidies; employment creation programmes; general food distributions; supplementary feeding programmes; special programmes for livestock and pastoralist populations; complementary water programmes; and complementary health programmes.

Floods

Floods are excessive accumulations or flows of water which result from heavy rainfall, snowmelt and other causes such as dam bursts and embankment failures. In coastal areas flooding may be caused by exceptionally high tides, sea wall ruptures or tsunamis and storm surges (see pages 31, 34). Flash floods are caused by heavy rainfall in sloping or hilly areas and may either be restricted to river courses or flow overland. River flooding involves river water spilling over into adjoining land. Rain water flooding involves the ponding of rainfall run-off in low-lying areas. Apart from Antarctica and land areas near the North Pole where precipitation is always in the form of snow, all land areas, even arid zones, are subject to flooding. Valley bottoms and floodplains are particularly attractive areas for human settlement for a variety of reasons (fertile soils, flat land, irrigation water, drinking water, water transport, etc.) and so floods have been a significant hazard to humans for thousands of years.

The impact of floods, in terms of casualties and damage, is dependent upon the nature of the event, the topography of the affected area and the nature of the human settlement and economic activity in the affected area. Where the water flows with some force because of either local land gradients or a topographical feature or construction which constrains the water and channels it through a narrow gap, the flood is particularly destructive and the ratio between the number of casualties and the numbers affected is likely to be high. In the case of river flooding in the floodplain areas of large river systems such as in India, China and Bangladesh, the water level usually rises to its flood peak over a period of hours or days. In such situations people are generally able to take to the roofs of their homes or to higher areas of land locally, sometimes taking valued, moveable possessions with them. In such situations the numbers affected by floods may be very substantial but the actual number of deaths attributable to the flood comparatively low. For instance, the 1988 floods in Bangladesh covered 60 per cent of the land area in a country with a total population of 110 million and damaged or destroyed over 7 million homes, but the number of deaths attributable to the flood was only 2 400.

River flooding in floodplain areas is a regular event resulting from seasonal rainfall regimes within the catchment area and/or snowmelt in the upper reaches of the catchment. Such flooding often performs a valuable function for farmers on the floodplains by irrigating their land and replenishing the nutrient levels in the soil (by virtue of the minerals carried in the sediment and deposited in the slow moving water). Flooding may therefore be an integral part of the economy of an area, resulting in high agricultural yields and enabling the area to support high population densities. Often those living in the floodplains will have learnt to live with ‘normal’ floods and even the risk of an occasional high flood, by constructing their homes on stilts or raised land or using locally available materials which are easily replaceable at low cost after a flood. Mitigation measures which aim to prevent all flooding would be inappropriate in such areas, and the appropriate measures are likely to be those which protect the floodplains only from unusually

high, 'disastrous' floods which may occur with a frequency of less than one year in 20 or more.

The hydrological characteristics of rivers and their propensity to flood will depend upon a number of natural factors such as the variability of rainfall and snowmelt within the catchment area, the shape of the catchment and the pattern of rivers within it, the vegetative cover within the catchment and the infiltration capacity of the soil. The last two factors are closely related. Soils with their vegetative cover removed or altered are generally less able to absorb water and run-off may be increased. Alteration of the vegetative cover through deforestation and grazing by livestock may well increase the flood levels. However, care needs to be taken in assuming that a change in land use automatically increases the flood risk, as deforested areas may be replaced by land uses which display similar run-off characteristics to forested areas[3].

Floods may be controlled and/or their effects mitigated through a variety of structural and non-structural measures. Flood-control methods include the construction of retaining walls or embankments (levées), the construction of reservoirs and retaining dams to control the peak flow, the widening and/or straightening of the channel, the setting aside of land of low intensity usage which may be used for temporarily 'storing' floodwater. Such methods are generally expensive and require a substantial planning effort. Unless built to withstand even the most extreme event, they cannot guarantee complete protection, and when their capacity is exceeded by such a rare event, they may have the effect of increasing its impact.

Non-structural measures include land-use controls in the floodplain, involving the prohibition of permanent settlement and businesses; the introduction of building codes incorporating flood-resistant designs, and the imposition of obligatory insurance payments on floodplain users to discourage their occupation of high-risk areas and ensure that they contribute to the costs of their relief and rehabilitation in the event of floods. Alternative options may need to be considered in low-income countries with high population densities, intense pressures to settle and utilise floodplains, and where the central and local authorities do not have the capacity to implement such measures. Developing effective warning systems, evacuation procedures and methods to facilitate post-flood recovery (such as seed and cheap credit provision) may be all that can realistically be achieved in some situations. Examination of the adaptation and coping strategies used by those living in the floodplain areas may reveal approaches which can be supported and made more effective, such as raising the height of the plinths on which homes are constructed.

Tropical cyclones

Tropical cyclones are known as hurricanes in the North Atlantic and South Pacific, typhoons in the North and Western Pacific and cyclones in the Indian Ocean. They consist of strong winds that circulate around a central area of extremely low pressure called the 'eye', the winds circulating clockwise in the

southern hemisphere and anti-clockwise in the northern hemisphere. Most tropical cyclones form between 5 and 30 degrees latitude on both sides of the equator. They form over open sea where the surface temperature is at least 26°C, the warm sea provides the overlying atmosphere with a continuous supply of energy and moisture, first to generate the cyclone and then to maintain its destructive force as it migrates forward. On average about 80 tropical cyclones with wind speeds in excess of 100 kilometres per hour form each year. Fully formed tropical cyclones have a diameter of 100 to 300 kilometres with gale force winds extending up to 600 kilometres from the eyes which are generally 20-40 kilometres in diameter. Wind speeds of 320 km/hr have been recorded in fully formed cyclones. Within the eye wind speeds are light and there is little if any cloud. The average life of a tropical cyclone is nine days, and during this period they may migrate up to 10 000 kilometres with a forward motion of between 10-50 km/hr. Once over land the supply of energy from the warm sea is reduced and the cyclones rapidly lose their destructive power. Because of their small size and location in cyclone-prone areas, small island states in the Pacific and Indian Oceans and the Caribbean are particularly prone to cyclones and vulnerable to their effects.

Tropical cyclones are capable of causing damage in three ways: by high winds, heavy rainfall causing inland flooding, and storm-surge flooding in low lying coastal areas. The latter phenomenon is caused by a combination of general sea level rises resulting from the extremely low atmospheric pressure and the high waves whipped up by the winds. The effect is greatest if the passage of the cyclone coincides with high tides. The 'funnel' effect of the coastline around the Bay of Bengal and the general northward migration of cyclones in this area accentuate the general rise in sea level, such that the cyclones of November 1970 and April 1991 raised the sea level by 6-9 metres in the coastal areas of Bangladesh. As a result of the very high death toll resulting from these two events (225 000 in 1970 and 140 000 in 1991), the majority of deaths caused by tropical cyclones are the result of drowning.

The frequency of cyclones may be predicted for particular geographical areas and time periods through the analysis of historical meteorological and other records. Table 1 shows such information on a monthly basis for the principal ocean areas affected by tropical cyclones. Where the data permit, the probability of a particular coastal zone being affected by a cyclone of particular severity may be estimated. When combined with additional analysis of sea level and land elevation information, risk maps may be prepared.

The duration of cyclones and the comparatively slow speed at which they migrate enable meteorological services equipped with satellite receiving stations to monitor the development and track of cyclones and to give warnings to the population in coastal areas. The accuracy of the warnings reduces with the length of the forecast, i.e. those for 24 hours ahead are significantly more reliable than those for 72 hours ahead. Nevertheless, such capacity, when linked to effective methods for communicating the warnings (national and local radio, sirens, mobile loudspeakers), means that populations can be advised to move to higher ground or into secure buildings. In coastal areas where the risk of storm surge-flooding is limited (either as a result of the configuration of the coastline or the land elevation

near the coast), efforts to reduce the loss of life and the economic damage to homes, businesses and lifeline services/structures are probably most effectively focused on warning systems and the imposition of building codes and programmes to strengthen existing structures in order to enable them to withstand high winds[4]. In low-lying coastal areas where there is a substantial risk of storm surges, the options for limiting the economic damage are likely to be limited. Efforts to reduce the loss of life in such areas are probably most effectively focused upon the warning system and the construction of a network of specially designed or strengthened structures[5].

Table 1. Frequency of tropical cyclones by areas and months

Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Northern Hemisphere												
Western North Pacific	0.5	0.2	0.5	0.7	1.1	1.7	3.9	5.1	4.5	3.8	2.7	1.1
Eastern North Pacific					0.3	1.3	2.1	2.0	2.4	1.4	0.2	
Bay of Bengal and Arabian Sea				0.3	0.7	0.6	0.5	0.4	0.4	1.0	1.1	0.4
North Atlantic Ocean						0.5	0.5	1.8	2.7	1.7	0.4	
Southern Hemisphere												
South Pacific Ocean	2.0	2.0	1.9	0.7	0.1	0.1					0.1	0.7
South Indian Ocean	0.5	0.5	1.8	2.7	1.7	0.4						

Source: Reproduced from UNDRO, 1991

Earthquakes

An earthquake is a sudden motion or trembling of the ground produced by the abrupt displacement or rupture of rock masses, usually within the upper 15 to 50 kilometres of the earth's crust. More than 3,000 perceptible earthquakes occur each year, but perhaps only 7-11 of these will involve significant loss of life. Earthquakes tend to be concentrated in particular zones which coincide with the boundaries of the tectonic plates into which the earth's crust is divided, and certain countries are therefore particularly prone to earthquakes whereas large areas of the earth's surface experience only minor tremors. Table 2 ranks the 10 most earthquake-prone countries as measured by the total fatalities between 1900 and 1992.

During the last 20 years the most lethal earthquakes have been the 1976 Tangshan earthquake in China which killed 240 000, the 1990 Manil earthquake in Iran which killed 40 000, the 1988 Armenian earthquake which killed 25 000 and the 1976 Guatemala earthquake which killed 23 000.

The *magnitude* of an earthquake is a measure of its strength, ie. the total energy release at its source as estimated from instrumental observations. The oldest measure is the Richter scale and the largest ever recorded earthquake registered 8.9 on this logarithmic scale. The *intensity* of an earthquake is a measure of the severity of the shaking of the ground at a particular location. Intensity scales are

those used for building and planning purposes. The two most widely used intensity scales are the Modified Mercalli (MM) and the more sophisticated Medvedev-Sponheuer-Karnik (MSK), each of which measures intensity in terms of the typical effect on people and different types of buildings. The intensity of an earthquake may vary considerably depending upon the nature of the rock types involved in the rupture, the depth of the shock, the velocity and amplitude of the shock waves, the nature of the local rock and soil types, the moisture content of the local soil type and the presence and nature of faulting within the rocks.

Table 2. The world's earthquake countries: their loss of life this century

		No. of lethal earthquakes 1900-1992	Total fatalities	No. of quakes >1000 killed	No. of quakes >10,000 killed	No. of quakes >100,000 killed	Average return period (years)
1	China	151	609 500	17	7	2	0.6
2	Japan	78	173 005	8	1	1	1
3	Italy	43	127 902	6	2		2
4	Iran	82	117 764	15	4		1
5	Turkey	110	73 967	14	1		1
6	FSU	46	71 022	5	3		2
7	Peru	53	70 382	1	1		2
8	Pakistan	18	61 773	1	1		5
9	Chile	34	36 020	4	1		3
10	Indonesia	48	25 526	2	1		2

Source: Reproduced from Coburn and Spence 1992.

About 75 per cent of the fatalities attributed to earthquakes are caused by the collapse of buildings. Though reinforced concrete buildings account for a growing proportion of the fatalities caused by buildings, masonry buildings account for the largest proportion. These are primarily weak masonry buildings (adobe, rubble stone or rammed earth) or unreinforced fired brick and concrete block masonry that can collapse even at low intensities of ground shaking and will collapse very rapidly at high intensities[6]. The bulk of the remaining fatalities are caused by secondary fires and landslides resulting from the earthquake.

The economic impact of earthquakes is highly variable. In cities or areas with concentrated commercial, financial and industrial activity the economic costs can be very substantial indeed, though the effect on GDP may be obscured by post-earthquake reconstruction activities. In rural areas the impacts are also variable. In areas with rainfed agriculture the impact is likely to be slight unless there are substantial casualties occurring at a key point in the agricultural calendar. However, in irrigated and hilly areas the costs can be substantial as a result of damage to terraces and irrigation systems. Unless built to very high standards of construction, dams are liable to burst during earthquakes.

Within the broad zones of seismic activity it is known that earthquakes are likely to occur. However, predicting the timing and location of earthquakes is extremely difficult. Extensive seismic monitoring by geologists can indicate active belts and specific areas where there is a build-up of tensions likely to lead to a

sudden displacement. Some earthquakes are preceded by so-called precursors such as minor tremors and localised deformations in the earth's surface, and this may enable reasonably accurate warnings to be issued. Because of Japan's location along an active seismic belt and the belt which runs along the west coast of the United States, these two countries have a particularly well-developed capacity for seismic monitoring and systems for the release of information to the public. Both countries are therefore well placed to support monitoring activities in developing countries and indeed already support such programmes. Despite the investment in monitoring systems the occasions on which geologists have been able accurately to predict an earthquake with sufficient confidence for the local authorities to evacuate towns and cities in the potentially affected area are rare. The most celebrated case was the severe Haicheng-Yngou earthquake of 1975 where towns and cities were evacuated two days before the event and only 1 300 people were killed in an event that might have been expected to have claimed the lives of tens of thousands.

Because of the difficulty of predicting earthquakes the principal measures for mitigation and preparedness are the adoption of earthquake-resistant designs in all forms of construction, the control of land use in areas adjacent to fault lines or on unstable slopes, the institution of public awareness programmes on how to react when an earthquake strikes, and the development and maintenance of local search and rescue capacity to save those trapped and injured during the crucial day or so after an earthquake[7].

Tsunamis

Tsunamis are sea waves generally caused by earthquakes or volcanic events occurring either under or out to sea. In deep sea such waves can travel at speeds of approximately 800 km/hr, but as they approach land they slow down and increase in height. The actual height of the wave depends on the magnitude of the undersea event and the offshore topography, but waves as high as 15 metres above normal sea level have been recorded. Such waves sweep over low-lying coastal areas causing extensive damage. 90 per cent of damaging tsunamis occur in the Pacific Basin at an average of more than two a year. During the period 1967-91 6 400 people were killed by tsunamis, approximately 3 000 of them by one event in the Philippines. The majority of destructive tsunamis occur within a few hundred kilometres of the point of landfall and, given the high speeds, there is little opportunity for warning. For waves travelling long distances warning systems are a viable option. In 1946 the US Government initiated a warning system now known as the Pacific Tsunami Warning System, which has 23 member nations. The system is based on a network of tide and seismographic monitoring stations, the hub of which is Honolulu. Within one hour of the detection of a tsunami anywhere in the Pacific, warnings, indicating the estimated time of landfall, are issued to over 100 dissemination points. Land-use controls in the main risk areas[8], evacuation plans, reinforcement of large buildings and sea walls or deflection barriers are the principal methods for mitigating the effects of tsunamis.

Volcanoes

Volcanic activity is caused by molten material (magma) within the earth's crust which wells upwards and is emitted at the surface in gaseous, liquid or solid form. Volcanoes are associated with tectonic activity and the majority occur on the rim of the Pacific plate (i.e. affecting Central America and western parts of North and South America, the Aleutians, the Kamchatka Peninsula, Japan, the Philippines and Papua New Guinea) and along the northern rim of the Indian-Australian plate (principally affecting Indonesia). Because of the high mineral content of the soil formed from historic magma flows, volcanic zones are attractive areas for human settlement and agriculture. Approximately 10 per cent of the world's population live in or near potentially active volcanoes.

Low-viscosity, easy-flowing magmas escape in *effusive eruptions*, as is characteristic of eruptions in Iceland and Hawaii. Higher viscosity magmas allow pressures to build up leading to *explosive eruptions*. The principal products of volcanoes are ash falls, pyroclastic flows, lava flows and gas emissions. The composition and mix of the products may vary substantially between volcanoes and even between different eruptions at the same volcano. Because of such differences it is difficult to generalise about their impacts.

The most lethal eruptions of the last 20 years have been the 1985 Nevado del Ruiz eruption in Colombia which killed approximately 22 000 people, the 1982 El Chichon eruption in Mexico which killed approximately 2 000, and the 1986 volcanic gas release at Lake Nyos in Cameroon which killed 1 800 people. Explosive eruptions naturally tend to affect a larger area than effusive eruptions. Eruptions producing substantial ashfalls, such as the 1991 Mt Pinatubo eruption in the Philippines, can destroy crops over large areas and settle on flat roofs and cause them to collapse. Subsequent rainfall may cause dangerous sediment flows known as *lahars* and the choking of rivers, possibly forcing changes in their course. Ash and dust forced to high altitudes by an explosive eruption such as Mt Pinatubo or the 1980 Mt St Helens eruption in the United States can circulate the globe in the upper atmosphere causing discernible alterations in weather patterns and affecting the operation of remote sensing satellites.

Many volcanoes located in hazardous areas have no more than a 2 per cent chance of erupting in a 100-year period and so, unless there is an awareness of a recent event, the local population are unlikely to pay much attention to the potential risks involved in living near a volcano. In such a situation the government itself should estimate the risks and the costs of mitigation measures. The principal methods for reducing the risks of living on or near a volcano are land-use zoning, the use of steep pitched roof styles, monitoring the activity of the volcano to give warnings of eruptions, public awareness programmes and evacuation plans.

Natural hazard maps

The following four maps show the relative vulnerability of various regions in the world to the hazards of cyclones, earthquakes, volcanoes and rainfall

variability. The latter map is based on UNEP's *World Atlas of Desertification* (1992), the three other maps on the *World Map of Natural Hazards* of the Munich Reinsurance Company, 2nd edition, 1988 (available from the company, Postbox 401320, D-8000 München, Germany).

Notes

1. Crop yields may also be reduced by such factors as the reduced availability of fertiliser, lack of weeding, the presence of pests and crop diseases, the lack of labour at critical periods in the growth cycle, unattractive producer prices, etc. Given the complex and highly variable nature of the factors affecting crop yields it may be difficult to assess the relative contribution of a reduction in moisture availability as against other factors.
2. For instance, the famines in the Soviet Union in 1932-4 which claimed approximately 5 million lives and that in China in 1958-61 which claimed between 15 and 29 million lives, were substantially caused by the governments giving higher priority to the goal of rapid industrialisation.
3. The apparent increase in the frequency of unusual floods in Bangladesh indicated by the successive floods of 1984, 1987 and 1988 led some observers to attribute the increase to deforestation in the upper reaches of the catchment areas of the Ganges and Brahmaputra systems. However, there is quite strong evidence that such conclusions are erroneous and that, whilst the rate of deforestation in Nepal has increased during recent decades, the land is often terraced for crop production and the run-off characteristics are little different from before (Ives and Messerli, 1989).
4. The differential effect of Hurricane David in 1979 upon Dominica and the nearby Dominican Republic provides a salutary example of the need to link warning systems with suitably resistant structures. In Dominica there was little advance warning and no churches or schools were open. Although more than 95 per cent of structures received substantial damage, fewer than 40 people lost their lives. In the Dominican Republic prior warnings were given and people were encouraged by the civil defence authorities to go to larger buildings for protection. Here, over 1,200 lives were lost, almost 60 per cent of them in the collapse of unreinforced churches and schools (Cuny, 1983).
5. The case of the April 1991 cyclone in Bangladesh illustrates the need for the warning system to achieve high levels of accuracy (many people chose to ignore the warnings because previous cyclones had turned out not to be as severe as forecast); the need to provide specially designed cyclone shelters in sufficient number and carefully sited to enable people to reach them easily; and the difficulties created by insecure land-tenure systems and the fear of leaving land/homes because of the threat of thieving (World Disasters Report, 1993).
6. The belt of seismic activity which runs from Turkey through Syria, the TransCaucases and Iran to Afghanistan and Pakistan is particularly vulnerable to earthquakes because the climate is arid and semi-arid, the days generally hot and the nights cold. Timber for construction is in short supply. Local building designs therefore rely strongly on thick masonry or mud-brick walls and heavy, but poorly supported, roofs for insulation. Such designs are highly liable to collapse and crush their occupants (Alexander, 1993).
7. The effectivenss of search and rescue (SAR) teams from outside the country is known to be limited, principally because of the time taken for them to reach the affected area. Information on survival rates shows that the majority of trapped survivors die within one or two days of the event and the survival chances of those rescued after this period are very slim. Because of the logistical and practical difficulties faced by international SAR teams few are able to begin operating in the affected area within the critical first two days. The arrival of many international SAR teams also creates communication and co-ordination problems for the local authorities (Coburn and Spence, 1992).
8. After the devastating tsunamis of 1946 and 1960, the central business district of Hilo, Hawaii was relocated to a safer area and the waterfront and estuarine areas made into public open spaces (Alexander, 1993).

Annex 2

The Effects of Disasters

The effects of disasters are generally classified into the following categories:

- casualties (killed and injured) and numbers affected;
- physical damage to housing, infrastructure, 'lifeline' systems and agriculture;
- financial and economic consequences;
- social consequences such as the trauma experienced by survivors, broken families, orphans, missed educational opportunities and indebtedness.

Assessment of the effects within each of these categories may be problematic, particularly in the context of developing countries[1]. The principal points from a disaster mitigation perspective are as follows.

Casualties and numbers affected

Casualties may arise either directly as a result of the hazard event or subsequently as a result of increased morbidity and mortality attributable to the disruption and damage caused by the hazard event. Thus, an earthquake may kill some people directly but the destruction of housing and water supply and sewage systems may result in increased incidence of disease or in epidemics, which may substantially increase the death rate unless water, sewage, accommodation and medical needs are quickly met following the initial disaster. Similarly, famines may develop in populations where the hazard event causes a decline in food availability in the area. But there may also be a reduction in the ability of people in the area to acquire food, arising from increases in food prices and/or reduction in household income resulting from the hazard event.

It is not uncommon in disasters affecting developing countries, particularly those where the casualty rates are substantial, for the casualty figures to be very imprecise. Often the initial estimates used by the media are substantially exaggerated[2]. Occasionally the local authorities will exaggerate the casualty rates in order to increase the level of the response by central government and the international community. Alternatively, they may reduce or even deny casualty rates where the truth may be embarrassing. Famines often take the form of increased mortality rates within rural communities which go unregistered by the

local administration and health services. Consequently, the death toll of famines is often subject to estimates which may vary by over 100 per cent. The scale of the destruction caused by tropical cyclones or floods may be such that many bodies are not found and the number of known survivors is simply subtracted from estimates of the pre-disaster population to arrive at an estimate of the approximate number of deaths. Where casualty rates form a basis for risk assessments and appropriate disaster mitigation measures, such figures should be treated with caution and cross-checked wherever possible.

The number affected is a highly ambiguous measure as it places individuals whose lives may have been only slightly affected within the same category as those whose lives were substantially altered by the disaster. For instance, floods are deemed to affect *all* those who live within the affected area, even if some have lost their homes, relatives and assets, whilst others have simply been inconvenienced by the inundation of their homes. Such ambiguity renders this measure of limited utility for mitigation purposes, and it is preferable that more specific measures should be employed.

Physical damage

Similar considerations should apply to assessments of physical damage to housing, infrastructure, 'lifeline' systems and agriculture. Initial estimates undertaken by the local administration may be based largely on 'guestimates' by officials rather than any rigorous assessment, as a result of communication and logistical difficulties in the affected area. Crop production estimates are particularly subject to manipulation by some governments for domestic and international political reasons. In most cases, the damage is subsequently assessed in a more rigorous manner by UN agencies or a combination of UN and donor agencies. Such assessments often rely substantially upon information provided by government agencies and perhaps non-governmental organisations, which is cross-checked by UN-led teams visiting parts of the affected area[3]. The estimates of damage produced by such means often serve as the only overall assessment of damage. Local assessments may subsequently be undertaken as part of the relief/rehabilitation response which result in revisions to the estimates contained in the UN-led assessments, but it is not common for such revisions to be collated into the final estimates of damage. Where damage assessments of previous disasters form the basis for risk assessments and the design of appropriate disaster mitigation measures, such figures should be treated with some caution. Where feasible, the more recent assessments should be subjected to a reassessment to make use of any subsequent figures.

Financial and economic effects

The financial and economic effects of disasters are complex and often difficult to measure. An added difficulty is that current approaches to the

measurement of the economic impact of disasters are simplistic and, from the perspective of economists, methodologically weak.

The disaster literature commonly divides the costs attributable to disasters into direct and indirect costs. In conceptualising this distinction the notion of 'stocks' and 'flows' is helpful, with the direct costs equating with the stock losses and the indirect costs equating with flow losses within the economy.

Direct costs are the financial costs of replacing or repairing the physical assets damaged or destroyed by the disaster. Such estimates rely on assessments of the physical damage discussed above and care needs to be taken to ensure the accuracy of such assessments. Differentiation is usually made between the costs of damage to public investments (public facilities and infrastructure) and those to private investments (factories, business premises and homes). The values used are generally the current costs of rebuilding and repairing the damaged structures. The use of current costs enables account to be taken of the commonly inflated costs for building materials and services after a disaster. Another useful distinction is that between the loss of productive and unproductive assets.

Indirect costs are the losses of current and future income to the economy directly attributable to the disaster. The estimation of such effects generally involves a calculation of the value of production and markets. Care is needed in making such calculations as losses incurred by one group within a sector may be mirrored by a gain by another group within the same sector. For instance, producers in areas unaffected by the disaster are likely to experience an increased demand for their output as a result of reduced production by producers located in the affected area. Similarly losses within one sector may to a certain extent be offset by gains within another sector. Aggregate measures of production such as GDP may therefore mask the negative effects within particular sectors and geographical areas within the economy. Such methodological problems are less apparent in the case of national exports. Lost export production and access to markets represent a genuine loss of national income to the affected country, though they may result in income gains in countries with competing products. However, there may be redistributive effects within the national economy if the loss of exports results in a deterioration in the balance of payments which would lead to exchange rate depreciation and the re-allocation of income between importers, who would lose from such a depreciation and exporters who would be gainers per unit of the goods exported.

The financial and economic effects of disasters are often confused within the disaster literature. For instance, it is not uncommon to see the total financial loss figure expressed as a proportion of GNP even though this effectively compares 'stocks' with 'flows'. Frequently too local replacement costs are misleadingly expressed in hard currency terms, even though this may involve a non-convertible or overvalued currency. In estimating the economic effects of disasters, economic analysis methods commonly used in the economic appraisal of large projects, such as the use of border prices and marginal labour costs, should be employed.

Disasters may also have a substantial impact upon government budgets. Tax revenues may fall as a result of reduced production and trade and this may lead to

downward pressure on government expenditure at the very time when the disaster is requiring increased expenditure on health care and the provision of relief and rehabilitation assistance.

The actual economic impact of a disaster will depend not only on its nature and severity, but also on the structure of the economy and the nature of the sectoral linkages within the economy. Thus a disaster impacting heavily upon a sector which has strong linkages with other sectors within the economy may result in an overall effect upon the economy which is several times greater than its effect on the initial sector. In contrast, a disaster impacting heavily upon a sector which has weak linkages with other sectors may result in an overall effect only marginally greater than its effect on the initial sector. For instance, where the principal impact of a disaster is the destruction of private, locally constructed, housing, this is likely to have a substantially lower overall economic impact than a disaster which cuts off water supplies to the industrial sector or deprives the local manufacturing and marketing sectors of their principal raw material or traded commodity. For these reasons droughts are likely to have substantially greater 'knock-on' effects within national economies than other types of natural disaster.

Comparatively little attention has been devoted to the analysis of the financial and economic effects of disasters, and this is reflected in the weakness of the current methodologies. DAC Member aid agencies could usefully support efforts to improve the understanding of economic processes involved and appropriate methodological approaches. A better understanding of economic impacts of disasters will help ensure an appropriate balance between expenditures on prevention, preparedness and relief approaches, will also ensure that the investments selected represent an optimal use of scarce resources, and will increase the likelihood that the possibility of disasters is taken account of in overall economic development plans.

Social effects

Populations within disaster-affected areas may experience a range of social effects. Survivors may be traumatised by their experience and suffer from post-traumatic stress disorders or related conditions. Families may be separated either by the chaos of the event or by adults migrating in search of work elsewhere, and have difficulty in tracing each other. Children may be orphaned and need placement with other families. Most studies of the social consequences of disasters have focused on disasters occurring in developed countries, and so less is known about the reactions and adaptations of survivors of disasters in developing countries. Perhaps as a result of this lack of understanding, the social consequences of disasters occurring in developing countries are often poorly recorded and are rarely addressed by DAC Member aid agencies in their mitigation and relief activities.

Disasters may have a significant effect upon the degree of social differentiation within a community or society. An often overlooked aspect of disasters is that there are 'winners' as well as 'losers'. Some groups or individuals

may benefit as a result of increased demand for their goods and services in the wake of a disaster, whilst others may be able to exploit a monopolistic position. To meet their immediate survival and rehabilitation needs households are often obliged to borrow money which, because of the increased demands for credit and the disruption to existing formal systems of credit provision, is invariably available only at very high rates of interest. A common effect of disasters is therefore to force an increased proportion of families in the area into long-term indebtedness to local moneylenders. Subsequent disasters may deepen their indebtedness and/or render them entirely destitute. A succession of disasters in an area may therefore have a 'ratchet' effect upon particular households or groups within the affected population.

The effects of disasters may also have a significant gender dimension. The death of male heads of households will increase the number of female-headed households, which in the absence of access to other income sources will become poorer. The disaster may increase the workload of women through the need to care for the sick and possibly travel further to reach fuel and clean water supplies. Such increases in workload may have implications for the nutrition and health of the family. The deaths of mothers place a greater workload on daughters, possibly resulting in curtailed education. In certain societies during times of scarcity, the share of available resources allocated to male family members may become increasingly disproportionate. The impoverishment of certain households and groups may lead to females being made more vulnerable to male exploitation and violence, and some may be obliged to obtain income through prostitution.

Notes

1. A recent analysis of the political economy of large natural disasters states: "Most disaster analysis is based on shaky foundations. Institutional bias, political interests and technical insufficiencies make disaster statistics unsatisfactory and unreliable" (Albala-Bertrand, 1993).
2. In the Armenian earthquake of December 1988 the first estimates widely published in the international press were of over 100 000 deaths, but by the end of January 1989 the official estimate of actually counted dead and missing people was revised down to just under 25 000 (Albala-Bertrand, 1993).
3. In the case of sudden-impact disasters such teams are usually led by either or both UNDP and the Department of Humanitarian Affairs, though the World Bank has been known to lead multi-donor assessment teams in certain contexts. In the case of drought and food security assessments, the FAO and/or the WFP usually lead such teams. In the case of conflict where medical needs predominate, the WHO may lead the assessments.

Annex 3

Disaster Statistics

Databases on hazards and disasters are maintained by a range of organisations. Unfortunately however partial coverage and the lack of internationally agreed definitions and protocols for collecting disaster statistics means that none of the existing databases currently provides a satisfactory basis for the global analysis of the occurrence and impact of the principal disaster types. Currently the closest approximation to a global database is the EM-DAT Disaster Events Database developed and maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain in Belgium. This utilises data collated from a variety of sources, including the UN Department of Humanitarian Affairs, the US Office of Foreign Disaster Assistance, national governments, insurance companies and news agencies. Because of the different sources there are problems of consistency in the definitions used. In addition, EM-DAT's coverage of certain disaster types (notably civil strife and drought) and disaster effects is incomplete.

Aggregate information on relief expenditures by donor organisations and from private sources is also not readily available. Whilst data collated by the DAC Secretariat separately identifies non-food emergency aid, unfortunately it does not currently distinguish emergency food aid from other categories of food aid. Consequently, a substantial proportion of the resources provided in humanitarian relief programmes are omitted from the DAC 'emergency aid' category. Similarly, whilst DAC does collect data on assistance provided by NGOs based in DAC countries, it does not distinguish between categories of assistance, and the important relief contributions by private donors are not identifiable. As part of its mandate to co-ordinate international relief assistance, the UN Department of Humanitarian Affairs (formerly the UN Disaster Relief Organisation UNDRO) requests and encourages donor agencies to provide information on all relief assistance provided in response to disasters. However, the reporting by some donor agencies is not complete, and the aggregate information is considered to contain so many gaps that it is not currently published by DHA. This leaves the information compiled by the OFDA as the best available source. However, caution is needed in using the OFDA data as they appear to contain a degree of both double-counting and under-counting.

Disasters and their effects: trends and national vulnerabilities

Because of the lack of a comprehensive and reliable global database, the identification of trends is problematic. Any trends that may be apparent should be treated with caution. A point of general agreement among existing analyses which appear to be intuitively correct, is that the number of natural disasters appears to be stable, whilst the number of deaths attributable to such disasters is increasing. The increase in populations living in hazard-prone zones is likely to be a principal contributory factor. Not only is population growth within the hazard-prone areas increasing the numbers of people living in such zones; population pressure in other areas is likely to be forcing people, usually poor households with limited alternative options, to move into hazard-prone zones. This process is evident in highly flood-prone areas of Bangladesh and in rapidly growing urban areas where shanty towns are often confined to hazardous flood plains or steep slopes prone to landslides. However, care does need to be taken in making generalisations about complex socio-environmental processes in widely differing contexts. For instance, a recent study of Machakos District in Kenya, which 40-50 years ago experienced high rates of soil erosion and has since experienced high rates of in-migration from the more densely settled highland areas, found that population increase is compatible with environmental recovery, provided that market developments make farming profitable[1].

Of the major disaster types, earthquakes have been the most comprehensively studied and data on earthquake fatalities are considerably more accurate and reliable than those for cyclones and droughts and possibly also than those available for floods. Analysis of the annual rate of earthquake fatalities suggests that the average number over the period 1950-90 has been approximately 14 000 compared with 16 000 over the period 1900-50[2]. Much of this reduction can be attributed to improved mitigation practices such as improvements in building stock in some countries and successful measures to reduce fire risk in Japanese cities — formerly a common secondary effect of earthquakes. However, there is reason to be sceptical about the ability of the present rate of vulnerability reduction to offset the rapid rate of population growth. A doubling of the global population every 40 years will require the average vulnerability of the world's building stock to be falling at a reciprocal rate and, given current circumstances, this appears unlikely.

Despite the methodological problems associated with the economic consequences of disasters and serious questions about the coverage and reliability of databases purporting to measure the economic consequences, there is strong evidence that, in global terms, the magnitude of the economic consequences of disasters is increasing. Intuitively this appears correct. Unless offset by greater use of mitigation measures, the magnitude of economic losses may be expected to increase as the value of economic activity and assets increases. However, the data on economic consequences are likely to be highly skewed by the trends in developed countries and may obscure trends in developing countries which are less evident.

What are the major disaster types? Table 1 shows the summary results for deaths and numbers affected for the period 1967-91 compiled by the EM-DAT

Disaster Events Database. As noted above, there are problems of coverage and data quality associated with this database and the results should be treated with caution.

Table 1. Numbers killed and affected 1967-91 by principal disaster types

Disaster type	Nos. killed	Nos. affected
Civil strife/Displaced persons	3 076 000	161 265 000
Drought/Famine	1 940 000	1 467 510 000
Flood	305 000	1 057 193 000
Cyclone/Typhoon/High wind/Storm	964 000	217 961 000
Earthquake	646 000	42 943 000
Volcano	28 000	1 938 000
Landslide	42 000	3 604 000

Source: Compiled from Table 4. World Disasters Report, 1993.

Though the Civil Strife/Displaced Persons category emerges here as the most significant in relation to numbers killed, it is almost certain that these figures represent a serious underestimate of the human death toll exacted by all forms of conflict. The period 1967-91 includes the Nigerian Civil War (1967-70); the principal period of the Vietnam War (1965-75); the War of Liberation in Bangladesh (1971); the genocide in Cambodia during the Pol Pot period (1975-78); the Chinese Cultural Revolution (1967-68); the Afghan War (1978-89); the wars in Angola and Mozambique (1975-91); the genocide in Uganda during the Idi Amin period (1971-78) and the subsequent civil strife in that country (1981-87); and the Iran-Iraq war (1980-88). A widely respected database on wars and war-related deaths[3] indicates that total deaths during this period were in the region of 13 million rather than the 3 million indicated by the EM-DAT database.

Leaving conflict aside, the Drought/Famine category stands out by a significant margin as the category responsible for the largest number of deaths, accounting for twice as many as the Cyclones/Typhoons category, three times as many as the Earthquake category and six times as many as the Flood category. However, some care is needed in the use of the figures within the Drought/Famine category as famines are frequently associated with conflicts. For instance, reviews of the African food crisis of the mid-1980s note that all the countries in which substantial famine deaths occurred (ie. Sudan, Ethiopia, Mozambique, Angola and Chad) were affected by conflict. However, there is reason to suspect that deaths attributable to drought are underrecorded and this may serve to offset those deaths in famines which might be more directly attributable to conflict than any decline in rainfall.

Though of questionable utility, the measure of numbers affected reveals the Drought/Famine category as being the most significant. The importance of the Flood category in terms of the numbers affected stands in some contrast to its importance in terms of deaths.

Vulnerability to disasters measured in terms of deaths

The process of identifying those countries that are most vulnerable to the effects of disasters is hampered by the limitations of existing databases.

A ranking of countries by the average number killed each year over the period 1967-90 gives the results as shown in Table 2.

Table 2. Average number killed each year, 1967-91

1	Ethiopia	48 517
2	Nigeria	40 720
3	Bangladesh	40 408
4	Cambodia	40 005
5	Sudan	16 195
6	Mozambique	15 763
7	China	12 755
8	Pakistan	8 688
9	Iran	5 801
10	India	5 044

Source: Table 1. *World Disasters Report*, 1993.

However, if the number of deaths is expressed as a proportion of the population the results are somewhat different. Table 3 ranks countries on the basis of the total numbers killed during 1981-91 (a shorter period than used in Table 2) expressed as a proportion of the mid-1986 population.

Table 3. Total numbers killed 1981-90 as a proportion of the mid-1986 population

1	Mozambique	2.77%
2	Sudan	1.79%
3	Lebanon	0.87%
4	Ethiopia	0.69%
5	El Salvador	0.48%
6	Liberia	0.48%
7	Somalia	0.35%
8	Sao Tome	0.17%
9	Colombia	0.16%
10	Angola	0.15%

Source: Calculated from EM-DAT using World Bank population estimates.

Four points emerge from these two tables. First, the significant impact of disasters upon smaller, less populous countries tends to be obscured by the use of total figures. Expressing the total deaths as a proportion of the total population yields some unexpected results. Second, the results are clearly sensitive to the time period selected. For instance, Nigeria appears in Table 2 by virtue of the inclusion of the civil war period. Similarly, had Table 3 been extended one more year it is likely that Bangladesh would have been ranked higher by virtue of the high death

toll of the 1991 cyclone. Third, conflict is an important cause of death. All of the highest ranked six countries in Table 2 were affected by conflict at some stage during the period covered, and conflict was a principal, if not the major, cause of death in all but one of the countries appearing in Table 3, the exception being Colombia. This reinforces the earlier point about the importance of conflict and points to the refined classification which separates proneness to conflict from proneness to natural disasters. Finally, the exceptional vulnerability of African countries is revealed when the number of deaths is expressed as a proportion of total population. Whilst four out of the ten countries in Table 2 were African, the proportion is seven out of ten for Table 3. Again, these figures reflect not so much the vulnerability of African countries to natural disasters, drought in particular, but of that continent's vulnerability to conflict due in part to the involvement of regional powers and superpowers in conflicts within the continent during the 1980s.

Vulnerability to disasters measured in terms of direct economic losses

A 1990 study by UNDRO attempted to devise a quantitative measure of the direct economic losses sustained by a country so as to identify the disaster-proneness of countries in economic terms for use by UNDP in its development planning activities. The study was based on estimates of the costs of damage contained in the OFDA Disaster History Database. Though such estimates cannot be considered to be particularly accurate or reliable, the results of the study are of interest. The total costs of damage caused by disasters during the 20-year period 1970-1989 were expressed as a proportion of the 1980 GNP for each country to give a Total Index, and then an Average Index was prepared by dividing the Total Index by the number of 'significant' disaster events. 195 countries were initially included in the study but sufficient data were available for only 133. Table 4 shows the 50 countries with the highest indices ranked by their Total Index results.

A remarkable feature of the table is the number of small island economies with very high indices. Of the ten countries with the highest indices half are small island economies (Montserrat, Vanuatu, Dominica, Cook Islands and St. Lucia)[4]. The particular vulnerability of small island economies to tropical cyclones is highlighted by these results. The fact that some countries such as India and the Philippines which are known to experience numerous disaster events do not appear in the table suggests two possibilities. First, that some countries, by virtue of their sheer size and geographical diversity, are comparatively less affected than smaller countries. Second, some of those countries which experience numerous disaster events may have developed a much greater capacity to cope with their economic consequences than other countries.

Table 4. Results of UNDRO study on economic proneness to disasters

Descending order by total index				Descending order by average index			
(D)	1.	Montserrat (1)	(E)	(D)	1.	Montserrat (1)	(E)
*(D)	2.	Vanuatu (4)	228.41	(D)	2.	Cook Islands (1)	119.05
	3.	Nicaragua (8)	206.95	*	3.	Yemen Arab Rep. (1+)	66.70-
*	4.	Burkina Faso (4)	191.23	*(D)	4.	Vanuatu (4)	57.74
(D)	5.	Dominica (3)	141.30	(D)	5.	Tokelau (1)	50.00
(D)	6.	Cook Islands (1)	119.05	*	6.	Burkina Faso (4)	47.81
*	7.	Chad (5+)	92.04+	(D)	7.	Dominica (3)	47.10
	8.	Bolivia (10)	84.16	(D)	8.	San Lucia (2)	40.58
(D)	9.	St Lucia (12)	81.17	(D)	9.	Antigua & Barbuda (1)	38.00
*	10.	Yemen Arab Rep. (1+)	66.67+	(D)	10.	St Kitts & Nevis (1)	28.00
(D)	11.	Jamaica (5)	64.40		11.	Nicaragua (8)	25.87
*(D)	12.	Comoros (3)	61.18		12.	Liberia (1)	21.28
*	13.	Ethiopia (7+)	60.82+	*(D)	13.	Comoros (3)	20.39
	14.	El Salvador (4+)	52.32+	*	14.	Chad (5+)	18.41-
*	15.	Bangladesh (7+)	50.32+	(D)	15.	St Vincent/Grenadines (2)	18.00
(D)	16.	Tonga (5)	50.20*	*	16.	Laos (1+)	17.98-
(D)	17.	Tokelau (1)	50.00		17.	Algeria (1)	14.19
*	18.	Mauritania (4)	41.15		18.	El Salvador (4+)	13.08-
(D)	19.	Mauritius (4)	40.68	(D)	19.	Jamaica (5)	12.88
(D)	20.	Antigua & Barbuda (1)	38.00		20.	Guatemala (1+)	12.80-
(D)	21.	St Vincent/Grenadines (2)	35.99		21.	Swaziland (1)	12.60
	22.	Honduras (4)	34.82		22.	China (2)	10.96
*	23.	Yemen, P D Rep (4)	29.05	*	23.	Mauritania (4)	10.28
(D)	24.	St Kitts & Nevis (1)	28.00	(D)	24.	Mauritius	10.17
*	25.	Afghanistan (6)	27.10	(D)	25.	Tonga (5)	10.04
(D)	26.	Sri Lanka (3+)	25.50+		26.	Honduras (4)	8.71
*	27.	Mali (3)	22.52	*	27.	Ethiopia (7+)	8.69-
	28.	Senegal (4)	21.98	(D)	28.	Sri Lanka (3+)	8.50-
	29.	China (2)	21.92		29.	Bolivia (10)	8.42
*	30.	Niger (3+)	21.53	(D)	30.	Madagascar (2+)	8.30-
	31.	Liberia (1)	21.28	*	31.	Mali (3)	7.51
*	32.	Laos (1+)	17.98+	*	32.	Gambia (2)	7.37
*	33.	Nepal (3)	16.84	*	33.	Yemen, P D Rep (4)	7.26
(D)	34.	Madagascar (2+)	16.60+	*	34.	Bangladesh (7+)	7.19-
*	35.	Gambia (2)	14.79	*	35.	Niger (3+)	7.17-
(D)	36.	Fiji (6)	14.68	*(D)	36.	Cape Verde (2)	6.03
	37.	Algeria (1)	14.19		37.	Chile (1)	5.90
	38.	Guatemala (1+)	12.80+		38.	Guadeloupe (1+)	5.85-
	39.	Swaziland (1)	12.60	*	39.	Nepal (3)	5.61
*(D)	40.	Cape Verde (2)	12.06	*	40.	Sudan (1+)	5.56-
	41.	Martinique (2)	11.00		41.	Martinique (2)	5.50
*	42.	Botswana (6)	10.13		42.	Senegal (4)	5.50
*	43.	Djibouti (5+)	9.82+	*(D)	43.	Haiti (2+)	4.61-
*(D)	44.	Haiti (2+)	9.21+	*	44.	Afghanistan (6)	4.52
	45.	Rumania	9.03		45.	Peru (2)	4.23
	46.	Peru (2)	8.45		46.	Australia (1)	4.08
	47.	Japan (2)	7.82		47.	Japan (2)	3.91
	48.	Belize (2)	7.15		48.	Belize (2)	3.58
	49.	Italy (2)	7.08		49.	Italy (2)	3.54
	50.	Chile (1)	5.90		50.	Rumania (3)	3.01

* Least Developed Country
(D) Island Developing Country
\+ Could be higher, depending on missing information on individual disasters
\- Could vary, depending on missing information on individual disasters
(n) Number of significant events which occurred during the period 1970-1989
(E) Estimate uncertain but greater than 100
Source: Preliminary Study on the Identification of Disaster-prone Countries, Based on Economic Impact; UNDRO, January 1990.

Notes

1. Tiffen Mary et al. (1993), *More People, Less Erosion: Environmental Recovery in Kenya*, Wiley, Chichester.
2. Coburn, A and Spence, R. (1992).
3. Sivard, Ruth Leger (1991), *World Military and Social Expenditures* World Priorities, Washington, DC.
4. It should be pointed out that several countries in Table 4 have high indices on the basis of only one "significant" disaster event during the period, namely Montserrat, Cook Islands, St. Kitts/Nevis, Algeria and Liberia.

Annex 4

Selected Documentation

The following are a selection of publications and contact points for those wishing to find out more detailed information on the subject of disasters and disaster mitigation. The list is not intended to be comprehensive and the inclusion of particular documents or contact points is not meant to indicate that they are being recommended over other documents or contact points not listed.

General texts on disasters and disaster mitigation

Asian Development Bank (1991), *Disaster Mitigation in Asia and the Pacific*. ADB, Manila.

Alexander, David (1993), *Natural Disasters.* UCL Press, London.

Carter, Nick (1992), *Disaster Management: A Disaster Manager's Handbook*. Asian Development Bank, Manila.

Cuny, Frederick (1983), *Disasters and Development.* Oxford University Press, New York/Oxford.

UNDRO (1991), *Mitigating Natural Disasters: Phenomena, Effects and Options*, New York/Geneva.

Kreimer, Alcira and Munasinghe, Mohan (eds) (1991), *Managing Natural Disasters and the Environment.* World Bank, Washington, DC.

Maskrey, Andrew (1989), *Disaster Mitigation: A Community Based Approach*. Oxfam, Oxford.

Texts on specific disaster types or aspects of disasters

Drought

Borton, J. and Nicholds N. (1991), *UN Disaster Management Training Programme Drought and Famine Module.* Overseas Development Institute, London.

Wilhite, Donald (ed.) (1993), *Drought Assessment, Management and Planning: Theory and Case Studies.* Kluwer Academic Publishers, Boston/Dordrecht/ London.

Economic impacts and insurance

Albala-Bertrand, J.M. (1993), *The Political Economy of Large Natural Disasters*, Clarendon Press, Oxford.

APO-Asian Productivity Organisation (1991), *Agricultural Insurance in Asia. Planning and Practices.* Tokyo.

APO-Asian Productivity Organization (1987), *Crop Insurance in Asia.* Tokyo.

Benson, C et al. (1993), *The Impact of Drought on Sub-Saharan African Economies: A Preliminary Examination*. Paper prepared for a Work-in-Progress Seminar, The World Bank, ODI, London.

Giarini, O. (ed). (1984), *The Geneva Papers on Risk and Insurance*. Geneva Association, Geneva.

UNCTAD (1990), *Statistical Survey on Insurance and Reinsurance Operations in Developing Countries 1984-86*. UNCTAD, Geneva

Vulnerability

Anderson, Mary and Woodrow, Peter (1989), *Rising from the Ashes: Development Strategies in Times of Disaster*. Westview/UNESCO, Boulder, CO/Paris.

Borton, J. and Shoham, J. (1991), *Mapping Vulnerability to Food Insecurity: Tentative Guidelines for WFP Country Offices.* Study commissioned by the World Food Programme. Relief and Development Institute, London.

Chambers, Robert (1989), *Vulnerability, Coping and Policy: Editorial Introduction, IDS Bulletin 20(2)*, Institute of Development Studies, Brighton, Sussex.

Downing, Thomas (1991), *Assessing Socio-Economic Vulnerability to Famine: Frameworks, Concepts andApplications*. FEWS Working Paper 2.1. AID Famine Early Warning System, Washington, DC.

Earthquakes

Coburn, A. and Spence, R. (1992), *Earthquake Protection.* John Wiley and Sons, Chichester and New York.

Food security

Drèze, Jean and Sen, Amartya (1989), *Hunger and Public Action.* Oxford University Press, Oxford.

World Bank (1991), *Food Security and Disasters in Africa: A Framework for Action* (mimeo). Food Security Unit, Africa Technical Department, Washington, DC.

Journals/Annual reports

World Disasters Report 1993. International Federation of Red Cross and Red Crescent Societies. Martinus Nijhoff, Dordrecht.

Disasters: the Journal of Disaster Studies and Management, Blackwells/Overseas Development Institute, United Kingdom (a quarterly journal began publication in 1977).

STOP DISASTERS (a free newsletter published six times a year on behalf of the IDNDR Secretariat, Palais des Nations, CH 1211 Geneva 10).

Training courses

UN DMTP - DHA-UNDRO, Palais des Nations, Geneva, Switzerland.
ADPC - Asian Institute of Technology, PO Box 2754, Bangkok 10501, Thailand.
PAHO, 525 Twenty-Third Street NW, Washington DC 20037-2895, United States.