PART I

RISK IDENTIFICATION

Chapter 1

Developing Countries and the Economic Impacts of Natural Disasters

Charlotte Benson and Edward J. Clay

Available data suggest that natural disasters can cause considerable damage, with potentially severe economic consequences. During 1990-98, natural disasters resulted in economic losses averaging an estimated US$76bn per year (in real 1998 prices) (Munich Re 1998).[1] Moreover, there is clear evidence that the costs of disasters are increasing. Real annual economic losses averaged US$4.9bn in the 1960s, US$9.5bn in the 1970s, and $15.1 bn in the 1980s. Record losses of US$191bn were recorded in 1995, the year of the Kobe earthquake. The second highest ever losses occurred in 1998, with a series of disasters around the world causing estimated economic damage of US$90bn and some US$15bn insured losses.

Such figures are dramatic. However, the full economic costs of disasters are probably even higher. Estimated figures are largely based on "direct" physical impacts, or losses of fixed capital and inventory (box 1). Meanwhile, many "indirect" and "secondary," or flow, effects on economic activity—such as changes in fiscal policy or the long-term consequences of the reallocation of investment resources—go unrecorded. This loss of information in part reflects difficulties in isolating the impact of natural disasters from other factors on economic performance; or of capturing such impacts in a single monetary figure.

Those assessing the costs of a disaster are also typically most concerned with meeting the short-term humanitarian needs of affected communities and funding reconstruction, so they concentrate on physical damage.

The emphasis on direct, physical losses has engendered a widespread perception that the absolute cost of disasters increases, and their relative cost as a percentage of gross domestic product (GDP) declines, as a country develops and, thus, as the value of capital assets rises.[2] However, recent analysis of the relationship between the structure and stage of development of an economy and its hazard vulnerability suggests a far more complex picture (Benson and Clay 1998). This analysis highlights the particular problems that disasters pose for middle- as well as low-income countries. It also underlines the importance of examining natural disasters not as singular events but rather as a series of successive random shocks which may have had a long-term impact on the pace and nature of development of particular countries. However, the analysis clearly indicates that there is considerable scope, both at a macro and household level, to influence the extent and nature of hazard vulnerability.

Determinants of Economic Hazard Vulnerability

The scale and nature of the economic impacts of a natural hazard depend on a range of factors, including:

- Type of hazard
- Geographical area and scale of impact
- Structure of an economy
- Prevailing economic conditions
- Stage of development of a country
- Stage of technical and scientific advancement.

Box 1 Measuring the economic impacts of a disaster

Direct costs relate to the physical damage to capital assets, including buildings, infrastructure, industrial plants, crops, and inventories of finished, intermediate, and raw materials destroyed or damaged by the actual impact of a disaster.

Indirect costs refer to damage to the flow of goods and services including lower output from damaged or destroyed assets and infrastructure; loss of earnings due to damage to marketing infrastructure such as roads and ports and to lower effective demand; job losses; and the increased costs associated with the use of more expensive inputs following the destruction of cheaper usual sources of supply. They also include the costs in terms of both medical expenses and lost productivity arising from increased incidence of disease, injury, and death. Indirect costs can be difficult to estimate, in part because of their "knock-on" effects. For example, disruption of the provision of basic services, such as telecommunications or water supply, can have far-reaching implications. Gross indirect costs are also in part offset by the positive knock-on effects of the rehabilitation and reconstruction efforts, such as increased activity in the construction industry. The complexity of indirect impacts can create problems of double-counting.

Secondary effects concern both the short- and long-term impacts of a disaster on overall economic performance, such as deterioration in trade and government budget balances and thus, perhaps, increased indebtedness. They can also include shifts in government monetary and fiscal policy, for example, to contain the effects of increased disaster-induced inflation or to finance additional government expenditure; and impacts on the distribution of income and scale and incidence of poverty.

The potential implications of a natural disaster for public finance and related fiscal and monetary policy provide an illustration of the complexity of indirect and secondary effects. Natural disasters may have several important impacts on public finance, resulting in either additional expenditure or partial redeployment of planned expenditure. Disasters can also reduce government revenue since lower levels of economic activity, including possible net falls in imports and exports, imply reduced direct and indirect tax revenues. Although such losses may be partly offset by increased flows of official external assistance, these flows are unlikely to offset completely increased levels of expenditure. Public enterprises may also experience disaster-related losses, placing an additional burden on government resources.

In consequence, a government may face increasing budgetary pressures which it will be obliged to meet by increasing the money supply, running down foreign-exchange reserves, or increasing levels of domestic and/or external borrowing. These financing options, in turn, have potentially significant knock-on effects. The creation of base money is inflationary. Domestic borrowing exerts upward pressure on interest rates and can result in a credit squeeze. Foreign borrowing can result in an appreciation of the exchange rate, reducing the price of imports and increasing that of exports. It can also place future strains on the economy via higher debt-servicing costs. Another option, the run-down of foreign-exchange reserves, is limited by the very size of those reserves and entails an appreciation in the exchange rate, with possible associated risks of capital flight and a balance-of-payments crisis (Fischer and Easterly 1990).

Type of Hazard

The type of hazard is relevant from three perspectives. Most obviously, different types of hazard cause varying nature and scale of damage. They are also associated with varying typical rates of frequency, in turn influencing perceptions of risk and behavioural responses; and with varying technical forecasting capabilities.

Different types of hazard cause varying levels of physical damage to infrastructure and agriculture, with implications for their indirect and secondary impacts. For example, droughts can result in heavy crop and livestock losses over wide areas of land, often affecting several neighboring countries simultaneously, but typically leave infrastructure and productive capacity largely unaffected. Earthquakes have little impact on

standing crops, excluding localized losses occurring as a consequence of landslides but can cause widespread destruction of infrastructure and other productive capacity over relatively large areas. Floods can also cause extensive physical damage to both infrastructure and agriculture, depending on their timing relative to the agricultural cycle. However, the area affected can vary enormously, in part dependent on topographical features. As compared to earthquakes, a much larger share of the damage may also be repairable rather than requiring total reconstruction.

The relative frequency of various hazards in particular regions of the world also plays an important role in determining the scale and nature of disaster mitigation and preparedness measures and, thus, subsequent financial and economic losses. Even strictly scientific, objective information on the probability of occurrence of a particular hazard of varying levels of severity over a specified period of time may be largely lacking. Moreover, where information does exist, it may not be widely disseminated. Perceptions of risk, therefore, play an important role in determining behavior. Perceptions are strongly influenced by the length of intervals between events and the resulting extent of experience with disasters, both within communities at risk and among policymakers and the donor community more broadly. For example, the Caribbean island of Montserrat was severely damaged by Hurricane Hugo in 1989, with an estimated 98 percent of the island's housing stock, as well as the main jetty, damaged or destroyed. Total damage was estimated at some US$240m (IFRC 1997). During reconstruction hurricane proofing features were introduced into the design of houses and other buildings. However, little regard was paid to available volcanological risk maps as there had not been a major eruption for over four centuries and the risk of a severe event was perceived as low. The subsequent eruption, which began in 1995, has since devastated the island's capital, located only four kilometers from the volcano. Much of the infrastructure repaired or replaced post-Hugo has been destroyed.

Conversely, predictable flooding or even annual dry periods may be used to economic advantage. For example, in the early 1960s, sugar cane production in Fiji was deliberately moved to the west of the country, where the drier climate ensured a higher sugar content. More generally, the widespread cultivation of deep-water rice types in south and southeast Asia is ecologically tied to areas of relatively extended annual inundation from 1 to 5 meters (Catling 1993).

Finally, forecasting and warning capabilities play some role in determining the extent and nature of shorter term preparedness measures and thus the impact of a hazard, assuming they are supported by effective dissemination systems. However, theoretical forecasting capabilities also vary significantly among hazard types. For example, in the case of droughts and floods there is some scope for long-term forecasting to the extent that such events are linked to El Niño weather variations. To some degree, it is also possible to respond to droughts as they evol.ve, reflecting their slow onset. Such warnings could prompt measures such as restrictions on water use or switch in the choice and type of crop planted. Short-term cyclone warnings can also be issued, reducing loss of life and physical damage if threatened communities undertake certain measures, such as securing windows and doors, tying down roofs, cutting tree branches, and relocating to cyclone shelters. In contrast, even in the two countries with the most advanced monitoring capacities, the United States and Japan, the timing and precise location of an earthquake remain extremely difficult to pinpoint, as illustrated by the unanticipated January 1995 Kobe earthquake. Broad known areas of seismic activity can be monitored, permitting the identification of locations where a build-up in tensions is occurring. Some more major earthquakes are also preceded by minor tremors, precipitating increased monitoring, but few earthquakes have been successfully predicted.[3]

Geographical Area and Scale of Impact

The proportion of a country and the particular region affected by a hazard has obvious implications. At one extreme, natural hazards can have severe economic impacts in the case of small-island economies. In the microstate of Niue in the South Pacific, for example, the cost of repairing damage to government-owned buildings alone as a consequence of Cyclone Ofa, which struck the island in February 1990, was esti-

mated at $4m, equivalent to a massive 40 percent of GDP (UNDHA/SPDRP 1997).

With the important exception of widespread drought, however, recent natural disasters have not had measurable short-term impacts on national economic aggregates—such as levels of GDP, the balance of payments or the rate of investment—in geographically larger countries. Instead, their effects are perhaps best conceived in terms of development opportunities foregone at a national level although they can still cause serious economic disturbances locally. For example, in the Philippines only modest achievements in efforts to improve the country's transportation systems and increasing difficulties in meeting the social infrastructural needs of the country's rising population are attributed to the fact that a large proportion of available public resources earmarked for such purposes have had to be redirected in response to calamities (Benson 1997c). Readily accessible data on relief and rehabilitation expenditure alone indicated annual expenditure of 1.5 percent to 3.5 percent of total national government expenditure and of 3.9 percent to 8.3 percent of discretionary expenditure in 1991–94, while the full cost is probably higher.[4] Additional expenditure on the relief and rehabilitation program associated with the July 1990 Luzon earthquake probably pushed total relief and rehabilitation expenditure as a percentage of discretionary spending into double figures in 1991.

Relative hazard risks can also influence the choice of location of investments, whether within or, in the case of multinational corporations, between countries. In Vietnam, for example, this phenomenon is contributing to widening regional disparities as some of the more hazard-prone regions have received disproportionately small shares in both private and public investment and external assistance (Benson 1997b). Farmers in such regions have also been less well placed to take advantage of higher yielding but less hazard-tolerant strains of rice.

Economic Structure

Some countries exhibit a high degree of dualism, with a large capital-intensive extractive sector which features significantly in the trade account but is weakly linked with other sectors of the economy. In such economies the impact of a hazard event is in part determined by its impact on the extractive sector. For example, the economic impact of an earthquake will differ significantly depending on whether the extractive sector is affected. Similarly, unless the extractive sector is water intensive and fails through lack of investment or poor management to insulate itself from fluctuations in water supply, the economic impact of drought in dual economies is likely to be limited to variability in the agricultural sector, with only limited multiplier effects.

If the extractive sector is not affected, the macroeconomic impact of a natural hazard may thus appear small in a dual economy. For example, levels of exports and the broad revenue base may be largely sustained although, particularly in less developed countries, hazard events can still have potentially profound impacts for large segments of the population. For example, in Botswana in 1982-87 (Drèze and Sen 1989) and Namibia in 1992-93 (Thomson 1994), the macroeconomic aggregate and trade account effects of drought were modest. The respective governments had sufficient resources of their own to finance substantial relief programs, reflecting the importance of extractive mining sectors in both countries.

More generally, other factors such as the choice of crops grown and the composition of the manufacturing and service sectors also play important roles in determining the extent of hazard vulnerability. For instance, in countries highly dependent on hydroelectric power for a significant share of their electricity supply, droughts can severely disrupt electricity supply, potentially causing extensive damage to some industrial plants and equipment. In another example, many traditional root crops and coarse grains are more drought tolerant than newer crop varieties whereas hybrid coconut trees can be more vulnerable to typhoons than more traditional varieties, which typically have longer rooting systems. In Fiji, for instance, the increased economic impact of natural hazards in the 1980s over the 1970s largely reflected the expansion of the country's important sugar industry onto more marginal lands, where crops are more vulner-

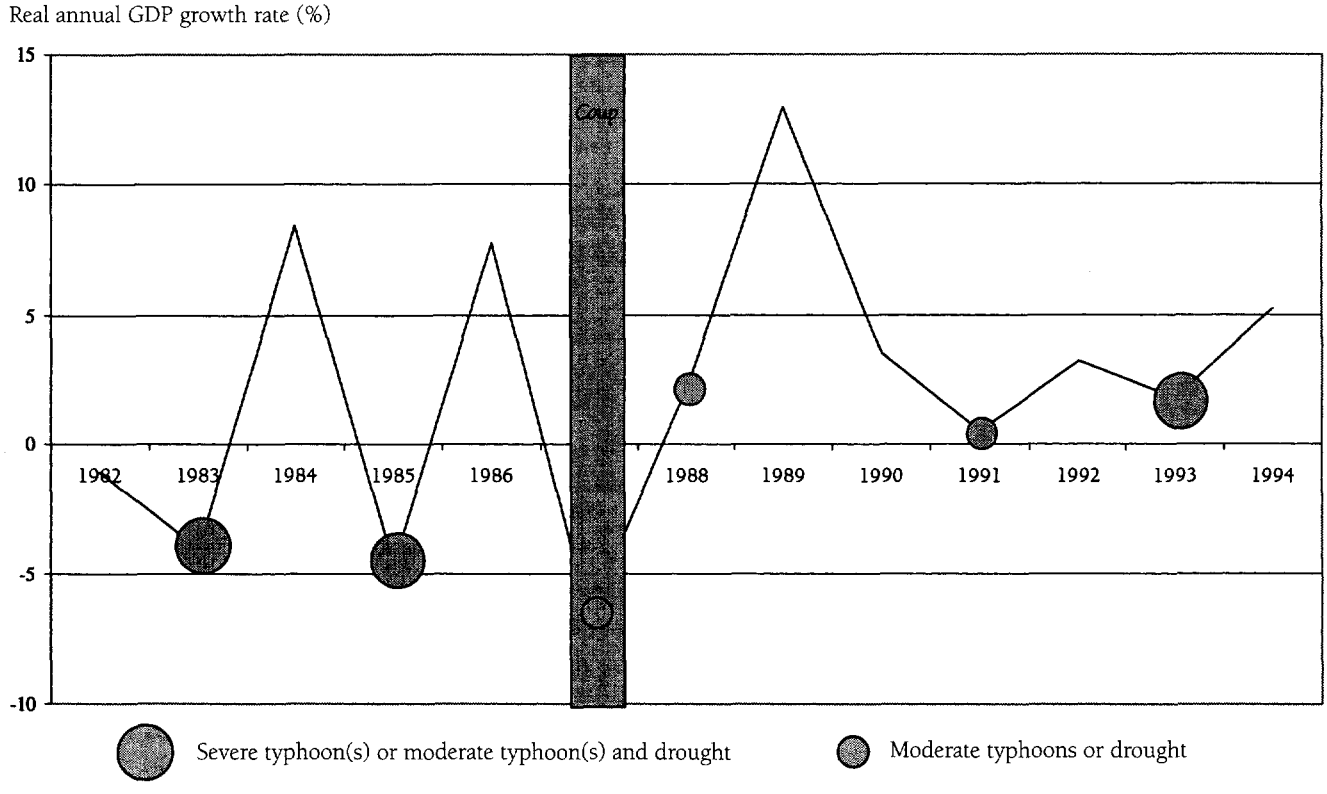
able to hazards. A second factor was the increasing senility of the country's coconut trees, again weakening their hazard tolerance (figure 1).

Prevailing Economic Conditions

Myriad other factors, both coincidental and deliberate, offset or amplify the economic impacts of hazard events, whether explicitly or implicitly. In terms of the balance of payments, for example, a number of developing countries rely on a handful of commodities for a significant part of their export earnings. Contemporaneous fluctuations in the prices of such commodities, as well as of major imports such as oil, can exacerbate or minimize the impacts of natural disasters, usually by random timing. For example, in 1984 high coffee and tea prices helped Kenya sustain its export earnings at a time of severe drought. In some cases, world market dominance also plays a role. For example, the Philippines has effectively benefited because of its position as a major coconut product exporter, with temporary disaster-related declines in production offset by higher international prices. Commodity reserves have also been successfully used to maintain export earnings and prevent loss of export markets in the aftermath of natural disasters, as illustrated by Fiji's use of its sugar reserves (Benson 1997a). On occasion disaster-related reinsurance inflows have further boosted a country's balance of payments.

Countries already experiencing other adverse economic shocks typically are more vulnerable to natural hazards. For example, Ghana faced almost continual economic decline from the early 1960s to early 1980s, with per capita incomes a third lower in 1980 than in 1970. A subsequent drought was one of several factors forcing the economy to a crisis point, finally resulting in the adoption of a succession of structural adjustment programs. Meanwhile, in both Ethiopia and Mozambique, the effects of droughts in the late 1980s and early 1990s were amplified by ongoing internal conflict.

Figure 1 Fiji: GDP growth and natural disasters, 1982–94



The existence and stage of a structural adjustment program can be another factor determining disaster impact. Disasters can exacerbate the short-term adverse impacts of reform, first and foremost via their effect on vulnerable groups. They may reinforce the inflationary impact of the removal of subsidies on basic food and other commodities, to the extent that governments continue this policy, and also contribute to job losses. Disasters can also intensify the short-term adverse economic impacts of reform more generally, for example, by prolonging tight monetary policy with implications for the rates of investment, as occurred in Zimbabwe in 1992-93.

The existence of reform programs and relationships with donors, particularly the international financial institutions (IFIs), more generally has also played an important role in determining the nature and level of the international response to disasters on some occasions, generating sometimes sizeable amounts of assistance to keep structural adjustment programs on course.

Disasters, in turn, can also impede the progress of reform. For example, in Zimbabwe the 1991-92 drought hampered government efforts to reduce the budget deficit and restructure the civil service and parastatals and, thus, to reduce domestic borrowing. In consequence, the expected domestic supply side response to the reform program, which was critical to its success, was partly curtailed. However, the drought shock also partly speeded up the restructuring of the manufacturing sector, as increased liquidity constraints forced enterprises to carry smaller stocks, shed surplus labor, and adopt less costly, efficiency-enhancing methods of production.

Stage of Development

The broader economic impacts of a disaster also need to be considered in the context of the stage of development of an economy, as defined in terms of factors such as the degree of sectoral and geographical integration, economic specialization, integration of financial flows, and government revenue-raising capabilities.

As already indicated, least-developed economies typically are perceived as most hazard vulnerable. Preliminary ongoing research indicates that over the past three decades more hazard-prone, low-income countries may have experienced a much slower pace of economic development than their less hazard-prone counterparts that had had similar levels of per capita income at the beginning of that period. In the former such economies the physical impacts of a hazard event may cause widespread destruction as there may have been little investment in hazard risks reduction measures. Loss of human life may also be high, in part reflecting poor warning capabilities, while disasters can exacerbate existing levels of poverty and indebtedness.

However, because of weak intersectoral linkages, a high degree of self-provisioning, and often poor transport infrastructure, the multiplier effects from the immediately affected regions and/or sectors through the rest of the economy may be fairly limited. Moreover, much of the relief and rehabilitation costs may be met through external grant and concessional assistance. Much of the economy may also revolve around rainfed agriculture, with little associated capital. For annual cultivation cycles, this implies that productive capacity can be restored relatively quickly if sufficient rehabilitation funds are made available to ensure the timely provision of seed, draught animals or agricultural machinery, other agricultural inputs, and tools.

Nevertheless, in its initial stages, increased development may not imply lower hazard vulnerability. Research at a household level suggests that poor and socially disadvantaged groups become more vulnerable to hazards in the initial stages of development due to the breakdown of traditional familial support as part of the disintegration of the old social fabric. Other factors include a decline in traditional coping measures, and rising land pressures, urbanization, and the increasing marginalization of poorer groups, forcing movement onto more hazard-prone lands (for example, SPREP/SPPO-UNDHA/EMA 1994; UN 1995). The decline in traditional coping mechanisms may result from planting less drought- or cyclone-resistant traditional crops as opportunities for marketing cash

crops increase and older patterns of self-provisioning are eroded. Or it may result from constructing houses from "modern" materials, invol.ving structures that are both more vulnerable to hazards and more costly to reconstruct.

Such patterns may be mirrored at a macroeconomic level. An economy at an intermediate stage of development is more integrated than a simple one, among both sectors and geographical regions. Integration increases the multiplier effects of adverse performance in a particular sector or regional economy. For example, droughts impact on larger manufacturing as well as on the agricultural and livestock sectors because the lower domestic production of agricultural processing inputs reduces nonagricultural production while forcing up input costs. Intermediate (rather than final, as in simple economies) goods are also likely to form a larger share in total imports, implying that any drought-related import squeeze will have additional knock-on implications for domestic production.

The breakdown of traditional coping mechanisms also plays a role. For example, the increasing specialization of labor and the breakdown of community and extended family ties may reduce the ability of households to adapt to temporary shocks. Farmers increasingly engage in the market economy, perhaps replacing production of more hazard-tolerant traditional crops with cultivation of cash crops.[5] This can have implications for the macroeconomy as well as for individual households.

For example, in Zimbabwe, the relative shift in maize and cotton production from the large-scale commercial to the communal sector, the latter of which is heavily concentrated in lower-potential marginal areas, since 1980 has also been associated with increased rainfall- related variability in agricultural production. From 1982-83 to 1992-93, regression analysis indicates that an annual rainfall level 10 percent below the 1969-93 national mean would be associated with a 25 percent reduction in maize yields from the communal sector compared with only a 17 percent drop in commercial sector yields. Meanwhile, a 30 percent reduction in rainfall would be associated with declines of 62 percent in communal and 47 percent in commercial sector maize yields.[6] These examples underscore the importance of a disaggregated approach in examining the sectoral impacts of drought, and of taking into account the effects of structural change in assessing the drought vulnerability of both individual sectors and the wider economy (Benson 1997d).

The structure of financial sectors and government financial policy are also likely to be more important in shaping the impact of a drought shock than in a simpler economy. Intermediate economies typically have more developed, economy-wide financial systems for the flow of funds, including small-scale private savings and transfers, which also diffuse the impact of disasters more widely. For example, again in Zimbabwe, the transfer of remittances from urban- to rural-based members of households was facilitated by the well articulated system for small savings in the aftermath of the 1991-92 drought. This mitigated the impact of the drought on the rural areas but at the same time spread its impact more widely, including into urban areas (Hicks 1993).

Meanwhile, the government is likely to meet a larger share of the costs of the relief and rehabilitation efforts, rather than relying almost entirely on international assistance. This will be financed by some combination of the reallocation of planned expenditure, government borrowing, and monetary expansion, with various indirect longer term implications, as discussed below. Large interannual fluctuations in economic performance, such as triggered by disasters, can also create economic management difficulties, for example, in controlling public expenditure.

Hazard-vulnerability of intermediate economies may be exacerbated by the fact that during the earlier stages of economic take-off, both governments and donors allocate considerable resources to new investment while recurrent costs are often underfunded, again potentially rendering a country more hazard vulnerable.[7] In some countries economic development may be accompanied by environmental degradation as already indicated, again increasing vulnerability to natural hazards.

In the later stages of development, evidence suggests that the economic impacts of disasters decline

again, in part reflecting the smaller relative role of the potentially particularly hazard-vulnerable agricultural sector in GDP, as a source of employment and as both a source of inputs to other sectors and an end-user of other goods. More developed economies typically are both more open and have fewer foreign exchange constraints, facilitating the import of any normally domestically sourced items in temporary short supply as a consequence of the disaster without forcing a decline in other imports.

Other factors contribute to a decline in vulnerability in more developed economies, including increased investments in disaster prevention, mitigation, and preparedness measures; improved environmental management; and a reduction in the scale of absolute poverty and thus of household vulnerability.[8] Moreover, a greater share of economic assets is likely to be held by the private sector and adequately insured against disaster. Similarly, a higher proportion of damage sustained by individual households will be covered by insurance. Thus, the scale and cost of relief and rehabilitation programs will be limited and is less likely to necessitate a substantial increase in government domestic or external borrowing. However, the small segment of the population comprised of lower-income households may be severely hurt in terms of loss of income, assets, and savings.

Stage of Technical and Scientific Advancement

The impact of a hazard is time dependent, related to a country's stage of socioeconomic development and of technical and scientific advancement.

The role played by the latter relates most obviously to the stage of development of structural hazard mitigation techniques and forecasting technology and know-how. For example, between 1991 and 1997, there were considerable advances in short-term climatic forecasting for the Sahel and Southern African regions. Such information impinges on private and public decisions—for instance, pertaining to the management of water resources, choice of crops grown, and the level of exports and imports of grain. These in turn affect the relationship between climatic variability and economic performance. Similarly, considerable advances in volcanological forecasting indicate how the impacts of vol.canic events are in part determined by such factors. In 1976 predictions of a major eruption led to the temporary evacuation of part of the island of Guadeloupe at an estimated cost of over $50 million (Wood 1987). More recent improvements in monitoring of andesitic volcanoes made it possible to avoid a comparable scale of response on the neighboring island of Montserrat, which otherwise would have required complete evacuation during 1995 or 1996 (Young and others 1998).

Application of technical and scientific developments in other fields can influence the impact of a hazard. For example, flood-tolerant cultivars used in deepwater rice cultivation in south and southeast Asia are gradually being displaced by shorter-stemmed cultivars, which require more controlled, often irrigated water management but also permit more intensive production. Where, as in Bangladesh, this intensification is associated with a switch to dry-season irrigated, high-input rice, this change may reduce overall production variability and vulnerability to natural hazards. However, as the scope for substituting dry-season for monsoon-season cultivation is exhausted, future growth may again require investments in flood control to permit expansion of more intensive monsoon season cereal cultivation on naturally inundated flood plains. This, again, is an objective of several flood control projects for regions of Bangladesh under the controversial Flood Action Plan.

Implications for Government and Aid Policies

As indicated in the previous section, a complexity of factors determine a country's hazard vulnerability. Although the scale of direct physical damage typically increases as one moves along the spectrum from least to most developed countries, this does not imply that more developed countries are most vulnerable. Instead, high hazard vulnerability itself may be an obstacle to development.

More positively, high levels of hazard vulnerability are not inevitable. There is considerable scope for reducing hazard risk through the application of appro-

priately designed disaster mitigation, preparedness, relief, and rehabilitation efforts. Such measures should not be viewed as discrete activities undertaken by specialist government agencies but as measures that can be incorporated in development projects as well as in economic activities and government policy and planning exercises more generally. Indeed, in addressing both hazard vulnerability and post-disaster response, more attention needs to be paid to economic activities, rather primarily to the protection of economic assets.[9]

Current practices in many areas of economic activity can be adapted to reduce hazard vulnerability. For example, extension workers can promote techniques that reduce hazard-related agricultural losses, such as to encourage planting of early or late crop varieties that can be grown outside the main typhoon or flood season. Similarly, building codes can be used to promote the incorporation of hazard-proofing features into the construction of public and private buildings and infrastructure in earthquake- and hurricane-prone areas.

Broader government and donor policy and planning documents can also take greater account of hazard risk. Rather than ignoring natural hazards, as sometimes occurs, they should recognize the potential threat hazards pose to sustainable, equitable development and attempt to reduce overall economic hazard vulnerability. Indeed, even governments with relatively limited financial resources can do much to reduce hazard vulnerability. The degree of public sector and donor commitments to such issues should not be measured in financial terms alone.

Finally, in responding to the impact of a disaster, it is important to take account of underlying socioeconomic and technical changes to avoid inappropriate forms of assistance. For example, failure to recognize the hazard vulnerability-related impacts of changes in cropping patterns, such as in rice cultivation in south and southeast Asia, could lead to over-compensation for the expected impact of a flood disaster on aggregate food production. Programming of additional cereal imports, in turn, could negatively impact, through prices, producer incentives in the following dry season and beyond, amplifying the effects of a natural disaster shock in terms of output variability and lower agricultural growth.

Analyzing Economic Impacts of Disasters

Finally, the evidence presented in this chapter contains certain lessons about methodological approaches in the analysis of the economic impacts of disasters. It underlines the the importance of distinguishing between both type of hazard and economy in examining the impacts of natural disasters. Each disaster is unique, not only in physical impact but also in time, as in turn expressed in terms of the stage of technical and scientific advancement and the prevailing economic environment and circumstances within which a hazard occurs.[10]

In terms of methodological approaches for the analysis of the economic impacts of individual disasters, in theory computable general equilibrium models (CGEs) offer one of the best available tools. CGEs incorporate the socioeconomic structure of an economy, prices, and macroeconomic phenomena. CGEs have been used to simulate the economic and social consequences of a wide range of scenarios including exogenous shocks. In the specific context of natural disasters, however, there are certain constraints, in part reflecting the all-pervasive impact of many disasters on economic life. For instance, disasters can have highly complicated effects on productive sectors as well as on public and external sector accounts. The nature of such behavior may be fundamental in determining the outcome of a hazard event. Nevertheless, aggregated specification of different sectors may not reveal adaptive behavior, such as substitution among products and activities, or redeployment of government and private investment resources within particular sectors. More fundamentally, the current state of knowledge of the economic impact of disasters itself may be too limited to design appropriately constructed CGE models.

Instead, the evidence seems to point toward a more eclectic analysis, using a mixture of partial quantitative and qualitative techniques. Analysis of disaster impacts and assessment of strategies for hazard risk

reduction need to explicitly consider socioeconomic and technical stages of development. This approach would place particular hazard events in their historical contexts, facilitating understanding of how impacts of future hazard events might differ and identification of appropriate responses before and after.

Notes

1. Munich Re's estimates of economic losses are based on figures released by governments and international agencies and on estimated ratios of insured to total economic losses. The latter are used to extrapolate the level of economic losses from reported figures on insured losses. For example, if insured windstorm losses in Germany are US$60m, then overall losses are usually estimated at around US$100m.
2. A third relationship commonly cited concerns a decline in the number of lives lost as consequence of disasters as one moves along the spectrum from least developed to highly developed economies. This reflects increasingly sophisticated meteorology and communications combined with downward revisions in acceptable levels of disaster risk. Improved technology provides both the means and the political impetus to improve the quality and timeliness of warnings and to ensure that appropriate action is taken to minimize loss of lives. The lower level of acceptable risk, in turn, reflects adjustments in household utility functions as improvements in levels of public health and other advancements reduce comparative risks in every day life (Coburn and others 1994).
3. A notable exception is the 1976 earthquake in Haicheng, Liaoning Province, China. The city evacuated before an earthquake measuring 7.3 on the Richter scale struck "almost certainly sav(ing) thousands of lives" (Alexander 1993, 43).
4. The Philippine Government faced very high nondiscretionary payments, accounting for 70 percent or more of total government expenditure, principally to meet debt-servicing and public sector wage bills.
5. This comment relates not only to drought-resistant crops—such as sorghum or millet—but to various crops and varieties better able to withstand floods or strong winds.
6. The results are sensitive to the choice of base and end years of analysis and to the rainfall indicator selected. The results reported, which are based on rainfall in critical winter months for selected stations in the various agro-climatic zones and include a time variable in the regressions, explain 88 percent of variation in communal sector yields and 77 percent in commercial sector yields, with highly significant t-ratios for the rainfall variable.
7. For example, annual repairs to existing dikes may receive insufficient funding while considerable resources are allocated to the expansion of a country's overall water control system.
8. At the household level, poverty is the single most important factor determining hazard vulnerability, in part reflecting location of housing, choice of building materials, and primary types of occupation.
9. In a similar vein, Adger (1996) notes that various studies undertaken on the related issue of the socioeconomic implications of climate change have typically focused on the impacts on physical assets, such as land and economic assets, and the number of people potentially at risk. This has resulted in "a mechanistic approach leading to policy prescriptions which uniformly protect physical assets, rather than policy prescriptions which incorporates variability in social, economic and cultural constraints and opportunities."
10. Similarly, Otero and Marti (1995), for example, also conclude that: "in general and on the basis of experience accumulated in the Latin American and Caribbean region, there is no predetermined pattern as to the consequences of different disasters."

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