

**NATURAL DISASTERS: LINKING ECONOMICS AND THE ENVIRONMENT  
WITH A VENGEANCE**

**Jan C. Vermeiren  
Department of Regional Development  
and Environment  
Organization of American States**

**CONFERENCE ON ECONOMICS AND THE ENVIRONMENT**

**Sponsored by  
The Caribbean Conservation Association  
Barbados  
November 6-8, 1989**

## ABSTRACT

An often overlooked aspect in the linkage between economic development and the environment is the vulnerability of development to environmental extremes, or natural hazards. The impact of a natural disaster on the economy of a small developing country can be devastating. Jamaica's GDP for calendar 1988 fell by 2% as against an expected growth of 5% . Settlements and their services, basic infrastructure, productive facilities, and even the natural resource base can sustain severe damage, forcing the country to divert scarce funds to their rehabilitation. The foreign exchange earning capacity of export agriculture and tourism can be wiped out for a substantial period, at a time when the country needs to acquire goods and services from abroad as inputs for the rehabilitation effort.

Countries in the region, and their international development assistance agencies continue to formulate development plans and investment projects without due consideration to the risks posed by natural hazards. Yet the recent disasters that affected the region serve as a reminder that sustainable development cannot be attained without mitigating hazard risks. The author identifies three reasons why decision-makers in development planning ignore disaster risk, and reviews several strategies for improving risk perception and response. Significant progress can be made towards this end by including hazard assessment and vulnerability analysis in the development planning process, and by expanding the project appraisal process to include a cost-benefit analysis for investment in appropriate loss reduction and mitigation measures.

## **1. Introduction**

I have chosen this title in an attempt to focus attention on a particular aspect of the linkage between economics and the environment, namely the relationship between economic development and environmental extremes. Natural disasters, after all, are nothing else but extreme environmental events that impact on human activities. As is the case in any systemic relationship, where cause and effect are frequently interacting, economic development not only suffers the impact of natural disasters, it is quite often also the cause of, or at least an important compounding factor in certain types of disasters. Environmental neglect or abuse can threaten development by exacerbating natural events.

By their location and physiographic nature, the Caribbean Basin nations are subject to strong atmospheric, hydrologic and geologic extremes. Meteorologic hazards such as tropical storms and hurricanes may pose the most frequent threats, yet earthquakes and volcanic eruptions have been responsible for the greatest loss of life in the modern history of the Caribbean (Tomblin, 1981). Flooding is generally triggered by heavy rains carried by tropical storms and hurricanes, with storm surges compounding the situation in coastal areas. Drought occurs when normal rainfall patterns are disrupted over extended periods of time. And the combination of steep topography and unstable soils found in much of the countries in the region can lead to severe erosion and frequent landslides.

Economic development in the Caribbean is highly vulnerable to disruption and damage by these environmental extremes. It is largely concentrated in coastal plains and low-lying areas subject to storm surges and landborne flooding. High demands placed on existing lifeline infrastructure combined with inadequate financing of expansion and maintenance have increased the susceptibility of breakdowns. Uncontrolled growth in urban centers results in a degrading of the physical environment and its natural protective capabilities. Building sites safe from natural hazards, pollution and accidents have become inaccessible to the urban poor, who are left to build their shelter on steep hillsides or in flood-prone areas (Bender, 1989). Agriculture, particularly the cultivation of bananas for export, is often practiced without necessary conservation measures corresponding to the soil, slope and rainfall characteristics of the area.

## **2. Natural disasters and economic growth**

Natural disasters directly threaten a country's development strategy and socio-economic performance by destroying infrastructure and productive capacity, interrupting production processes, and creating irreversible changes in the natural resource base. The number of people affected by disasters and their losses are on the increase worldwide. The Office of Foreign Disaster Assistance of the U. S. Agency for International Development has been collecting yearly figures of these damages. According to their figures, an estimated 574 million people have been affected during the six years from 1980 to 1986, principally

by drought, floods and tropical cyclones, compared to 277 million people affected by disasters during the sixties (OFDA, 1988). In these six years, total losses of US\$75.4 billion were reported, excluding losses in the USA and the USSR.

The United Nations Disaster Relief Organization distinguishes between direct, indirect and secondary effects of a disaster in evaluating its impact on a country (UNDRO 1979). This classification has been adapted by the Economic Commission for Latin America and the Caribbean, ECLAC, in its assessment of sectoral damages and impact on over-all economic performance and living conditions with the following definitions (Jovel 1989):

- the direct effects on the property of state, business enterprises and population affected by the disaster: these include damage to social and economic infrastructure and losses of capital stock and inventories;
- the indirect effects which result from the decline in production and in the provision of services: these include loss of revenue due to disruption of production and services, and increased costs of goods and services; and
- the secondary effects which may appear some time after the disaster: decreases in economic growth and development, increased inflation, balance of payment problems, increases in fiscal expenditures and deficit, decreases in monetary reserves, etc.

In focussing on the economic and social aspects of the impact of natural disasters, the ECLAC definition fails to take into account the effect of disasters on the resource base and the corresponding impact on development, or to paraphrase the title of this conference, the linkage between environment and economic development. Landslides and accelerated erosion caused by tropical storms reduce agricultural productivity. Damage to the vegetative cover in water catchment areas affects the quality and quantity of water at the intake. Destruction of mangroves reduces productivity of inshore fishing activities. Resource deterioration through damage and irreversible change has significant and long term negative effects, which should be assessed as direct effects on economic growth.

Small island nations are particularly vulnerable to natural disasters since they can be affected over their entire area, and major infrastructure and economic activities may be crippled by a single event. Scarce resources that were earmarked for development projects have to be diverted to relief and reconstruction, setting back economic growth.

The direct effects of Hurricane Gilbert on Jamaica in 1988, as estimated by the Planning Institute of Jamaica, amounted to a total loss of US\$ 956 million, with nearly half from losses in agriculture, tourism and industry, 30% in housing, health and education infrastructure, and 20% in economic infrastructure. Economic projections for 1988 had to be adjusted dramatically, based on expected losses in export earnings of US\$ 130 million, and lost tourism earnings of more than US\$ 100 million. Instead of a growth in GDP of 5%, a

decline of 2% was now projected. Other changes induced by the disaster were expected increases in inflation (30 %), government public expenditures (US\$ 200 million) and public sector deficit (from 2.8% to 10.6% of GDP).

### 3. Risk perception in the case of natural hazards

In the economic analysis framework commonly used by planning and development financing agencies to make decisions on investments, the potential threat posed by natural disasters to capital stock and productive assets can be treated as a risk or uncertainty about return on assets. In the best of cases, this uncertainty can be expressed as a probability, making it amenable for incorporation in the analysis framework through quantification. When information about the uncertainty is less structured, other techniques will have to be employed.

Natural disaster risk is a function of the likelihood of occurrence of a hazardous event, and of the vulnerability of the system at risk. Vulnerability is a complex concept, which includes not only the question of physical resistance of structures to the forces of the hazardous event, but extends to the function performed by the system, and the likelihood of disruption in case of damage to the structures. Its complexity increases with that of the system it derives from, and concepts such as social resilience and economic robustness are added to the more common definition of physical resistance.

Areas where natural disaster risks occur are known as hazard prone areas. The impact of landborne flooding on low lying areas can be accurately delineated in function of topography and predicted magnitude of the hazardous event. The areas of impact of other hazardous events such as landslides, earthquakes and hurricanes are less predictable and are commonly zoned according to the probability or possibility of effect. Negative effects of hazardous events can often be lessened or prevented through the avoidance of hazard-prone areas, and through appropriate design and engineering standards.

Even though the concepts of economic and financial risk are familiar to those responsible for economic analysis of development projects, risk introduced by the possibility of damage or disruption from a natural disaster is commonly overlooked. Cases abound of development projects subject to significant hazard risk because of inappropriate design or location in hazard prone areas, and even of projects that were rebuilt the same way on the same site after having been destroyed the first time. Other cases can be cited where schools and hospitals funded with bilateral aid were built with design standards suitable for the donor country, but incapable of resisting hurricane strength winds prevalent in the recipient country.

The tourism sector in the Caribbean is notorious for its apparent disregard of the risk imposed on it by hurricanes and associated hazards. A hotel complex built with insufficient set-back from the high water mark not only risks being damaged by wave action and storm surge, but its buildings interfere with the normal processes of beach formation and dune stabilization, and thus reduce the

effectiveness of a natural protection system against wave action. After the first serious damage is incurred the owners of the hotel will most likely decide to rebuild the structure in the same site, and to invest in seawall protection, rather than considering to move the structure to a recommended set-back.

The questions that should be asked in this case are: was the hotel owner was aware of the level of risk to his property when it was first built, and did he at that time have an idea of the expenses that might have to be incurred over the years to protect the investment? A positive answer to the first question alone would not be sufficient for the owner to have considered taking the necessary mitigative steps during before the hotel was built. Some knowledge of the likelihood of long term costs is needed in order to justify in economic terms the up-front investment in loss reduction.

Whereas one can argue that in the case of the previous example the risk is borne fully by a private decision-maker, who is also the owner of the capital at risk, the official responsible for public investment decisions cannot afford to ignore the possibility of a natural disaster and the implied level of risk to the potentially affected population and capital investment. Yet, disregard of natural disaster risk seems to be at least as prevalent in the public sector as it is in the private sector. The main reasons for this can be listed as follows:

1. The decision-maker is unaware of the risk, or has pre-judged it as being insignificant.
2. The decision-maker recognizes the risk, but accepts it as inevitable, since he or she does not know what to do about it.
3. The decision-maker is aware of the risk, has some knowledge about response options, but cannot determine which response is worth implementing.

#### **4. Strategies for improving risk perception and response**

Let us now see how we can deal with these problems in risk perception. The challenge facing those who want to promote an explicit treatment of disaster risk in investment decision-making starts with recognizing exactly what situation the decision-maker finds himself in. The first situation calls for a broad based exploration of the origin of the disaster risk, and of the possible responses to it. Relevant information has to be produced and presented in a way to impress on the decision-maker that the level of risk can be determined, and that different options exist as response to the risk. The techniques used are hazard assessment and vulnerability analysis.

The second situation is addressed through systematically identifying the different options to reduce the vulnerability or the risk. The technique used

here is the formulation of a mitigation strategy and plan. The last situation is perhaps the easiest to recognize, but requires the most demanding response in terms of technical expertise. A variety of techniques can be used to estimate the level of risk posed by natural disasters on an existing or future investment.

#### 4.1 Improve hazard awareness

An assessment of natural hazards is carried out to determine in a systematic way what hazardous events can occur that can impact on the system under study -- be it an area, sector, or project -- and what, in broad terms, the effect of the impact could be. Further detailing of the potential impact by relating level of damage to the intensity of the forces affecting the system is the domain of vulnerability analysis. Documentation of past disasters impacting on the same area is an essential part of the assessment, and is also very effective in enhancing hazard risk awareness. Much of the efforts in hazard assessment will be directed at reviewing existing information, mainly of a scientific nature, and transforming it into information that can be used by planners and investors to guide their decision-making with respect to locating settlements and economic activities.

Hazard assessments can be carried out in various forms, and should be structured to correspond to the information needs experienced by those responsible for the formulation of the project. Hazard susceptibility maps or impact zonation maps covering a region or an entire country prove to be very useful in cases where location of the project is a variable, or where an investment in lifeline infrastructure is being considered. A typical example of this type of exercise is a preliminary assessment of the natural hazard affecting St. Kitts, undertaken in support of settlement development planning in the island. (OAS, 1986). The results of this assessment, a summary of which is shown in Figure 1, served as a basis for identifying hazard mitigation and disaster prevention opportunities in the context of integrated development planning.

Vulnerability analysis is the technique in which damages are quantified in function of intensity and magnitude of the event, and of the physical and socio-economic characteristics of the system. Before this detailed analysis can be undertaken on a complex system, it is necessary to recognize the different dimensions of overall vulnerability, by identifying all elements that may be affected, and analyzing how each one may be impacted by the hazard and what the consequences of impact may be. An example of a framework in which such an assessment may be undertaken is given in Figure 2. It was developed as part of a proposal to analyze the vulnerability of the tourism industry in a Caribbean nation, and shows how the main elements of the sector could be affected by a hurricane, with the consequences for the sector and for the wider economy.

#### 4.2 Improve understanding of mitigation

The second situation presents a bigger challenge. To change a decision-maker's perception from risk as being inevitable to one of risk as a manageable aspect of a situation, he or she will need to be convinced that realistic mitigation alternatives exist and that it is worthwhile to invest in them. This

FIGURE 1

## ST. KITTS: PRELIMINARY IDENTIFICATION OF NATURAL HAZARD PRONE AREAS

Impacting elements	Hazard Type						
	Earthquake	Volcanic Eruption	Wind	Hurricane	Flood	Debris Flow	Landslide
	Ground shaking, most acute on slopes over 20%	Ash drop, gas emission, projectiles	Lava flow	Surge Tide	Rising Water	Rock, sediment mud	Rock, alluvial material, soil
Hazard prone area	Entire island, most acute on slopes over 20%	Entire island	Entire island	Coastal and inland areas lying below 20 feet elevation above mean sea level; coastal areas within 100 feet of the sea; habitat space below or at 10 feet above mean sea level	Coastal areas more than 100 feet from the sea and island areas, both lying below 20 feet elevation above mean sea level; gut areas up to 10 feet elevation above actual gut bottom	Gut areas up to 20 feet elevation above actual gut bottom	Coastal and other cliff areas; gut head and walls; steep slopes with exposed, loose rock (rock slides)
		<p>Mount Liamurga: all watersheds north and west including Godwin and Georges Guts</p> <p>Verchil'd's Mountain: Godwin, Church, Merrifield, Georges, Bakers, Christ Church and Lodge watersheds</p> <p>Olivees Mountain: all watersheds south and east including East River and Ottleys guts, but north and west of the Main Road between Basseterre and Canada Estate</p>					

Source: "Report on Natural Hazards Assessment and Settlement Development Planning in St. Kitts and Nevis," OAS-Department of Regional Development, 1986.



FIGURE 2

FRAMEWORK FOR ASSESSMENT OF HURRICANE HAZARD IMPACT ON TOURISM SECTOR

Elements	Type	Hazard effect	Sector impact	Country impact
INPUTS				
Supplies	<ul style="list-style-type: none"> <li>-produce</li> <li>-consumer goods</li> <li>-crafts/souvenirs</li> </ul>	<p>interruption of supply</p>	<p>shortages substitution with imports</p>	<p>loss of revenue increased demand on foreign exchange</p>
Services	<ul style="list-style-type: none"> <li>-local transport</li> <li>-entertainment</li> <li>-sports</li> </ul>	<p>disruption</p>	<p>reduced offerings to guests</p>	<p>loss of revenue</p>
Labor	<ul style="list-style-type: none"> <li>-employees</li> </ul>	<p>loss of life and injuries staying home to tend to private matters</p>	<p>loss of staff employee absenteeism</p>	<p>social welfare expenditures</p>
INFRASTRUCTURE				
Water and sanitation	<ul style="list-style-type: none"> <li>-main connection</li> <li>-on site storage</li> <li>-waste water treatment</li> </ul>	<p>interruption of supply storage and treatment breakdown</p>	<p>water rationing water purchase polluted discharge</p>	<p>repair costs loss of revenue negative environmental effects</p>
Electricity	<ul style="list-style-type: none"> <li>-main connection</li> <li>-on site generation</li> </ul>	<p>interruption of supply generator breakdown</p>	<p>loss of supplies loss of services reduced comfort</p>	<p>repair costs loss of revenue</p>
Local transportation	<ul style="list-style-type: none"> <li>-access to site</li> <li>-access to services</li> <li>-access to airport</li> </ul>	<p>blocked access lack of transportation for employees and guests</p>	<p>disruption of services safety hazard loss of business</p>	<p>repair costs loss of revenue</p>

Elements	Type	Hazard effect	Industry impact	Country impact
Communications	-telephone -telex -radio	disruption	loss of services loss of business	repair costs loss of revenue
International transportation	-airport -port	interruption in traffic	interruption in supplies guest no-shows loss in cruise business	repair costs loss of revenue loss of foreign exchange
Natural resources	-beach front -dunes -scenic attractions -reefs	destruction partial or total loss	loss of amenities loss of naturally occurring protection rehabilitation costs	rehabilitation costs loss of revenue
CAPITAL STOCK				
Structures	-hotels -restaurants -sports facilities -shops	partial or total destruction	safety hazard repair costs loss of business	loss of revenue loss of foreign exchange increase in unemployment
Equipment	-food processing -climatization -data processing -communication -sports equipment	partial or total damage	safety hazard repair costs loss of services loss of business	loss of foreign exchange
HUMAN RESOURCES				
Guests	-overnight guests -day visitors	safety and health hazard discomfort	liability for guest welfare	liability claims
Employees	-staff -wage labor	safety and health hazard	liability for employee welfare	social welfare expenditures

will require a systematic identification and clear formulation of different mitigation measures, their expected effect on the reduction of the risk, and some preliminary estimate of their implementation cost.

The measures taken to mitigate the effects of natural hazards can be classified in two broad categories. Structural mitigation measures are physical measures introduced to reduce the vulnerability of what is at risk. These measures can consist of the erection of structures such as dams or retaining walls, of agricultural practices such as planting windbreaks or terracing slopes, or of the application of more stringent building codes and technical parameters. Non-structural measures are policies and practices of development which, when put into effect reduce the risk to the development. Land use zoning, crop diversification, relocation out of a flood zone, and the use of forecasting and warning are all non-structural measures. A summary overview of both types of measures, their implementation costs and benefits can be seen in Figure 3.

#### 4.3 Analyze costs of mitigation against benefits derived from implementation

The last situation is the one where awareness of disaster risk exists, but where the necessary expertise to determine how much to invest in mitigation is lacking. The key element in this decision process is the estimation, with a reasonable degree of accuracy, of the costs and benefits of the different mitigation options. Economic analysis dictates that a mitigation measure should only be implemented when the net present value of expected loss reduction exceeds the implementation cost. Mitigation measures can be implemented as part of a new investment project, in which case mitigation costs are added to the cost of the project, and the expected reduction in losses is incorporated in the project benefits. If mitigation is to be implemented as a stand-alone project, it will have to be justified in terms of its own costs and benefits, with the benefits consisting mainly of the reduction in losses to the system that is receiving the protection.

What follows is a brief description of a selection of methods to incorporate risk in benefit-cost analysis. The choice of a particular method will depend on the information produced in the earlier phases by the natural hazard assessment and vulnerability analysis. More accurate techniques are possible if key natural hazard and other variables can be estimated as probability distributions; without probabilistic information, cruder methods have to be employed. A more detailed description of these techniques can be found in a "Primer on Natural Hazards" by the OAS Department of Regional Development, currently under preparation.

A first set of techniques is used when the information produced by the hazard assessment and vulnerability analysis is limited to episodic descriptions of past disasters and damages, and of conditions surrounding the impact of the disasters:

FIGURE 3

INTRODUCING HAZARD PREVENTION IN PROJECT DESIGN:  
OPTIONS, COSTS, AND BENEFITS

	Type of Mitigation Measure	
	STRUCTURAL	NON-STRUCTURAL
Definition	Physical measures or standards designed to reduce vulnerability to natural hazards	Policies and practices of development and investment designed to avoid risk from natural hazards
Examples	Building of protective structures like levees, retaining walls Use of more stringent building standards Aforestation Coastal fortification	Land-use zoning Forecasting and warning Relocation Resource management to save natural protective systems Fiscal Measures Insurance
Implementation cost	Substantial direct costs of building physical structures or in using more stringent standards for new construction or for retrofitting Cost of carrying out detailed vulnerability analysis	Usually less substantial costs incurred in implementing land use control and protection measures, or building forecasting systems Opportunity costs of foregone land use Substantial social and economic costs of relocating population
Operation and maintenance costs	Costs to operate and maintain physical structures that were built to protect the project	Enforcement costs of zoning and conservation measures Maintenance costs for forecasting/warning equipment
Benefits	Costs avoided through reduction in vulnerability of the project Transfer of benefits to private sector	Costs avoided through reduction in risk to the project, and benefits derived from alternative uses
Main project appraisal techniques	Benefit-cost analysis	Cost-effectiveness and cost-risk analysis

1. The use of a cut-off period for calculation of project costs and benefits.

This is perhaps the crudest method of dealing with uncertainty. The decision-maker in essence gambles on enjoying a disaster-free period long enough to realize the return on capital he or she requires.

2. Adjustment of the Discount Rate.

A more or less arbitrary risk premium is added to the discount rate to reflect the increase in uncertainty about future costs and benefits.

3. The use of Game Theory Strategies.

Costs and benefits of different implementation options for the same project can be compared under various disaster scenarios, and the preferred option is selected in function of strategies that either maximize the minimum gain or minimize the maximum shortfall.

4. Sensitivity Analysis.

The values of key parameters subject to uncertainty from disasters are changed in function of that uncertainty to determine their effects on the NPV of the project.

A different set of techniques can be used when investigations into the hazards affecting a project and their possible impact were able to yield probabilistic information on the occurrence of such events, or directly on the impact the events would have on the costs and benefits of the project, and thus on its NPV. These techniques are:

5. Mean-Variance Analysis.

Alternative projects, or different implementation scenarios are selected based on comparisons of the expected value (mean), as well as on the risk (variance) of the probability distributions of the NPV.

6. Safety-First Analysis.

In this case, only potential losses from disasters are taken into account by selecting project alternatives that maximize NPV subject to avoiding losses that exceed a preset amount.

## 5. Making disaster risk management an integral part of the development planning process

In June of this year, the World Bank Environment Department organized a colloquium on "Disasters, Sustainability and Development: a Look at the 1990's" in which experts from the Bank and other agencies involved in international development assistance discussed ideas, beliefs, facts and projections about the relationship between disasters and economic development. The high degree of interest displayed by the participating agencies in this relationship should be seen as an encouraging step towards a more explicit treatment of disaster risk in the economic development of developing countries. Two observations from this colloquium merit to be highlighted:

The first is that agencies present in the colloquium expressed a growing sensitivity to the interaction between development and environment, and in particular to its influence on the vulnerability to disasters. As stated by the coordinator of the colloquium, the extent of damage resulting from natural hazards is to a significant degree a function of the decisions made, activities undertaken, and technologies utilized during the process of development (Kreimer, 1989). Acceptance of this relationship by the major development assistance agency should greatly strengthen the basis on which realistic and effective mitigation of natural disasters can be introduced into development planning in developing countries. Once it is recognized how development decisions contribute to vulnerability to disasters, it will be much easier to justify amending these same decisions to include mitigation in the development.

The second observation is that several of the World Bank staff participating in the colloquium indicated that better ways in which to finance mitigation measures have to be found. Opportunities will have to be identified beyond the traditional reconstruction and rehabilitation loans, and should include mitigation components in non-emergency projects, or stand-alone hazard mitigation projects for disaster-prone regions or countries. More attention will have to be given to improving the technical and political aspects of the decision making for determining acceptable levels of disaster risk, and for weighing acceptable risk against the willingness to pay for mitigation.

We also have to recognize that governments in developing countries have had little success so far with including natural hazard management in their development planning, and with implementing disaster prevention in their communities. The obstacles encountered in promoting mitigation are complex, and combine elements of a political, institutional, and technical nature. A detailed discussion of these obstacles can be found in a paper on "Incorporating Natural Hazard Assessment and Mitigation into Project Preparation" prepared by the OAS for the Committee of International Development Institutions on the Environment (OAS 1987). Some of these obstacles of particular relevance for the region are:

1. Political pressures for providing shelter and basic services to an ever growing population while faced with insufficient financial resources;
2. Inadequate knowledge of mitigation options, both of a structural and non-structural nature;
3. Weak institutions and shortage of trained manpower and information to formulate mitigation plans, including investment projects, and to supervise their implementation; and
4. Insufficient economic resources to implement and enforce realistic mitigation measures.

In view of these obstacles, I would like to propose that developing countries adopt a disaster prevention strategy that overcomes the limited capacity of the public sector, and makes the best use of the resources available to the private sector. International development assistance agencies should take the lead in initiating this strategy, by integrating it in their financial and technical support programs designed for these countries.

The proposed strategy is sector specific, and is intended to be carried out with maximum involvement of the different interest groups of the sector, and in particular, those that are directly affected by disasters. It is believed that this approach is most effective in raising the hazard awareness of decision-makers in the sector, and in facilitating implementation of recommended loss-reduction measures. It would consist of the following four steps :

1. Select critical or priority sectors in the national or regional economy, and identify interest groups directly affected by disasters.
2. For each sector selected, carry out, with direct involvement of those interest groups, a hazard assessment, a vulnerability analysis, and the identification of possible mitigation options.
3. Prepare a systematic economic analysis of the loss-reduction alternatives for the sector. Realistic estimates will be needed of the costs of mitigation measures and of the losses avoided to the sector and the economy as a whole by implementing these.
4. Adopt an effective institutional framework in which public, private, and community interests can agree to set priorities among loss reduction measures and cooperate in their implementation.

## CONCLUSION

The General Assembly of the United Nations has established that the 1990's will be the International Decade for Natural Disaster Reduction. It is to be hoped that the expected increase in worldwide attention to natural disasters will be matched by an increased commitment of resources to loss reduction on the part of governments and multilateral development assistance agencies. The planning community can play a critical role in bringing this about when it succeeds in making hazard assessment and mitigation an integral part of the development planning process.

Several important tasks will need to be tackled. First, more has to be done to improve the utilization of basic research on natural hazards produced by the scientific community. In its present form, much of this information is ill suited to support planning decision-making. Second, treatment of disaster risk has to be fully integrated in the practice of economic analysis of development projects. Innovative adaptation of existing techniques and divulgation of successful case studies will be needed to bring about a change in policy and practice in the leading development financing agencies. And third, more effective institutional frameworks have to be devised in which to implement disaster mitigation. There should be a shift away from a reliance on already overburdened government agencies towards private interest involvement in sector specific loss reduction programs and a greater participation of affected communities.

The ultimate success of the Decade will depend to a large extent on how well we will be able to convince planners and politicians during the first few years of the Decade that mitigation of natural hazards is essential to realize the long term development potential of the Third world.



## BIBLIOGRAPHY

1. Bender, Stephen O., "Urban Growth, Environmental Change, and Natural Hazards in Latin America and the Caribbean," Annual Meeting of the Association of American Geographers, Baltimore, Maryland, 1989.
2. Jovel, Roberto, "Economic and Social Consequences of Natural Disasters in Latin America and the Caribbean," United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC) Santiago, Chile, 1989.
3. Kreimer, Alcira, "Disasters, Sustainability and Development: A Look to the 1990's," Paper prepared for Colloquium with same title, World Bank, Washington, D.C., 1989.
4. Office of Foreign Disaster Assistance, "Disaster History: Significant Data on Major Disasters Worldwide, 1900 - present," U.S. Agency for International Development, Washington D.C., 1988.
5. Organization of American States, "Incorporating Natural Hazard Assessment and Mitigation into Project Preparation", Report to the members of the Committee of International Development Institutions on the Environment, Washington, D.C., 1987.
6. Organization of American States, "Report on Natural Hazards Assessment and Settlement Development Planning in St. Kitts and Nevis," Report by Stephen O. Bender, Department of Regional Development, Washington D.C., 1986.
7. Tomblin, John, "Earthquakes, Volcanoes and Hurricanes: A Review of Natural Hazards and Vulnerability in the West Indies". Ambio Vol. 10 No. 6, 1981.
8. United Nations Disaster Relief Organization (UNDRO), "Disaster Prevention and Mitigation, Vol. 7, Economic Aspects," United Nations, New York, N.Y., 1979.