Available online at www.sciencedirect.com

SCIENCE DIRECT®

Climate Policy 3 (2003) 233–248

CLIMATE POLICY

www.climatepolicy.com

Climate change and extreme weather events: can developing countries adapt?

M. Monirul Qader Mirza*

Adaptation and Impacts Research Group (AIRG), The Institute for Environmental Studies, University of Toronto, 33 Willcocks Street, Toronto, Ont., Canada M5S 3E8

Received 25 November 2001; received in revised form 4 February 2003; accepted 14 May 2003

Abstract

Developing countries are vulnerable to extremes of normal climatic variability, and climate change is likely to increase the frequency and magnitude of some extreme weather events and disasters. Adaptation to climate change is dependent on current adaptive capacity and the development models that are being pursued by developing countries. Various frameworks are available for vulnerability and adaptation (V&A) assessments, and they have both advantages and limitations. Investments in developing countries are more focused on recovery from a disaster than on the creation of adaptive capacity. Extreme climatic events create a spiral of debt burden on developing countries. Increased capacity to manage extreme weather events can reduce the magnitude of economic, social and human damage and eventually, investments, in terms of borrowing money from the lending agencies. Vulnerability to extreme weather events, disaster management and adaptation must be part of long-term sustainable development planning in developing countries. Lending agencies and donors need to reform their investment policies in developing countries to focus more on capacity building instead of just investing in recovery operations and infrastructure development.
© 2003 Elsevier Ltd. All rights reserved.

Keywords: Developing countries; Climate variability and change; Extreme weather events; Adaptation and adaptive capacity; Disaster management; Sustainable development; Investments; Capacity building

1. Introduction

Developing countries are vulnerable to extreme weather events in present day climatic variability and this causes substantial economic damage. On an annual basis over the past decade, developing countries have absorbed US$ 35 billion a year in damages from natural disasters. On a per capita gross domestic product (GDP) basis, this is 20 times the cost in the developed world (Freeman, 2001a). The magnitude of vulnerability varies in terms of geographical location, seasonality and exposure of population and

* Tel.: +1-416-978-6201; fax: +1-416-978-3884.
E-mail address: monirul.mirza@utoronto.ca (M.M.Q. Mirza).

1469-3062/$ – see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S1469-3062(03)00052-4

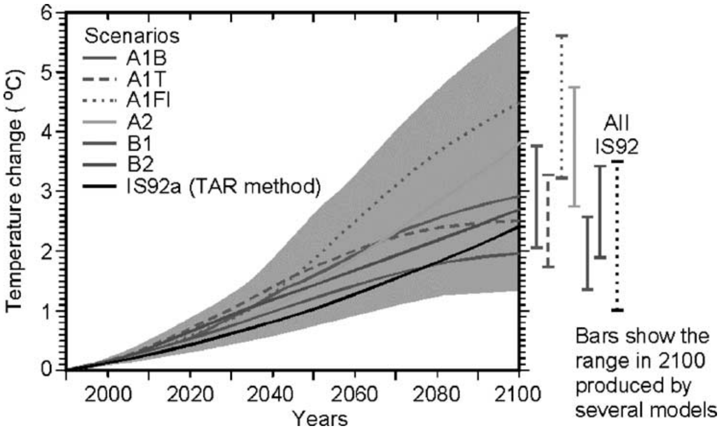

Fig. 1. Temperature increase as projected by the IPCC Working Group I for scenarios from the *Special Report on Emissions Scenarios*.

infrastructure. People who live on arid or semi-arid lands, in low-lying coastal areas, in water limited or flood prone areas, or on small islands are particularly vulnerable to climatic variability and change. Other factors include economic and social conditions, natural resource capital, political and institutional mechanisms, equity in terms of resource distribution and gender, and coping and adaptive capacity. In the future, a warming climate (Fig. 1) will influence the normal range of weather patterns for major regions of the globe (IPCC, 2001a).

The normal range of weather patterns will be influenced in two ways. *First*, there will be gradual changes in average weather patterns. Incremental changes in precipitation patterns will result in either

Table 1
Estimates of confidence in observed and projected changes in extreme weather and climate events

Confidence in observed changes (latter half of the 20th century)	Changes in phenomenon	Confidence in projected changes (during the 21st century)
Likely	Higher maximum temperatures and more hot days over nearly all land areas	Very likely
Very likely	Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely
Very likely	Reduced diurnal temperature range over most land areas	Very likely
Likely, over many areas	Increase of heat index over land areas	Very likely, over most areas
Likely, over many northern hemisphere mid-to high latitude land areas	More intense precipitation events	Very likely, over many areas
Likely, in a few areas	Increased summer continental drying and associated risk of drought	Likely, over most mid-latitude continental interiors
Not observed in the few analyses available	Increase in tropical cyclone peak wind intensities	Likely, over some areas
Insufficient data for assessment	Increase in tropical cyclone mean and peak precipitation intensities	Likely, over some areas

Source: IPCC (2001a).

Table 2
Selected impacts of climate-related extreme events in developing regions

Region	Expected regional impact of extreme events
Africa	Increases in droughts, floods, and other extreme events will add to stress on water resources, food security, human health, and infrastructure, and would constrain development in Africa (*high confidence*) Sea level rise would affect coastal settlements, flooding and coastal erosion especially along the south-eastern African coast (*high confidence*) Desertification, exacerbated by reductions in average annual rainfall, runoff, and soil moisture (*medium confidence*) Major rivers highly sensitive to climate variation: average runoff and water availability would decrease in Mediterranean and southern countries in Africa, affecting agriculture and hydro-power systems (*medium confidence*)
Asia	Extreme events have increases in temperate Asia, including floods, droughts, forest fires, and tropical cyclones (*high confidence*) Thermal and water stress, flood and drought, sea-level rise, and tropical cyclones would diminish food security in countries of arid, tropical, and temperate Asia; agriculture would expand and increase in productivity in northern areas (*medium confidence*) Sea-level rise and increase in intensity of tropical cyclones would displace tens of millions of people in low-lying coastal areas of temperate and tropical Asia; increased intensity of rainfall would increase flood risks in temperate and tropical Asia (*high confidence*) Climate change increase energy demand, decrease tourism, and influence transportation in some regions of Asia (*medium confidence*)
Latin America	Loss and retreat of glaciers would adversely affect runoff and water supply in areas where glacier melt is an important water source (*high confidence*) Floods and droughts would increase in frequency, higher sediment loads would degrade water quality in some areas (*high confidence*) Increases in the intensity of tropical cyclones would alter the risks to life, property, and ecosystems from heavy rain, flooding, storm surges, and wind damages (*high confidence*) Coastal human settlements, productive activities, infrastructure, and mangrove ecosystems would be negatively affected by sea-level rise (*medium confidence*)
Small Island States	Projected sea-level rise of 5 mm per year for the next 100 years would cause enhanced coastal erosion, loss of land and property, dislocation of people, increased risk from storm surges, reduced resilience of coastal ecosystems, saltwater intrusion into freshwater resources, and high resource costs for adaptation (*high confidence*) Islands are highly vulnerable to impacts of climate change on water supplies, agricultural productivity including exports of cash crops, coastal ecosystems, and tourism as an important source of foreign exchange for many islands (*high confidence*)

Source: IPCC (2001a). *Note*: The IPCC uses the following words to indicate judgmental estimates of confidence: *very high* (95% or higher), *high* (67–95%), *medium* (33–67%), *low* (5–33%), and *very low* (5% or less).

floods or droughts. *Second*, the increased variability of extreme weather events associated with changes in surface temperature and precipitation. The Intergovernmental Panel on Climate Change (IPCC, 2001b) has summarised the estimates of confidence of extreme events, as shown in Table 1. Increases in mean temperature and precipitation, rise in sea level and extreme weather events due to climate change would make developing countries more exposed to disasters. Table 2 summarises selected impacts of climate-related extreme events in developing regions.

Will developing countries with economic and social development limitations be able to face the challenges imposed by climate change? This paper addresses some pertinent issues related to this question. Section 2 reviews various vulnerability and adaptation (V&A) assessment strategies both currently practised and proposed. Section 3 discusses three case studies of extreme weather events drawn from different climatological and geographical contexts and the coping capacity and adaptation measures. Section 4 discusses whether developing countries can adapt to climate change in the context of present situations. It focuses on the capacity of the absorption of economic shock of a disaster and a shift in development policies to put more emphasis on capacity building than on recovery operations.

2. Vulnerability, impact and adaptation assessment strategies

V&A assessment received international momentum after the birth of the UN Earth Summit and the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 (Warrick, 2000). The UNFCCC recognises the need for adaptation to climate change, and specifies that financial assistance will be made available to "... the developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to these adverse effects" (Article 4.4 of the UNFCCC). Primarily driven by this provision for developing countries, the requirement for a guideline for V&A was felt. The IPCC quickly responded with a set of draft guidelines (Carter et al., 1994), as did the US Country Studies Program (Benioff et al., 1996) and UNEP (1998). Recently, the United Nations Development Programme (UNDP) and the secretariat of the UNFCCC also finalised two different guidelines. In effect, these guidelines present almost similar methodological frameworks for conducting climate change V&A studies or analyses, within which specific methods and models are described.

2.1. IPCC guidelines for impacts and adaptation assessment

The general IPCC (Carter et al., 1994) for conducting climate impacts and adaptations assessment contains seven steps, as shown in Fig. 2. While this framework has proven useful, it is structured mainly for determining impacts, so is subject to several weaknesses. *First*, it does not determine the vulnerability[1] of a sector or system. Diagnosis of vulnerability in terms of vulnerable elements should be the primary task for adaptation assessment in developing countries. This is because a disaster is the product of one or more hazards[2] and some affected vulnerable elements. *Second*, the framework lacks any step to involve stakeholders in the impact assessment processes. Stakeholders in a society or system could be at many levels and their realistic integration is necessary in the assessment processes and feedback system.

2.2. UNDP adaptation policy framework

UNDP (2001) unveiled a new five steps *adaptation policy framework* in the context of *present* climatic variability and extremes and future climate change (Fig. 3). It was defined as the "second generation" V&A framework as it was more focused on policy than climate science (UNDP, 2001). The "first generation" V & A was more focused on climate science. The five steps of the "second generation" framework are:

[1] Vulnerability is the degree to which a system is susceptible to cope with, adverse effects of climate change, including climate variability and extremes (IPCC, 2001a).

[2] Hazard is a threatening event that could cause loss of life or damage to property or the environment. It is measured in terms of severity, duration, quantity, intensity, toxicity or frequency (Shook, 1997).

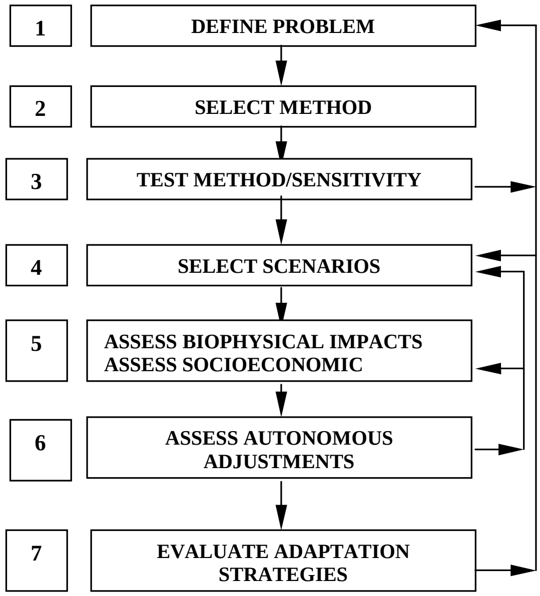

Fig. 2. The seven steps of climate impact assessment (Carter et al., 1994).

- scope the project,
- assess current vulnerability,
- characterise future conditions,
- prioritise policies and measures,
- prepare for adaptation.

This framework is a step forward from the IPCC's general framework (Carter et al., 1994) in terms of impacts to risk based assessments, but it has some limitations. *First*, one of the strong weaknesses of the framework is its one-way feedback mechanism; it only takes input from the stakeholders. It does not show how the benefits of implementation of designed policies will be distributed among the key stakeholders or the inter-dependency between the steps. *Second*, it does not show the process involved in identification of the stakeholders. It is apparent from Fig. 3 that the composition of the stakeholders is already known beforehand but this is not the case in the real world. *Third*, the framework is data hungry and the amount of data needed to carry out such an assessment is not easily available and accessible in the case of many developing countries. *Fourth*, there is a challenge in terms of maintaining a standard for such an ambitious assessment across developing countries.

2.3. UNFCCC's national adaptation programmes of action (NAPAs)

The UNFCCC has undertaken a different approach for adaptation assessment in the least developed countries (LDCs). It developed the national adaptation programmes of action (NAPAs) which was action oriented, participatory, and country driven. It established a set of guidelines for communicating urgent and immediate needs of the LDCs to adapt to climate change (UNFCCC, 2002). It argued that that the rationale for developing NAPAs rested on the low adaptive capacity of LDCs, which rendered them in need of

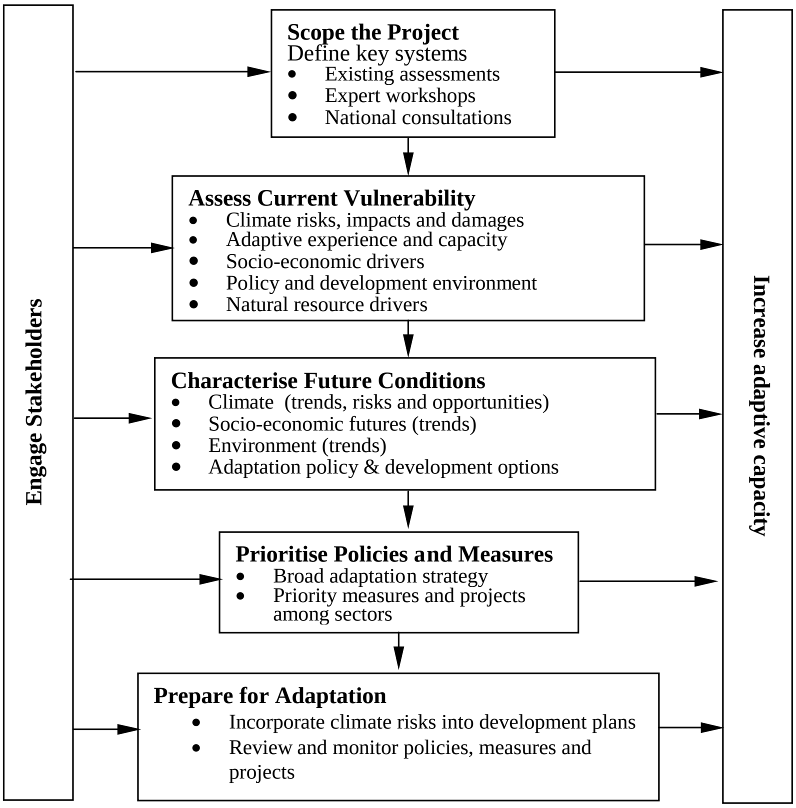

Fig. 3. The adaptation policy framework or “second generation” framework (UNDP, 2001).

immediate and urgent support to start adapting to current and projected adverse effects of climate change. It identified a set of criteria for selecting priority activities such as: life and livelihood, human health, food security and agriculture, water availability, quality and accessibility, essential infrastructure, cultural heritage, biological diversity, land management, other environmental amenities and other socio-economic factors, especially poverty. The NAPA is a four-step framework to be based on current knowledge, avoiding the whole process of formal V&A assessment.

While all three above approaches have advantages, the real challenge for the frameworks is how to integrate the concerns of climate variability and change in the national sustainable development plans. Duplication of works or waste of resources is very common in developing countries in the field of climate change. In the last 10 years, many V&A assessments were carried out in developing countries but stakeholders’ oriented adaptation assessment and action plans are still absent.

3. Extreme weather events in developing countries: coping capacity and adaptation

Developing countries are vulnerable to extreme weather events (Box 1). Over the decade of the 1990s, both the number and severity of such events increased. Comparing the figures for the 1960s and the decade of 1990s, the number of great natural catastrophes has risen by a factor of 3, with economic losses—after

Box 1. Examples of extreme weather events

Primary climatic events

- Floods (riverine, rain, storm, flash and glacial lake outburst floods, etc.).
- Droughts (hydrological, meteorological and agricultural, etc.).
- Tropical cyclones (hurricanes, typhoons, etc.).
- Heat waves or cold waves.
- Coastal storms and storm generated surges.

Secondary events (*may be climate-driven*)

- Malnutrition or under nutrition and hunger (caused by infrastructure damage, employment and equity problems).
- Outbreaks of diseases or epidemics.
- Rural and urban water shortages (may be aggravated by equity problem).
- Crop plantation failure or harvest failure.
- Landslides, mudflows and saline water intrusion.

being adjusted for inflation—rising by a factor of 9 and insured losses by a factor of not less than 15 (Fig. 4) (Munich Re, 1999). The extreme weather events have generated enormous pressure on poor economies, shattered infrastructure and made the poor more vulnerable. The following three case studies focus on vulnerability, coping capacity and adaptation of developing societies in different hydro-climatic and geographical contexts.

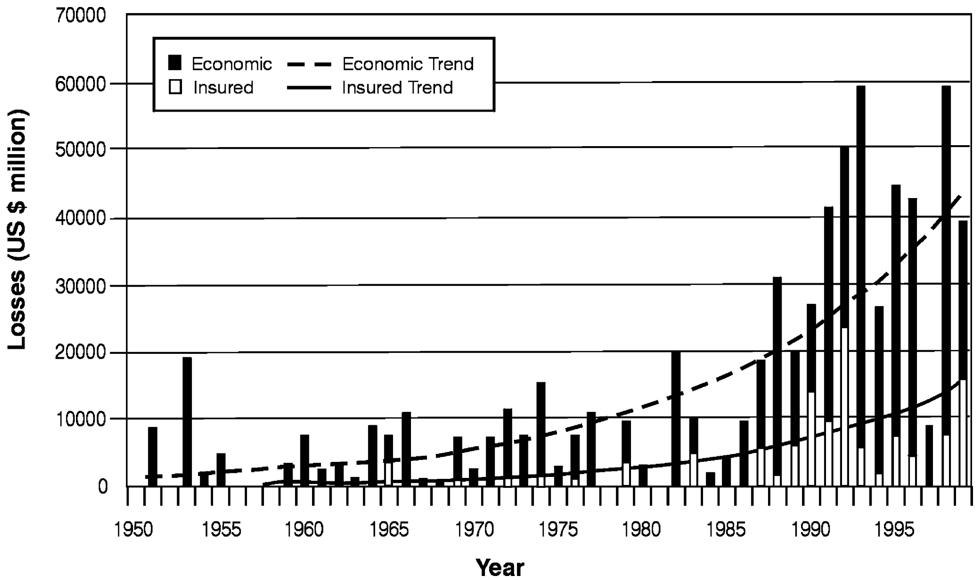

Fig. 4. Natural catastrophes and economic losses during 1960–1998. *Source*: Munich Re (1999).

3.1. Floods in Mozambique

In early February 2000, exceptionally heavy rains with a return period of 200 years occurred over Mozambique, north-eastern parts of South Africa and Zimbabwe and caused severe flooding (Smithers et al., 2001; Dyson and van Heerden, 2001). Floods in 2000 in Mozambique left a trail of devastation. The affected sectors were agriculture, infrastructure, including roads, railways, bridges and water control embankments, water intake and treatment plants and supply systems. Floods left over 700 people dead and half a million homeless. The UN World Food Programme reported that Mozambique lost at least one third of its staple food maize and 80% of its cattle. In 2001, floods destroyed thousands of homes and 27,000 ha of crops. It also affected 400,000 people, 40 people were killed and 77,000 made homeless (WSWS, 2001).

Vulnerability of Mozambique to floods has many notable dimensions. *First*, socio-economic conditions in terms of poverty and lack of development increase vulnerability. Forty percent of its population lives on less than US$ 1 a day and another 40% on less than US$ 2 (WSWS, 2001). *Second*, the debt problem is one biggest economic challenges Mozambique is now facing. Annually, the country has to pay US$ 71 million as debt repayment when it can only afford US$ 20 million on primary health care and just US$ 32 million on primary education (OCAA, 1998). *Third*, most of the floodwaters originate in the cross-border shared basin areas. *Fourth*, most of the dams in Mozambique are not multipurpose. They are only used for electricity generation, and authorities want to protect water for this purpose. Therefore, when a large flood arrives, the dams are unable to hold any water to reduce the extent of flooding (Page, 2000). *Fifth*, there are no separate design criteria for embankment construction for rural and urban areas. The standard procedure is to construct with design discharge of 5–10-year return periods. Therefore, these embankments are unable to protect urban and rural settlements from a flood of higher return periods (Vaz, 2000). Many common structural and non-structural measures for flood management have been in place in Mozambique for many years. However, during floods, planning, design and implementation of the measures were found to be, by and large, inadequate and ineffective (Vaz, 2000). *Sixth*, rural areas depend heavily on agriculture and are generally more affected than urban areas. *Seventh*, communication with the outside world is poor and the international press is found to be less interested during flooding events than ordinary events of the developed countries. In 2000, rivers began swelling on 9 February, but were not reported in the news media in the United States until 1 March (WSWS, 2001). *Eighth*, there are serious equity problems in Mozambique with regard to distribution of resources. The benefits of the rapidly growing economy go to a minority of the population (WSWS, 2001). Therefore, vulnerability to flood hazard remains unchanged. *Ninth*, there is a lack of adequate human and material resources to tackle the massive disaster-like floods that occurred in 2000.

3.2. Cyclones in Orissa

On 29 October 1999, the Indian “super cyclone” made landfall over the Indian State of Orissa (UK met-office, 1999). It was the strongest and deadliest cyclone in the region since the Bangladesh cyclone of 1991. The recorded wind speed was 356 km/h (Kriner, 2000) and it generated 8–10 m high surges. The cyclone and its aftermath led to about 10,092 deaths, the demolition of millions of dwelling units, over 80% damage to standing crops, especially ready to harvest crops, and a loss of about 454,000 heads of cattle. The source of vulnerability of the Orissa population to natural disasters lies in its socio-economic conditions, locations and poor institutional mechanisms. It is one of the poorest states in India and ranks

Box 2. Recent cyclones in Orissa and damage

7–14 September 1971	90 people died and 8000 cattle heads perished. Considerable damage to agriculture, houses and telecommunications occurred.
26–30 October 1971	10,000 people died and more than one million rendered homeless. In addition, 50,000 cattle heads perished and 8,000,000 houses damaged.
31 May–5 June 1982	High tides caused extensive damage to areas along the coast.
18 October 1999	Killed 300 people and destroyed all standing crops.
24–30 October 1999	Slightly over 10,000 people were killed and caused enormous destruction to agriculture, housing, ecosystems and infrastructure.

third in terms of lowest per capita income after Assam and Bihar. In 1997–1998, per capita income was less than half of that of all India average (GOO, 2000). During the same year, 48.6% of population was below the poverty line which the second highest (Bihar ranks first with 54.6%). Over the years, literacy in Orissa has not changed; it has remained within the group of states with a low literacy rate.

In recent years, Orissa has significantly increased non-development expenditure as compared to that for development. The ratio of development expenditures to that of non-development was 4.1 in 1980–1981. In 1995–1996, this had decreased to 2.2. A major reason for escalation of non-development expenditures has been the steep rise in the interest burden of the state (UNDP, 1998). Increases in non-development expenditures hindered funding of social sectors, and this eventually affected the vulnerability of the Orissa population to the disasters.

Despite recurring visits of cyclonic storms (Box 2), Orissa was found to be careless about cyclone preparedness and disaster mitigation planning. For example, Orissa has only 23 cyclone shelters, each capable of housing only some 2000 people (Robinson, 1999). In the absence of proper warning/communication mechanisms in place, most people learned of the 1999 cyclone, with its 288 km/h winds, less than a day before it struck. By contrast, less powerful storms approaching the Bangladesh coast were tracked and reported many days in advance (IFRC & RCS, 2001).

After the cyclone passed, mismanagement in relief handling and distribution occurred (IFRC & RCS, 2001). Thousands of tonnes of relief supplies remained undelivered for days due mainly to bureaucratic bottlenecks. This suggests that a more rigorous method for disaster management is needed. A communication gap was also seen between the Orissa state government and the central government in New Delhi. The Indian central government did not set-up a task force to co-ordinate relief and rehabilitation until nearly 2 weeks after the disaster. The central government did not provide any additional funding for relief operations and disaster management. The government released some funds but only as an advance against the state's regular allotment of national tax revenues (Robinson, 1999). Repeated disasters have pushed back development in Orissa by years. It has also sent millions into extreme poverty. Despite this, development planning has taken disaster risk into account either very little or not at all.

3.3. Floods in Bangladesh

Bangladesh acts a drainage outlet for the vast river basins of the Ganges, Brahmaputra and Meghna rivers (Fig. 5). The cross-border and local runoff generated by intense monsoon precipitation often causes floods in Bangladesh where more than 70% of the country is vulnerable to floods. Annually, floods inundate

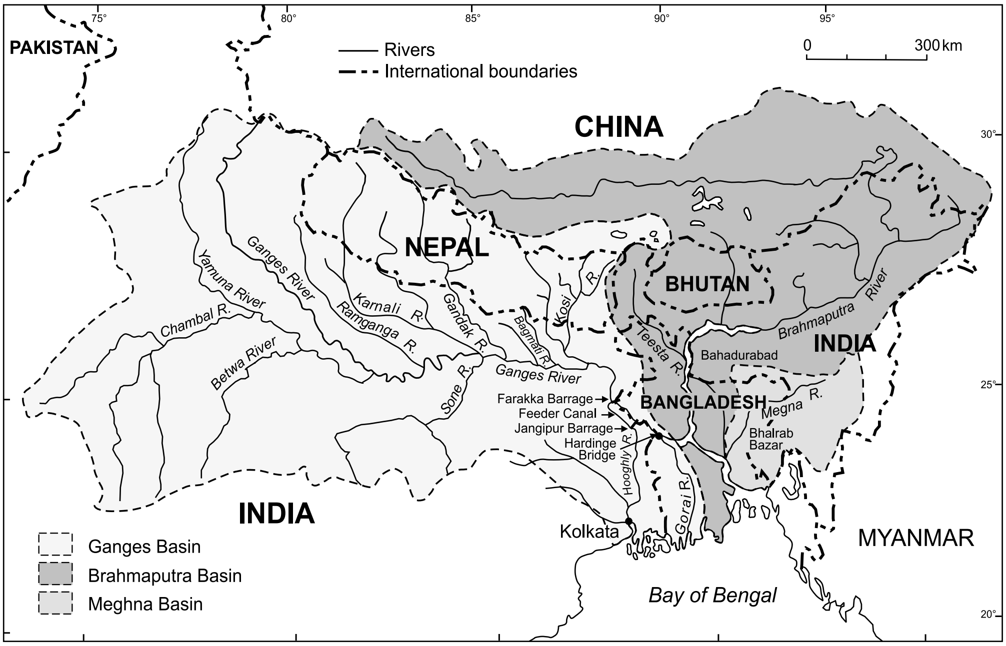

Fig. 5. The Ganges, Brahmaputra and Meghna basins.

20.5% or 31,000 km^2 area. In an extreme case, this may go up to 70% of the area of the country. Four types of floods generally occur in Bangladesh. They are: flash, riverine, rainfall-induced and storm surge floods. Floods in Bangladesh often cause extensive damage to its economy and could be in the range of US$ 3–4 billion, such as resulted from floods in 1998 (Ahmed and Mirza, 2000). Flood damage during the period 1955–1998 in Bangladesh is shown in Fig. 6.

Vulnerability to floods and other natural disasters is caused by the high population density, widespread poverty, unemployment, illiteracy, enormous pressure on rural land, and on economy traditionally dominated by agriculture. The World Bank estimates that 49% of the population lives below the poverty line

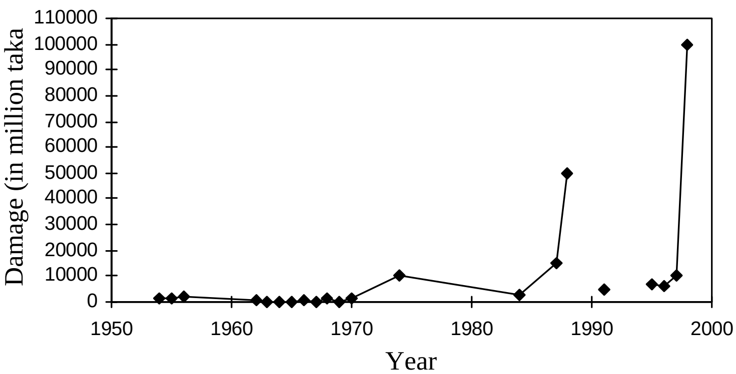

Fig. 6. Flood damage in Bangladesh during 1955–1999. *Source*: Mirza et al. (2001).

in Bangladesh. Sixty percent of the poor do not have the resources required to buy 80% of the minimum necessary diet (CRED, 2000).

Children and women are particularly vulnerable. Eighty-five percent of the deaths during disasters are women and children (CRED, 2000). This can be attributed to malnourishment and ill health. Social causes can also lead to deaths of women. Women traditionally play the role of protector of home and belongings; they are usually reluctant to go to secure shelters. Khuda and Nizamuddin (2000) conducted a socio-economic survey among 480 households in district severely flooded by flood 1998 in south-west Bangladesh. The study revealed that only 21% of the affected population went to the nearest shelter and flood protection embankment. About 36% stayed in their homes despite the flooding.

4. Can developing countries adapt to climate change?

Three case studies in different geographical and hydro-climatic regimes identified the elements of vulnerability to extreme weather events. It is evident that all these countries/regions are vulnerable to extreme weather events and they can hardly manage disasters with present adaptation/mitigation measures. The poor generally are more vulnerable, suffer greater costs, and have less capacity to take compensating measures, than the richer class in society. Effects on women and children are also disproportionate compared to men. The huge social and human cost of extreme weather events is unaccounted for in developing countries, although it is often claimed that a country or society has recovered from a natural disaster by looking at the macroeconomic parameters. Extreme weather events thus pose a more serious threat than would appear from the macroeconomic data (Albala-Bertrand, 1993).

Developing countries suffer enormous amount of direct losses from natural disasters which has been estimated at US$ 35 billion annually, averaged over the last decade. These losses are *more than eight times* greater than the losses suffered over the decade of the 1960s (Freeman, 2001a). Often the losses can be significant portions of the GDP of a country. Swiss Re (1998) has identified a list of developing countries for whom losses from floods could be expected to exceed 1% of GDP. Among these countries are Argentina, Ecuador, Honduras, Nicaragua, and China. Direct losses of more than US$ 1 billion from natural catastrophes have been identified for 28 developing countries[3] in the past 20 years. For small countries, losses much less than US$ 1 billion can have significant long-term consequences in terms of sustainable economic growth (Freeman, 2001a).

Can developing countries adapt to future change in climate? The answer to this question has to be considered in the present situation within the context of the capacity for economic shock absorption, development and investment policy paradigms. In this regard, a case study on Honduras is carried out. A shift in development policy paradigm in terms of investment in capacity building can help in absorbing the economic shocks of extreme weather events.

4.1. Absorption of shock: a case study on Honduras

Swiss Re (2000) conducted studies to estimate the country's potential losses from hurricanes, flood, earthquakes (non-climatic event) and landslides. It derives potential losses using geological and

[3] These are Algeria, Egypt, Mozambique, China, India, Bangladesh, Taiwan, Indonesia, Philippines, Korea, Afghanistan, Armenia, Georgia, Iran, Mongolia, Thailand, Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Venezuela (Munich Re, 1999; Swiss Re, 1998).

Table 3
Storm and flood loss in Honduras

Return period	Expected capital stock loss (in million US$)	As percentage of capital stock
10-year	100	1
50-year	650	5
100-year	1600	12
500-year	4000	31

Source: Swiss Re (2000).

meteorological models and extensive databases of historical catastrophic events and resulting economic losses. The result of the analysis is shown in Table 3. The loss in column three is shown as percentage of capital stock of US$ 13 billion of Honduras in 2000.

The return period in Table 3 represents the probability of *exceeding* the indicated loss. A 100-year event means that there is 0.01 (1/100) probability of a catastrophe with equal or greater losses occurring in a given year. This means there is 1% probability of a storm or flood event causing at least US$ 1.6 billion of damage or destroying 12% of the capital stock. The annual expected loss is the sum of all the possible losses weighted by the probability of each loss occurring in any given year (Freeman, 2001a). The annual expected loss represents the amount of money that, on average, will need to be set aside every year to fund catastrophic losses when they occur. For Honduras, the annual loss from storm and flood damage is estimated to be US$ 72 million. The loss from Hurricane Mitch was US$ 5 billion or 38% of the capital stock (Freeman, 2001b).

Direct losses lead to indirect and secondary losses. Direct losses refer to the financial value of damage to, and loss, of capital assets. Secondary impacts are the short- and long-term impacts upon aggregate economic performance. Secondary impacts could include disruption of development plans, increased balance of payment deficits, increased public sector deficits and debt, and worsened poverty (Benson and Clay, 2000).

Benson and Clay (2000) analysed the impact of Hurricane Mitch on economic growth in Honduras (Fig. 7). They demonstrated that high hazard risk and high vulnerability to macroeconomic losses amplify the indirect and secondary impacts of catastrophes. An average annual US$ 170 million additional external funding is required to meet expected direct and indirect losses. This is nearly 2.5 times the cost of the expected loss. If this amount of foreign funding is not available, the catastrophe could flatten growth estimates for Honduras over the next 8 years (Benson and Clay, 2000), as shown in Fig. 7.

Hurricane Mitch put Honduras's economic development back 20 years (IFRC & RCS, 2002). Many developed countries and lending agencies came forward to assist Honduras with aid packages, but in the traditional fashion of investing in recovery operations and infrastructure development. A significant investment in capacity building can help reduce economic, social and human losses as well as absorption of shock.

4.2. Shift in development policy and investment paradigm

None of the economic development models introduced in developing countries in the last few decades considered the reduction of risks and poverty by mitigating effects of extreme weather events. In the late 1980s, the World Bank concluded in one of its reports that ". . . for developing countries, it is not only more

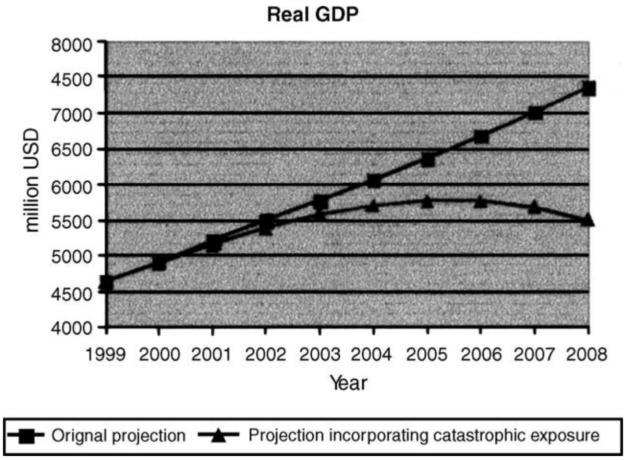

Fig. 7. Projection of GDP growth in Honduras with and without loss from catastrophes. *Source*: Benson and Clay (2000).

cost effective to prevent disasters than to recover from them but, if sustainable development is indeed the goal, it is imperative that disaster proneness considerations be incorporated into all development programming and planning. Not to do so, especially in areas of recurring disasters and especially for disaster types where the state of the art for prevention and mitigation is advanced, is both unnecessary and wasteful of scarce development resources (Anderson, 1990, p. iv)". However, over the years, the lending policy of the bank has not been reformed accordingly. In its Annual Report 2001, the bank made a similar conclusion "... Integral to any poverty reduction strategy should thus be measures to prevent and manage economic crises and natural disasters and to establish safety nets, with ensured financing, to help poor people cope when these adverse shocks do occur (World Bank, 2000, p. 176)". Note that in case of most developing countries, a recently released World Bank led 'Poverty Reduction Strategy Papers (PRSPs)'[4] also fell short of mentioning extreme weather events and their relationship with development and poverty. In an exceptional case, the PRSP prepared for Mozambique has a section on "reducing vulnerability to natural disasters", but no money was earmarked for this purpose (IFRC & RCS, 2002).

The resources available to the international development community are limited and have remained stagnant for nearly 10 years (World Bank, 1999). As the cost of disasters caused by extreme weather events increase, the demand on the international financial community to provide needed resources has also increased. Whatever the available resources were, little of it was spent on capacity building. The bulk of it was spent on infrastructure development. Over the past decade, the World Bank has annually loaned approximately US$ 25 billion to the infrastructure sector. The direct damage to infrastructure in Asia alone approximates nearly 50% of the total lending activity of the bank. No, or very, little information is available on how much of the granted resources was spent on capacity building. In 2001, the Inter-American Development Bank (IDB) disbursed US$ 408 million among various countries of Latin America and the Caribbean and only US$ 1.36 million (or 0.33%) was granted for natural disaster mitigation and related technical co-operation (IDB, 2002, personal communication). Of the money Mozambique requested to replace river water level and rain gauges destroyed by 2000's floods, donors promised just 15% for this

[4] Developing countries are now preparing PRSPs as a condition to have access to concessional lending and debt relief facilities of the World Bank Group and the IMF.

purpose. Yet in May 2000, donors pledged US$ 470 million for reconstruction. Meanwhile, essential repairs to dykes before the next rainy season were impossible due to the slow release of donor funds (IFRC & RCS, 2002). Donors need to dedicate an increased amount of resources for risk reduction, as opposed to relief and infrastructure. The European Community's Humanitarian Office (ECHO), for example, spent just 1.5% of its aid budget on disaster preparedness in 2001 (IFRC & RCS, 2002). Last year at the meeting of the Seventh Conference of the Parties (COP 7) of the UNFCCC, just US$ 410 million per year by 2005 was pledged to help developing countries adapt to climate change (UNFCCC, 2002). By contrast, industrialised nations spend US$ 70–80 billion per year on energy subsidies, including fossil fuels (IFRC & RCS, 2002).

Climate variability and change is still a neglected issue for most lending agencies/donors. The current Operational Manual of the World Bank offers many entry points to include natural hazard vulnerability considerations into bank work. However, most of them are very indirect. Climate change vulnerability is not specifically mentioned and general climate risks are mentioned explicitly in only a few instances. Burton and Aalst (1999) suggested a "full risk analysis" of the bank projects, which would contain natural hazards, including climate risks and the possibility that these risks are increasing due to climatic change. The *Asian Development Bank* also does not address climate variability and change directly. The bank's policy is to assist in the rehabilitation efforts of its developing member countries (DMCs) after they are struck by disasters. The *Inter-American Development Bank* directly addressed natural hazards caused by climate related extreme weather events in its lending policies. Specific objectives of its participation are to prepare for, and to prevent and/or mitigate the hazards, which cause loss of life and property and damage to the economic infrastructure and the environment. The IDB provides assistance during and after the emergency. The capacity building approach of the bank focuses on (1) disaster preparedness which aims to lessen the impact of a disaster by structuring in advance the countries' ability to cope quickly and effectively with the emergency; and (2) disaster prevention and/or mitigation including measures undertaken to prevent phenomenon or potential hazard from having harmful effects on persons, economic infrastructure and the environment (IDB, 1999).

Lending agencies/donors can introduce mandatory V&A studies for relevant development projects in developing countries. This is one step forward from the present arrangement of environmental impact analysis, which was not in place until the late 1980s. A mandatory V&A assessment will reveal the strengths and weaknesses in existing capacity in developing countries in reducing vulnerability to extreme weather events. However, this may have implications in terms of economic analysis and increased investment requirements. Although initial investment may be higher than a project without capacity building and adaptation measures, in the long-run, return will be higher. For this kind of exercise, Burton and Aalst (1999) suggested to extend the time horizon for economic analysis beyond the project life. In many cases, the physical life of a project is expected to be significantly longer than the economic life and the project itself, as well as the dependencies it creates, may be vulnerable to climate change. Lending agencies/donors should also strengthen their in-house capacity to provide assistance in the area of V&A in developing countries. They may also proceed to encourage national governments to formulate their National Adaptation Policy (NAP).

The challenges posed by climate change and possible increased extreme weather events and urgent need to reduce vulnerability and strengthen adaptive capacity through capacity building, demand a strong co-ordination between the stakeholders of multilateral environmental agreements. It also demands more resources be diverted to developing countries and a consensus should be reached among the development partners with regard to a framework for V&A assessments.

5. Conclusions

The frequency and magnitude of extreme weather events may increase in the future, due to climate change. The vulnerability of developing countries to extreme weather events may also increase. Developing countries can improve their ability to absorb the cost of disasters by incorporating an analysis of the chronic economic and social impacts of extreme weather events into their planning process. However, due to economic and social constraints, they alone cannot do it. Donor and lending agencies can form a partnership with developing countries to ensure a sustainable future by strengthening adaptive capacity. Such agencies need a radical transformation of their lending policies, keeping extreme weather events in focus. This will require more investment in capacity building in the developing countries.

References

Ahmed, A.U., Mirza, M.M.Q., 2000. Review of causes and dimensions of floods with particular reference to Flood'98: national perspectives. In: Ahmad, Q.K., et al. (Eds.), Perspectives on Flood 1998. University Press Limited, Dhaka, pp. 67–84.

Albala-Bertrand, J.M., 1993. Political Economy of Large Natural Disasters with Special Reference to Developing Countries. Clarendon Press, Oxford, pp. 259.

Anderson, M.B., 1990. Analyzing the costs and benefits of natural disaster responses in the context of development. Environment Working Paper No. 29. World Bank, Washington, DC, 27 pp.

Benioff, R., Guill, S., Lee, J., 1996: Vulnerability and Adaptation Assessments: An International Handbook. Kluwer Academic Publishers, Dordrecht.

Benson, C., Clay, E.J., 2000. Developing countries and the economic impacts of natural disasters. Managing disaster risk in emerging economies. In: Kreimer, A., Arnold, M. (Eds.), Disaster Risk Management Series No. 2. World Bank, Disaster Management Facility, Washington, DC.

Burton, I., Aalst, M.V., 1999. Come Hell or High Water: Integrating Climate Change Vulnerability and Adaptation into Bank Work. The World Bank, Washington, DC, 60 pp.

Carter, T.R., Parry, M.L., Harasawa, H., Nishioka, S., 1994. IPCC Technical Guidelines for Assessing Climate Change. IPCC, Geneva, 59 pp.

Centre for Research on the Epidemiology of Disasters (CRED), 2000. Current practices in the measurement of the impacts of disasters—methodological approaches and experience from the field (http://www.cred.be/centre/publi/146e/ch3.htm).

Dyson, L.L., van Heerden, J., 2001. The heavy rainfall and floods over the north-eastern interior of South Africa during February 2000. S. Afr. J. Sci. 97 (3–4), 80–86.

Freeman, P.K., 2001a. Infrastructure, Natural Disasters, and Poverty. International Institute for Applied Systems Analysis (IIASA). Luxemburg, Austria, 9 pp.

Freeman, P.K., 2001b. Estimating chronic from natural disasters in developing countries. A case study on Honduras. In: Paper Presented at the Annual Bank Conference on Development Economics, Europe: Development Thinking at the Millennium, Pierre Mendes France Conference Center, Paris, 26–28 June, 10 pp.

Government of Orissa (GOO), 2000. Nation and our state (http://orissagov.com/nationstate/nsdp.htm).

Inter-American Bank (IDB), 1999. Op-704 natural and unexpected disasters (http://www.iadb.org/cont/poli/OP-704E.htm).

Intergovernmental Panel on Climate Change (IPCC), 2001a. Climate Change 2001—Impacts, Adaptation, and Vulnerability: Summary for Policymakers and Technical Summary of the Working Group II Report. IPCC, Geneva, 89 pp.

Intergovernmental Panel on Climate Change (IPCC), 2001b. Climate Change 2001: Synthesis Report. Cambridge University Press, Cambridge, 397 pp.

International Federation of Red Cross and Red Crescent Societies (IFRC & RCS), 2001. World Disasters Report: Focus on Recovery. IFRC & RCS, Geneva, Switzerland, 248 pp.

International Federation of Red Cross and Red Crescent Societies (IFRC & RCS), 2002. World Disasters Report 2002. IFRC & RCS, Geneva, Switzerland.

Khuda, Z.R.M.M., Nizamuddin, K., 2000. Flood'98: relief, rehabilitation and management. In: Ahmad, Q.K., et al. (Eds.), Perspectives on Flood 1998. University Press Limited, Dhaka, pp. 31–50.

Kriner, S., 2000. Three Months After Super Cyclone. Orissa Begins to Rebuild. Disaster Relief (http://www.disasterelief.org/Disasters/000201Orissaupdate).

Mirza, M.M.Q., Warrick, R.A., Ericksen, N.J., Kenny, G.J., 2001. Are floods getting worse in the Ganges, Brahmaputra and Meghna basins? Environ. Hazards 3 (2), 37–48.

Munich Reinsurance, 1999. Climate Change and Increase in Loss Trend Persist. Press Release, 15 March 1999.

Oxfam Community Aid Abroad (OCAA), 1998. Recovery for Nacaragua and Honduras. Oxfam International Briefing Paper (http://wwww.cca.au/oxfam/advocacy/debt/mitchrecovery.html).

Page, D.L., 2000. Floods: A Predictable Disaster (http://www.sn.apc.org/wmail/issues/0103316/OTHERS86.html).

Robinson, A., 1999. Super Cyclone Exposes Pretense of India's Nationalism (http://www.ncmonline.com/commentary/1999-11-19/cyclone.html).

Shook, G., 1997. An assessment of disaster risk and its management in Thailand. Disasters 21 (1), 77–88.

Smithers, J.C., Schulze, R.E., Pike, A., Jewitt, G.P.W., 2001. A hydrological perspective of the February 2000 floods: a case study in the Sabie River Catchment. Water SA 27 (3), 25–31.

Swiss Reinsurance Company, 1998. Floods—An Insurable Risk? Swiss Re, Zurich.

Swiss Reinsurance Company, 2000. Natural catastrophes and man-made disasters in 1999: storms and earthquakes lead to the second-highest losses in insurance history. Sigma 2/2000. Swiss Re, Zurich.

United Kingdom Meteorological Office (UK met-office), 1999. Indian Cyclone Fact Sheet (http://www.met-office.gov.uk/sec2/sec2cyclone/tcbulletins/05b.html).

United Nations Development Programme (UNDP), 1998. State Government Expenditures: Trends in Development Expenditure (http://undp.org.in/Report/IDF98/idfstate.htm).

United Nations Development Programme (UNDP), 2001. Elaborating an adaptation policy framework with technical support papers. UNDP, New York, USA.

United Nations Environment Programme (UNEP), 1998. In: Feenstra, J., et al. (Eds.), Handbook on Methods for Climate Impact Assessment and Adaptation Strategies. United Nations Environment Programme, Institute for Environmental Studies, Amsterdam, The Netherlands, 359 pp.

United Nations Framework Convention on Climate Change (UNFCCC), 2002. A Guide to the Climate Change Convention and its Kyoto Protocol. UNFCCC Secretariat, Bonn, 39 pp.

Vaz, A.C., 2000. Coping with floods—the experience of Mozambique. In: Paper Presented in the International Conference on Mozambique Floods, Maputo, 27–28 October 2000, 15 pp.

Warrick, R.A., 2000. Strategies for vulnerability and adaptation assessment in the context of national communications. Asia Pac. J. Environ. Dev. 7 (1), 43–51.

World Bank, 1999. World Bank Development Indicators. World Bank, Washington, DC, 396 pp.

World Bank, 2000. Managing economic crises and natural disasters. In: World Development Report 2000/2001: Attacking Poverty. Oxford University Press/World Bank, Washington, DC, Chapter 9, pp. 161–176.

World Socialist Web Site (WSWS), 2001. Mozambique Flood Disaster Returns (http://www.wsws.org/articles/2001/feb2001/moz-f28.shtml).