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Chapter 14

Disaster risk reduction: Practical adaptive options

Introduction

This chapter puts the issue of disasters into the broader perspective of the management of natural resources for sustainable development.

In contrast to economic vulnerability, which is mainly inherent in small and island states, some aspects of environmental and human vulnerability to disasters can be prevented by local and by international action. This chapter argues that reducing vulnerability and increasing the resilience to environmental risks, however, should involve a comprehensive assessment of likely political and economic impacts: options in the use of scarce resources and the relative returns on investment, against other choices for improving welfare.

The relative impact of disasters is compared with other causes of death and environmental damage such as road traffic accidents, war and personal violence, with the issue of disasters set within the context of public policy choices. This chapter examines the strategic approaches being developed for assessing the vulnerability of countries in the Pacific and the Caribbean regions to common disaster risks, the work of the UN International Strategy for Disaster Reduction (UNISDR) and the UN-endorsed Hyogo framework for policy and action in this field.

The scope of disaster risk reduction

Risk is defined by ISDR[1] as the probability of damage or loss resulting from the effects of hazards on human life and the environment. Risk in a country may be expressed by the equation:

[2]Risk = Hazards × vulnerability/capacity for effective response

This equation defines risk in terms of the multiple of the hazards and vulnerability of a country to them, per unit capacity for effective response (other things being equal). Technically, this equation defines risk as the slope of the curve of the multiple of hazard and vulnerability – which might be termed effective exposure – to effective response capacity. Thus risk increases as the frequency and strength of hazards increase; as the vulnerability to them increases, and as the capacity for effective action diminishes. The management challenge is to reduce risk by cost-effective measures and by avoiding disproportionate responses. This task can be approached by:

- assessing a hazard;
- taking cost-effective action to reduce vulnerability; and
- increasing capacity for effective action to respond to the hazard.

Risk analysis provides an assessment, for a country or location, of the probability of the impact of hazards, having regard to vulnerability or exposure and adaptation to expected effects. Impact is the measure of those effects, that is, the actual loss resulting from the disaster. Risk assessment is subject to uncertainty and the limitations of information and knowledge, and may not accurately predict the impact of a disaster. Risk assessment is also subject to the variability of other factors, which are not included in the risk equation, but which may not comply with the assumption of remaining constant. Hence 'other things' may not remain 'equal'. For example, external to the risk equation is the population variable. The impact of risk may change as the size of the population exposed to it changes and as the environment changes in response to population change. In SIDS if the population on the sea coast increases, for example through tourism, then the adverse impact of the risk of a tsunami or sea surge is likely to be increased, although the defined risk of the event may remain constant.

The effect of the combination of increased sea-coast tourism and sea level rise, through Climate Change, for example in the Maldives, will have the combined effect of raising both the risk and the potential adverse impact on life, property and the natural environment on which tourism depends. Thus policy and management approaches to disaster risk reduction must take into account a wider range of factors than are evident from the simplified equation of risk above.

Disaster risk management

Using the risk equation, Table 14.1 shows a range of activities that disaster risk reduction can embrace:

- Reduce the frequency and strength of hazards
- Reduce vulnerability to such hazards
- Increase capacity for effective response

In exploring the relevant and most cost-effective action to take to reduce disaster risks, it is necessary to be more precise about the definition of these phenomena and the potential risk reduction measure (see Box 14.1).

Whilst for the factors giving rise to the economic vulnerability of small states and SIDS are inherent, not all their risks of environmental disasters arise from inherent vulnerabilities. Some disasters can be avoided entirely, whilst vulnerability to others can be substantially reduced. However, in all cases the strategic resilience of small and island states can be improved.

It is evident that natural hazards such as volcanoes and tsunamis that give rise to some natural disasters present potential risk to people and environments in their pathway. The vulnerability of countries to these hazards can be reduced, however, by not placing social and economic infrastructure in the path of such natural hazards and by designing and building structures that reduce, rather than augment, any adverse impacts.

Table 14.1. Activities for disaster risk reduction

Objectives	Activities
Reduce the frequency and strength of hazards	• Reduce emissions of greenhouse gases. • Reduce the power levels in electrical cables. • Regulate the number of locations of hazardous industrial premises and processes. • Reduce the use and number of military landmines.
Reduce vulnerability to hazards	• Provide protective barriers, danger signs and set-back controls against the hazards of sea surges, flooding and exposure to hazardous chemicals. • Provide protective clothing and safe procedures for workers and others exposed to hazards. • Develop fail-safe designs for hazardous processes (braking systems, ejector seats, parachutes and life jackets). • Provide early warning systems for evasive action to reduce the exposure to approaching hazards.
Increase capacity for effective response	• Increase capacity for rescue of the environment, property and people from the impact of hazards. • Improve emergency support and relief to mitigate effects of immediate impact. • Extend capacity for repair and rehabilitation of the environment, property and people after the impact of hazards. • Increase long-term rehabilitation, evaluation and reinforcement of capacity for resilience and risk reduction.

Box 14.1. Key terms in Disaster Risk Management

We may define the key terms in this field in the following way:

A **disaster** is an event or series of events causing significant impact on the natural environment, adversely affecting normal human activities, and causing sudden loss which may exceed the capacity of the local community resources to effectively respond in the rescue and rehabilitation of people and systems affected. Examples of disasters include the tsunami of 2004/5 in the Indian Ocean causing widespread loss of life and damage to many communities from Sri Lanka to the Maldives and the Seychelles; Hurricane Katrina which in 2005 devastated New Orleans in the USA and adjacent communities and territories; and forest fires in Greece in 2007 which caused death and injury to the resident population and widespread property damage. Disasters also include man-made events such as marine oil-spills, industrial fires, meltdown of nuclear reactors, shipwrecks and airplane crashes.

A **hazard** is an identified object, activity, process or event that could give rise to injury or damage to people or the environment. Hazards may arise from natural phenomena such as submerged rocks or icebergs at sea, volcanoes and avalanches, or from human activities, such as dangerous sports or industrial processes, from military activity such as the laying of explosive landmines, from built infrastructures such as high-power electrical pylons, and unguarded coal mines and quarries. Hazards may be classified in terms of their location, level of risk, strength, frequency and potential for causing loss and damage.

Disaster risk reduction is action taken to reduce the frequency and strength of hazards and to reduce the vulnerability of people and the environment to those hazards.

Disaster risk management is the process of policy development and decision-making to lessen the risks and impact on people and the environment of hazards of natural and other disasters. This may be based upon a conceptual framework of those elements considered most critical in producing adverse impacts of disasters and the most cost-effective measures for prevention, preparedness, adaptation and mitigation of the consequences.

Impact is the resulting loss from an event, such as a disaster, in terms of its adverse effect on people, property and the environment. The impact may be expressed in terms of physical effects (numbers of deaths, injuries, jobs lost, homes, workplaces and communities affected, buildings and roads destroyed or damaged); or it may be expressed in economic terms using monetary values of the losses incurred. In comparing economic losses from disasters in different countries, account should be taken of the inter-country differences in the values placed on losses of life, property and the environment, which may largely reflect differences in the wealth of countries, rather than the relative size of the physical impact of the disaster.

Resilience is the capacity to recover from shocks (from the Latin *to leap back*). It has been explored from an economic perspective with respect to small states[3] Briguglio and his colleagues defined economic resilience in three dimensions as the ability of an economy:

a to recover quickly;
b to withstand shocks; and
c to avoid shocks.

The concept of resilience, in this approach, is seen as a nurtured capacity, whilst vulnerability is considered inherent.

Environmental resilience is similarly the capacity to respond to ecological shocks. Professor Albert Binger, of the West Indies University department of environment and development '(WSSD 2002), has argued that SIDS are inherently vulnerable in so far as they depend upon the unsustainable use of non-renewable natural resources' and are exposed to natural disasters; their resilience depends upon developing alternative economic structures which reduce their capacity to exploit non-renewable natural resources and invest in environmental regeneration. Resilience includes the development of effective responses to disasters including search and rescue, rehabilitation and evaluation to provide improved risk assessment, education, skills training, early warning systems and preparedness.

Risk analysis is concerned with the assessment of the nature and extent of risk, the probability that an adverse event might occur, the factors that affect that chance and their environmental and human consequences. The function of risk analysis is to identify the nature of risks, their potential economic, social and environmental impact, people's perception of risk, how society can manage risk, and the role of analytical techniques, such as economics, in illuminating such questions. There are four components to risk assessment and its analysis: hazard identification; dose-response estimate; exposure assessment; and risk characterisation (which includes safe exposure levels, acceptable risk level, uncertainty, and data limitations). The process of risk analysis reviews the technical features of hazards (location, intensity, frequency and probability), the physical and social extent of vulnerability, and the capacity for prevention, mitigation, adaptive response and rehabilitation in relation to potential impact.

Vulnerability is the extent of exposure to attacks or harm. Briguglio et al. (2006), define economic vulnerability as '*exposure to external shocks arising from intrinsic features of the economy, measured by economic openness, export concentration, and dependence on strategic imports*'. The index developed from this approach has been used in conjunction with an index of **resilience** to map the responsiveness of countries to varying levels of intrinsic vulnerability. Briguglio's work on economic vulnerability arose from a 1995 UN call for the development of a vulnerability index as part of a programme of action in small states. In parallel, the UN called for the development of an index of ecological vulnerability, especially to track the impact of disasters, but this approach was frustrated by lack of adequate data from enough countries.

Social and environmental vulnerability is the condition of being exposed and susceptible to loss and damage from natural and other hazards. The level of exposure is affected by isolation and the location, frequency and extent of hazards. Vulnerability may be lowered by providing protection against known hazards or removing vulnerable environmental elements from their path. Risk can be further mitigated by adaptation and by building up capacities that can reduce the extent of loss and damage and achieve rapid response, rescue, and recovery.

Sea walls can protect coastlines, property and people from sea surges. But if they are not well designed they can cause unexpected environmental and human loss that might have been better avoided by set-backs. Concrete houses that are destroyed in an earthquake may cause more damage to people and the environment than the straw houses they replaced. In California and Japan, buildings have been designed to withstand the impact of certain defined levels of earthquakes; but if poorly built, they may give rise to a greater loss of life or property. Bridges are commonly designed to withstand excessive loads from heavy traffic and from wind and water pressure, but their performance may critically depend on standards of construction and maintenance[4]. Moreover certain types of environmental hazard can be caused or accentuated by human activity such as those arising from climate change, global warming, sea-level rise, desertification, land and air pollution. In addition to the human enhancement of the potential risk of natural hazard, disasters can be the result of entirely man-made hazards. These include, for example, nuclear accidents and marine oil spills.

Types of risk and responsiveness to them

Table 14.2 sets out a stylised classification of the state of countries in the face of the risks of certain disasters and their capacity for risk reduction. It can be seen from this that countries differ in their responsiveness to similar risks. Countries may be broadly classified in terms of their responsiveness to risk as in Tables 14.2 and 14.3. For example, Mauritius has a low risk from cyclones but this has been achieved not because of low levels of exposure but because it has achieved high resilience and protection from their impact. Exposure to hazards remains high but the capacity for effective response through prevention, mitigation and rehabilitation has been highly developed. Thus, the impact of cyclones in Mauritius is low by comparison with Madagascar. In the latter case, the risk ishigh, arising from both elevated levels of hazards and exposure to them and from the low level of response. In the hypothetical kamikaze case of 'Cona', the risk of flooding has been made worse by locating increasing numbers of people in the low-lying areas.

Table 14.2. Stylised risk analysis by disaster type and country capacity for resilience

Disaster type	Nature and extent of risk	Probability/ frequency	Physical/ social vulnerability	Capacity for prevention, mitigation, rehabilitation	Expected impact	Vulnerability/ Resilience type
Mauritius Cyclones	Low	Some every year	High	High	Low/ Medium	Self made
Madagascar Cyclones	High	Many every year	High	Low	High	Catastrophic
Mauritius Malaria	Low	Rare imported cases	High	High	Very low	Self made
Comoros Malaria	High	Endemic	High	Low	High	Catastrophic
Mauritius Volcanoes/ earthquakes	Low	Rare	Low	High	Very low	Best case
La Réunion Volcanoes	High	Every ten years	High	High	Low	Self made
Maldives Sea surges and sea-level rise	High	Frequent	High	Low	High	Catastrophic
"Cona" Flooding	High	High	High	Low	High	Kamikaze
Nuclear power plant accident in SIDS	None	Zero	High	Low	Zero	Not relevant
Marine oil spill accidents IOC islands	Low	Low	High	High	Low	Self made

Table 14.3. Vulnerability and capacity for resilience

Vulnerability	Resilience	
	Low resilience	*High resilience*
High vulnerability	Class 1	Class 3
	Catastrophic/worst case	Self made
Low vulnerability	Class 2	Class 4
	Kamikaze	Best case

Mauritius can thus be classified as a class 3 or 'self-made' state (see Table 14.3) with high vulnerability and high resilience. Madagascar can be classified as a 'catastrophic state' with high vulnerability and low resilience. The challenge of management is to steer Madagascar towards the 'self-made' state by increasing its capacity for effective response to hazards and lowering its vulnerability to them.

Table 14.2 also says that while the IOC islands[5] have a high vulnerability to marine oil-spills, they have developed an effective regional response which provides protection through prevention and rapid response measures.

The worst case scenario is stylised for the hypothetical island state of 'Cona', which is subject to the hazard of flooding and has made itself more vulnerable to this hazard by locating an increasing number of people in flood-risk areas and failing to provide protection for them.

Potential for risk reduction

Table 14.4 sets out examples of the potential for disaster risk reduction in the face of a range of recognised hazards. For some hazards certain interventions are not relevant. For example, cyclones, tsunamis and volcanoes are largely inescapable hazards; whereas the risks of malaria, desertification, marine oil spills, nuclear power accidents and some aspects of climate change are susceptible to hazard prevention or limitation.

In the face of desertification, search, rescue and emergency treatment are less relevant for risk reduction than hazard reduction and the building of strategic resilience. By contrast, sea surges may not be avoidable, but the repair and maintenance of sea walls and flood defences are vital to reduce exposure. Together with search and rescue they reduce the risk and the impact on people, property and the natural environment in the face of an inescapable hazard.

Table 14.4 shows that in the case of the risk of man-made disasters, such as accidents in nuclear power plants and marine oil spills, the full range of management responses is relevant from prevention, reduction of exposure, rescue, rehabilitation and the building of strategic resilience through education, skills development and infrastructure investment

Table 14.4. Potential for risk reduction

Disaster type	Potential for action on risk reduction					
	Reduce hazard	Early warning protective	Search and rescue	Emergency support and	Repair and rehabilitation	Strategic resilience reinforcement
Cyclones	✘	✔	✔	✔	✔	✔
Malaria	✔	✔	✔	✔	✘	✔
Desertification	✔	✘	✘	✘	✔	✔
Volcanoes	✘	✘	✔	✔	✔	✔
Tsunamis	✘	✔	✔	✔	✔	✔
Climate change	✔	✘	✘	✘	✔	✔
Sea surge flooding	✘	✔	✔	✔	✔	✔
Nuclear power plant accident	✔	✔	✔	✔	✔	✔
Marine oil spill	✔	✔	✔	✔	✔	✔

Impact of disasters

Economists approach disaster risk reduction by considering both the cost of resources required for intervention and the opportunity cost of using those resources for such intervention rather than for alternative uses. The concept of opportunity cost thus embraces the issue of the choice of investment in one type of action compared with another and the loss arising from not using resources for a more cost-effective intervention.

Disasters are characterised by their infrequency and their confined location, whereas other classes of events causing death, injury and environmental damage, like road traffic accidents, tend to be frequent and widely scattered. This paradoxically makes each road accident less newsworthy[6] and less the subject of sharply focused risk reduction measures. Thus the impact of each road accident tends not to give rise to review of public policy or programmes, despite the fact that the cumulative impact of road accidents results in more deaths than the impact of individual disasters.

Box 14.2, Table 14.5 and Figure 14.1 provide a perspective on the impact of a major tsunami in the Indian Ocean in 2004–5, a major hurricane that hit the southern states of the USA in 2005 and other significant disaster events in the past four decades.

Box 14.2. Disaster alert 2005

The impact of the tsunami of December 2004 in the Indian Ocean and hurricane Katrina in the western Atlantic went far beyond immediate catastrophic damage, which was immense in both cases. It raised fundamental questions about how far countries are adequately prepared for avoiding the worst impact of such major events.

Following the 2005 UN SIDS Mauritius conference, two substantial international reviews on disaster risk management were produced[7] which built on strategic work undertaken

through the UNISDR, whose aim is to reduce losses from disasters. A number of SIDS contributed national reports to the process of development of the Hyogo Framework for Action[8] which emerged from this work in 2005 and which is based on an integrated approach to hazard and risk assessment and capacity building for emergency preparedness, response and recovery.

Investment in safety normally progresses through statutory regulation and insurance requirements, which are usually re-formulated following notable disaster events. The standards adopted in both regulation and insurance cover transport, buildings and infrastructure standards and include regulations and licensing procedures for the design, manufacture and registration of aircraft, ships, trains and road vehicles, and safety standards for buildings covering robustness, safety protection, escape and rescue.

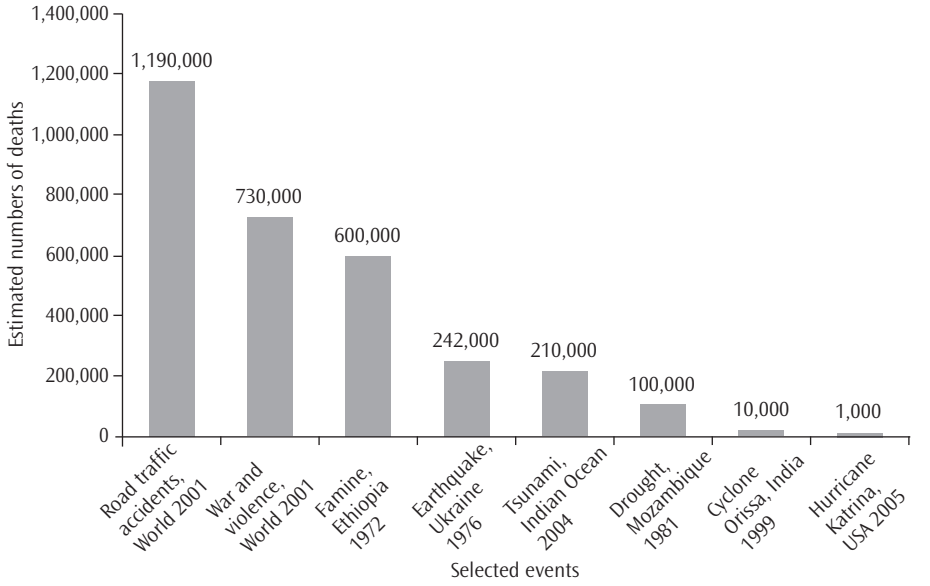
Against this background it is reasonable to ask: why is it that the preparedness and mitigation whichis now emerging as rational policy was not adequately incorporated into statutory regulations or insurance requirements before the tsunami and the hurricane disasters? Why were so many people vulnerable to the tsunami? Why were there no early warnings for bathers? Why were the hotels not set back from the sea? Why were the buildings not built to a standard to withstand the battering? What can now be done for rehabilitation and preparedness in case of another such event? In the case of hurricane Katrina, there was plenty of warning, both accurate and timely, but people are asking why were so many people vulnerable? Why were the levees (the flood barriers) not built to withstand the worst-case scenario? Why were so many people not evacuated by public transport? Why were emergency services not standing by to rush in water, food and security? Such questions are generally explored in post-hoc enquiries (see Table 14.5).

Table 14.5 provides a summary of the impact of the tsunami of December 2004 and what emerged from the impact of Katrina. The local inquiries following these events have set out the mitigating measures that could have reduced the damage and saved many lives and the means and the costs of implementing such measures in the future. The international strategic reviews re-examined the broader questions of intergovernmental preparedness and response. They built on the lessons evident from these two most recent case studies of how nature can overwhelm the coping capacity of even the richest of countries.

For the AIMS countries[9] the range of disaster hazards and risks are wide and varied. They include droughts, floods, wind storms, locusts, volcanoes, earthquakes, oil-spills, landslides and forest fires and the intense cross-boundary smoke clouds arising from them. Action taken by countries has been summarised in the 2004 AIMS Synthesis Report on progress with the Barbados Programme of Action[10], but further review is being undertaken to fill in the gaps in the information for region-wide learning from country experience.

Investing in risk reduction and better safety measures against inescapable natural events needs to be set within a broader framework of the relative costs and benefits of saving life, injury and damage to property and the environment, through risk management as a whole. Global figures of deaths from road accidents, armed conflict and inter-personal

Figure 14.1. Disasters, accidents and injury, deaths from selected events 1972–2005



Sources: UNISDR and WHO

Table 14.5. The costs of the 2004 tsunami, hurricane Katrina and future investment for disaster management

Impact and costs	2004[11] Indian Ocean Tsunami	2005 Hurricane Katrina Western Atlantic
Deaths	170,000–250,000	1000
Emergency relief and rehabilitation	US$3 billion[12]	US$200 billion[13]
Mitigating action against future events	• Early-warning systems and communications • Evacuation plan • Rapid rescue and emergency response • Building setback • Beach protection • New building standards	• More effective evacuation of poor, elderly and sick • Strengthening of flood protection • Rapid rescue and emergency response • New building standards and physical planning

violence outweigh the impact of natural disasters (see Figure 14.1). In this context, it is worth noting that WHO estimates that the introduction of seat belts in passenger cars in the USA cost US$1,406 per life saved, and that the US savings from the use of safety helmets by motorcyclists exceed the costs by US$23 million a year[14]. Such assessments of cost-effectiveness are becoming a standard issue in public policy, always bearing in mind the opportunity cost of not protecting life and property more cheaply in alternative fields of action.

Relative impact from disasters and from other fatal risk factors

Table 14.6 shows the relative impact at national and regional levels of disasters compared with other risk factors that give rise to fatal injuries, including road traffic accidents, inter-personal violence, fires and war. It can be seen that in each case the death toll from road traffic accidents and from inter-personal violence is greater per million of population in each of the regional strata of which the countries are part, than the national death toll from disasters. The hurricane Katrina disaster of 2005 killed about 1,000 people; the annual death toll from road traffic accidents in North America is about 50,000. Annual deaths from violence per million of population in the UK and the USA are respectively 24 and 50 times greater than deaths per million of population from disasters.

Social vulnerability and disaster risk reduction in SIDS

In assessing the impact of any adverse event, it is necessary to consider the social economic impact as well as the impact on the natural environment. Whilst road traffic accidents are frequent, with an immediate loss of life and injury and vehicle damage, much of this is subject to legally enforced insurance cover and rapid emergency response, treatment and repair. Special features of many natural disasters are their large-scale impact, logistical difficulties in rapid emergency response, gaps in insurance cover, and the long-run impact on social and economic activity and on the environment. This may include not only damage to property, to social and economic systems, but also adverse effects on water and sanitation systems, agriculture, woodlands, natural habitat, biodiversity and ecological systems. For SIDS, aspects of ecology linked to social and economic systems may be affected, including beaches, coral reefs, inshore fishing and aquaculture, and protected marine and coastal areas.

Table 14.6. Relative impact from disasters and other selected risk factors: Deaths per million population per year, national and regional figures

Country	Disasters[15]	Road traffic accidents[16]	Violence	War	Fires
Venezuela	67	178	274	18	9
Turkey	16	100	36	9	14
Vietnam	12	179	41	2	12
Tajikistan	4	100	36	9	14
USA	1	149	58	9	12
UK	0.2	114	10	2	7
Median values	8	131	38	9	13

Source: WHO (2008) World Health Report, Geneva

International policy on disaster risk reduction

Disaster risk-reduction policy has been a process of development through the UN and its agencies supporting and enhancing regional and national efforts. The 2002 World

Summit on Sustainable Development gave special attention to this field and the 2005 UN SIDS Conference, through the Mauritius Strategy, further promoted policy development and the improvement of risk programmes.

The WSSD policy called for countries and regional organisations to support SIDS in developing 'comprehensive hazard and risk management, disaster prevention, mitigation and preparedness, and help relieve the consequences of disasters, extreme weather events and other emergencies'[17]. This commitment followed on from the recognition promoted by the UN Disaster Relief Organisation in 1990 that the economic impact of disasters over the previous 20 years revealed that more than half the disaster-prone countries were SIDS. Further, the FAO had found that SIDS were prone to extremely damaging cyclones, storm surges, volcanic eruptions, earthquakes, forest fires, extended drought and extensive floods[18].

Immediately after the 2005 UN SIDS Mauritius Conference the UNISDR at Kobe agreed with member countries the Hyogo Framework for action on disaster reduction (see Box 14.3). These policies remain the theme for international development in this field, although there are significant gaps in evidence about best technical practices for dealing with each type of hazard in different locations and communities and the cost effectiveness of intervention. Recent work by the World Bank, the UNISDR – which has itself been

Box 14.3. Extract from the 2005 UN SIDS Mauritius Strategy

Natural and environmental disasters

19. Small Island Developing States (SIDS) are located in the most vulnerable regions in the world in relation to the intensity and frequency of natural and environmental disasters and their increasing impact, and face disproportionately high economic, social and environmental consequences. The tragic impacts of the 26 December 2004 Indian Ocean earthquake and tsunami and the recent hurricane/cyclone/typhoon season in the Caribbean and Pacific highlight their vulnerability. SIDS have undertaken to strengthen their respective national frameworks for more effective disaster management and are committed, with the necessary support of the international community, to:
    - **a** Strengthen the International Strategy for Disaster Reduction and related small island developing states regional mechanisms as facilities to improve national disaster mitigation, preparedness and early-warning capacity, increase public awareness about disaster reduction, stimulate interdisciplinary and intersectoral partnerships, and the mainstreaming of risk management into the national planning process.
    - **b** Use opportunities such as the 10-year review of the Yokohama Strategy on Natural Disaster Reduction, including the programme outcome for 2005–2015 of the World Conference on Disaster Reduction, to be held in Kobe, Japan, in January 2005, to consider the specific concerns of small island developing states, including issues relating to insurance and reinsurance arrangements for small island developing states.
    - **c** Augment the capacity of SIDS to predict and respond to emergency situations, including those affecting human settlements, stemming from natural and environmental disasters.

undergoing major reforms in its strategy and structures – and regional organisations, especially in the Pacific and Caribbean SIDS regions are throwing light on these issues[19].

Response systems in SIDS

In the Pacific islands, many of which are low lying and very isolated, a regional response system – The Comprehensive Hazard and Risk Management system (CHARM) – has been designed as a tool for integrated disaster risk reduction. The Pacific SIDS have fragile ecosystems with many populated coastal low-lying areas especially vulnerable to extreme weather conditions, and the potential of sea-level rise from climate change[20]. For these reasons, Pacific SIDS are committed to the implementation of development projects to reduce risks to people, property and the environment. They have strengthened their national and regional resilience to hazard impacts. The historical record of specific disaster-reduction initiatives also shows that Pacific island states have adopted positive approaches in both traditional and more contemporary ways to enable Pacific islanders to maintain a respect for their chosen cultural values.

In the Caribbean, the Caribbean Hazard Mitigation Capacity (CHAMP) has been developed. CHAMP provides a means for making assessments of the critical infrastructure facilities that may be vulnerable to extreme events. It provides hazard-specific maps covering a variety of critical facilities such as power generation, water and sanitation, waste management, public buildings, fire and emergency services, schools and hospitals. The assessments identify the value of probable maximum loss reflecting topography, design, building practice, materials and condition. The results of the assessments are used to prioritise investment in capacity building for resilience.

In the Maldives, community awareness of vulnerability is common. The islands were severely affected by the tsunami of 2004 losing over 70 lives, and suffering extensive flooding and loss of vital infrastructure facilities and damage to water and sanitation systems. It was estimated that the Maldives would need 10 years or more to recover from these adverse effects. To prevent hazards such as severe storms and waves from becoming future disasters, local communities and NGOs are working together planting trees on the beaches and constructing sea walls to prevent beach erosion. This has helped to reduce the impact of waves on the islands but proved insufficient to withstand the impact of the tsunami in 2004 (see UNISDR 2004 p.186)[21].

ISDR reports that there is considerable geographic variation in the occurrence and impact of natural hazards in the last decade. Asia was affected by approximately 43 per cent of all natural disasters and accounted for almost 70 per cent of all lives lost due to natural hazards. During the two El Niño periods of 1991–92 and 1997–98, floods in China alone affected over 200 million people in each period. Nevertheless, in relative terms, Africa is the most heavily affected region, per capita, especially when drought, epidemics and famine are considered. The special aspect of risk associated with SIDS is the limited area of refuge for escaping from the immediate effects of disaster. The largest island in the Maldives is smaller than Heathrow airport and the highest point is less than 2 metres above sea level.

Environmental sustainability and disaster risk reduction

The 10th Special Session of the Governing Council/Global Ministerial Environment Forum of the UN in Monaco in February 2008 reviewed progress on the environmental impact of disasters and progress with disaster risk reduction across the world. The Council acknowledged that the various strategic policy initiatives through the UN, including the:

- Millennium Declaration,[22]
- Millennium Ecosystem Assessment,[23] and
- Hyogo Framework for Action[24]

have different perspectives but that environmental degradation, poverty and disaster risk share common causal factors as well as common impacts on security and welfare. The Council accepted that better environmental services, management, and information offer opportunities to reduce risk, decrease poverty and achieve more sustainable development.

The Council asserted that '*healthy ecosystems provide natural defences, wetland ecosystems for example function as natural sponges that trap and slowly release surface water, while mangroves, dunes and reefs create physical barriers between communities and coastal hazards. Conversely, degraded ecosystems reduce the coping capacities of communities and social systems. Disaster recovery processes need to take the state of ecosystems and ecosystem services into account*'.

Conclusion

Disaster risk reduction is the focus of international, regional and national concern in sustainable development strategy and management. Policy frameworks in this field have been the focus of increasing UN commitment for decades and have been elaborated in relation to the special risks for SIDS, other small states and low-lying countries. This concern has been amplified following the growing threats of climate change and sea-level rise, to which many SIDS are seriously exposed. The 2004 tsunami in the Indian Ocean and the 2005 hurricane Katrina in the Caribbean and in the Southern USA promoted further international deployment of resources in the analysis of risk, the rehabilitation of people, property and the environment, and the call for better information, management and preparedness, including effective early-warning systems. This chapter has reviewed the evidence of the relative costs of disasters compared with other hazards to life, property and environment and has identified the need for greater attention to evidence-based policy, the better assessment of risk and more thorough evaluations of the cost effectiveness of intervention.

Further reading

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Strachan, J. et al. (2005). *The Plain Language Guide to the World Summit on Sustainable Development*. London: Earthscan, p. 91.

Useful website links

United Nations Strategy for Disaster Reduction: www.unisdr.org
The Hyogo Framework for action 2005–2010, www.unisdr.org/wcdr and Hyogo Framework for Action 2005–2015: Building the resilience of nations and communities to disasters: http://www.unisdr.org/eng/hfa/hfa.htm

Notes

1 See www.unisdr.org
2 See Box 14.1 for definition of key terms.
3 Briguglio et al. (2006)
4 See www.wbdg.org/design/resist-hazards and www.unisdr.org
5 The IOC islands are Comoros, Madagascar, Mauritius, La Réunion (a Department of France), and the Seychelles.
6 Dog bites man; not news; man bites dog; front page story!
7 One by UNESCO working with the Intergovernmental Oceanic Commission and other bodies. Another has been undertaken by the Commonwealth Secretariat with particular attention to the vulnerability of SIDS working with CARICOM (the Caribbean Community), PIFS (The Pacific Island Forum Secretariat) and the IOC (Indian Ocean Commission). www.unisdr.org. 2nd Pacific regional disaster risk management meeting for Pacific CEOs of finance/planning and disaster management; Caribbean Disaster Emergency Management Agency: http://www.cdera.org 3rd Caribbean Conference on Comprehensive Disaster Management December 2008; World Bank Disaster Risk Management Team: http://web.worldbank.org/; Global Facility for Disaster Reduction and Recovery: www.gfdrr.org. The Commonwealth's effort arose from commitments made at the January 2005 UN SIDS strategy meeting in Mauritius to follow up the 2004 tsunami and levels of technical preparedness in small island developing states.
8 The Hyogo Framework for action 2005–20010, was developed through the UNISDR (UN agency for International Strategy for Disaster Reduction) in Japan in 2005. Its stated outcome

is 'the substantial reduction of disaster losses in lives and in the social, economic and environmental assets of communities and countries; see www.unisdr.org/wcdr

9 AIMS countries are UN-recognised small island developing states and low-lying states in the Atlantic, Indian Ocean, Mediterranean, and South China Seas; namely: Bahrain, Cape Verde, Comoros, Cyprus, Guinea Bissau, Maldives, Malta, Mauritius, Sao Tome and Principe, Seychelles, Singapore.

10 IOC (2004) AIMS Synthesis Report, progress on the Barbados Programme of Action. IOC for the AIMS Group, pp. 43–45.

11 www.tsunami.civil.tohoku.ac.jp/sumatra2004/report for a research-based assessment of the impact; and http://en.wikipedia.org/wiki for a review based upon news coverage.

12 The comparatively low estimate of cost in the Asian and African countries affected, contrasts with the figure for the US event and the impact of buildings, infrastructure, business and property which in the US economy are more expensive to replace; both figures are based on local estimates of costs of local labour and building materials, etc.

13 Arising from extensive property and infrastructure damage and the evacuation and subsequent need for resettlement of over 750,000 people across a territory the size of the UK.

14 WHO (2002) *Reducing the Risks, Promoting Healthy Life*. The World Health Report, Geneva: WHO.

15 National figures from Khan, M.E. (2005). 'The death toll from natural disasters, the role of income, geography and institutions', *The Review of Economics and Statistics*, **87** (2) 271–284.

16 Other figures in this table are from the regional strata in which each of the countries is located in WHO (2002), pp. 190–191.

17 WSSD 2002 Plan of Implementation, paragraph 58 (h) UN 2002 op.cit.

18 Strachan J. et al. (2005) *The Plain Language Guide to the WSSD*. London: Commonwealth Secretariat, Earthscan. p. 91.

19 See www.unisdr.org; and http://www.worldbank.org/hazards

20 See www.unisdr.org for current summaries of policies, case studies and best practices in action in SIDS and elsewhere.

21 UNISDR (2004) *Living with Risk; a global review of disaster reduction initiatives*. UN.

22 UN Millennium Declaration http://www.un.org/millennium/declaration/ares552e.pdf, Also known through the Millennium Development Goals (MDGs). See UN General Assembly Resolution 55/2, 8 September 2000.

23 UN Millennium Assessment Reports: http://www.millenniumassessment.org/en/index.aspx

24 Hyogo Framework for Action 2005–2015: Building the resilience of nations and communities to disasters: http://www.unisdr.org/eng/hfa/hfa.htm