THE WORLD BANK

POLICY PLANNING AND RESEARCH STAFF

Environment Department

# Analyzing the Costs and Benefits of Natural Disaster Responses in the Context of Development

*Mary B. Anderson*

*May 1990*

Environment Working Paper No. 29

This paper has been prepared by Dr. Mary Anderson, Consultant to the Environment Policy and Research Division of the Environment Department, The World Bank. The author wishes to acknowledge critical comments and insights in early drafts of this paper by Herman Daly, John English, William Magrath, Mohan Munasinghe and Jeremy Warford, all of The World Bank. The author wishes to express special appreciation to Alcira Kreimer who initiated this effort and who, also, provided many insightful and helpful suggestions along the way.

## FOREWORD

Disasters impact development. Bank lending for emergencies has expanded since 1970, particularly in the second half of the 1980s. In the period 1970-90, about one hundred Bank-financed operations were targeted to emergency reconstruction after disasters. The Bank's principal mechanisms for responding to emergencies are self-standing operations. But other mechanisms are also used, such as adjusting programs in the pipeline or reallocating proceeds under existing loans with uncommitted, undisbursed amounts. These mechanisms are used when, in an emergency, the government and implementing agencies change priorities and adjust their investment programs to respond to the crisis. In fiscal years 1988 and 1989, the amount devoted to emergency recovery was about US$1.5 billion, including self-standing reconstruction loans and reallocations of operations with uncommitted undisbursed amounts. In recent years, special efforts have also been made to identify preventive measures and to include disaster prevention and mitigation in development projects.

In countries hit by disaster, a typical question is, why are we so vulnerable? Vulnerability and poverty go hand in hand, and it is not easy to find quick fixes. A relevant question that has been asked in the past is how much should be invested in prevention and mitigation vis-a-vis recovery?

The following paper is one in a series addressing the issue of disasters and sustainability. It discusses the challenge we now face in assessing the economic losses from extreme events and in deciding when, how and how much to invest in preventive activities. Although much remains to be done to answer all the questions prompted by extreme events in developing countries, it is our hope that this paper will contribute towards a well balanced understanding of the integration of disaster prevention and mitigation in development.

Alcira Kreimer
Senior Environmental Specialist
Environment Department,
The World Bank
Washington, May 1990

# ANALYZING THE COSTS AND BENEFITS OF NATURAL DISASTER RESPONSES IN THE CONTEXT OF DEVELOPMENT

## Abstract

1. The paper asks the question, "Which is more cost effective for a developing country -- disaster prevention or disaster recovery?" The general approach of benefit/cost analysis is used, but the focus is on understanding the circumstances which are particular to the developing countries which affect the choice between prevention and recovery.

2. Disasters are costly to all countries. One study shows that between 1970 and 1985, disasters of only three types (wind-storms, floods and earthquakes) cost on average US$18.8 million per day. The impact of disasters is disproportionately high on the developing countries, with the losses to GNP due to disasters being about twenty times greater in the developing countries than in those which are more developed.

3. Assessments of the costs of disasters include consideration of both the actual immediate impact on physical assets, employment and output as well as the impact on future economic prospects. Costs of disasters are assessed in three categories: direct costs, indirect costs and secondary costs.

a. Disasters happen more often and have a proportionately greater impact on poor countries than rich countries.

b. Development programs and projects can, themselves, actually increase disaster proneness if care is not taken to prevent this.

c. Development resources and investments are frequently wasted through failure to consider disaster proneness of countries where these resources are invested. The waste occurs both when infrastructure is unnecessarily wiped out; it also occurs when plans and priorities must be changed to respond to a preventable disaster.

5. Citing evidence that wealthier countries do, in general, find prevention economically and politically preferable to recovery, the paper ten examines the circumstances which are peculiar to the developing countries which may alter the calculation of benefits and costs in these circumstances. Four special circumstances are identified which, in fact, mean that the costs (and, in particular, the indirect and secondary costs) of disaster recovery are higher in developing than in developed countries. These are:

a. Losses to disasters as a percentage of national wealth are higher in developing than in developed countries.

b. Disasters and poverty are mutually reinforcing.

c. Disasters, especially repeated ones, have a negative impact on investment and entrepreneurial incentives which are necessary for development.

d. Disasters have special negative impacts on the nonformal economic sector, and in countries where this is an important sector, estimates of the costs of disasters are consistently underestimated.

6. The paper concludes that, for developing countries, it is not only more cost effective to prevent disasters tan 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.

TABLE OF CONTENTS

# ANALYZING THE COSTS AND BENEFITS OF NATURAL DISASTER RESPONSES IN THE CONTEXT OF DEVELOPMENT

## I. Setting the Question

### I.1 Introduction

"A stitch in time saves nine," wrote the American inventor and philosopher, Benjamin Franklin. This straightforward admonition that preventive actions taken early can save costly repairs later would seem to contain a message for the governments of disaster prone nations and for the lending and donor institutions which provide funds to these governments. Applied to situations where disasters are apt to occur, this aphorism argues for investing resources in activities focussed on preventing disasters rather than waiting until after a disaster to allocate resources to recovering the losses of life and property.

But policy-makers and economists are not so easily persuaded. They point out that it is necessary to consider the opportunity costs of the stitch "in time." "What," they ask, "does it cost us to take the present stitch relative to the later costs (discounted to the present) of the nine stitches? Is it better to take only one stitch now, or two? And, how do we know if the rip will occur and, if so, when it will occur?" The choices about where, when and how much of a nations's resources should be used to prevent an uncertain event is much more complicated than our Mr. Franklin's terse statement acknowledges.

### I.2. The Question of this Paper

In this paper, we shall explore the choices which governments of disaster-prone developing countries face as they adopt programs for economic and social development and attempt, at the same time, to manage the losses and suffering from natural disasters. The question we shall ask is, "Which is more cost effective for a developing country--disaster prevention or disaster recovery?" By posing the question this way, we focus explicitly on the implications of prevention versus recovery for long term, systemic development. To a large extent, we shall rely on the approach of benefit-cost analysis to examine the issues which governments--and their donors--must consider as they decide when, where and how much of their resources to allocate for disaster response.

To address the question of the relative cost effectiveness of disaster prevention versus recovery in the context of development, we need first to define what constitutes a disaster and, then, to examine the relationship between disasters and development. This latter step--understanding the linkages between disasters and development--is critical in

the assessment of the benefits and costs of prevention and recovery. The occurrence of disasters very frequently undermines development efforts and leads to waste of development resources. Our examination of these issues is directed toward avoiding the misallocation of scarce development resources.

In Section II, below, we shall set out the definitions with which we are working and explore the linkages between disasters and development. In Section III, we will look at the tacit models of choice between disaster response alternatives that exist in the developed world and will examine how the different circumstances facing the developing countries affect their decisions between adoption of prevention versus recovery strategies. In Section IV we shall, then, look at the benefits and costs of the prevention and recovery approaches in the circumstances of different disaster types. Our focus throughout will not be on the theoretical and methodological arguments that arise in attempting to assess alternative costs and benefits. Rather, we shall focus on the set of factors of which policy makers should be aware as they make decisions about their approaches to disasters and to development. The paper concludes that, given the capacity for forecasting and preparing for disasters to which all societies now have access, the failure to allocate resources to disaster prevention is both inefficient and wasteful.

## II. Definitions and the Relationship between Disasters and Development

### II.1. Definition of Disasters

Frederick Krimgold[1] defined a disaster as a crisis event which outstrips the capacity of a society to manage or cope with it, at least for a time. This definition is closely matched by the definition of emergencies applied by the World Bank for deciding whether or not Emergency Recovery Assistance is warranted. The Bank specifies that a disaster is "an extra-ordinary event of limited duration, such as war, civil disturbance, or a natural disaster (e.g., earthquake, flood, hurricane), which causes serious dislocation to a country's economy."[2] Furthermore, for the Bank to consider emergency assistance, the event must be on a significant enough scale to "cause the government to modify its economic priorities and programs sub-stantially,"[3] i.e., to alter, at least for a while, its development strategy.

Underlying Krimgold's and The Bank's definitions is an understanding that not every crisis event is a disaster. Even though an earthquake may be severe, if it occurs in an unpopulated area or in a populated area where there

---

[1]. Frederick Krimgold in: Overview of the Priority Area Natural Disaster, United Nations, New York (15th October 1976).

[2]. World Bank, Operational Directive OD 8.50: "Emergency Recovery Assistance," September, 1989, Washington, D.C., p.1.

[3]. President's Memorandum, "Lending by the Bank for Emergencies," prepared for consideration by the Executive Directors' Meeting on November 10, 1988, Washington, D.C., p.15.

has been sufficient preparation for such a crisis so that damage is minimal (as in San Francisco in October 1989), it may not become a disaster. That is, it does not exceed the society's coping capacity (nor does it qualify for World Bank emergency lending). In this paper, we use the term "disasters" to refer to events which usually have a "natural" basis (winds, water, land movement) but which also have human and societal aspects as well. It is the negative impact of a natural phenomenon on human life--its economy, its society, and its polity--that justifies the term "disaster."

## II.2. The Importance of the Question: The Relationship between Disasters and Development

It is important to consider the relative cost effectiveness of disaster prevention and disaster recovery in terms of their potential impacts on the long term development of the developing countries because there is a basic relationship between development and disaster proneness. Oddly, disasters are seldom discussed in the development literature though development is discussed in the disasters literature. But, as we shall show, an understanding of the relationship between disasters and development is of central importance for efficient development planning in disaster prone areas. There are three reasons why the disaster "variable" should be integrated into development planning if such planning is to be effective.

### 1. Disasters are linked to poverty.

The first reason why development planners should consider disaster proneness in their planning is that poverty increases disaster vulnerability. Most disasters (by the definition of events which outstrip the capacities of a society to cope) occur in poorer countries, and the people who suffer most from disasters are almost always the poor people of any society.[4] One study estimated that 95% of deaths which are the result of disasters occur among the 66% of the world's population that lives in the poorer countries.[5] For

---

[4]. Analogous and related findings exist within the literature on environmental management and sustainable development. It is the poorer countries "which are most vulnerable to the effects of environmental degradation" and "it tends to be the poorest people in those countries who suffer most from environmental degradation." Warford, Jeremy J., "Environmental Management and Economic Policy in Developing Countries," in Schramm, G. and Warford, J.J., Environmental Management and Economic Development.. A World Bank Publication, Johns Hopkins University Press, Baltimore, 1989., p.7.

[5]. UNDRO, 1976.

example, in Japan, the average annual death toll from natural disasters is 63, while in Peru, with similar natural hazard occurrence, the annual death toll is 2,900.[6]

In addition, though natural events which cause loss of property and life occur in every country, the losses, when seen relative to the resources which a country has, represent a higher burden on the poorer countries. Even though economic losses from disasters may be absolutely higher in the wealthier countries because there is more property of higher value to be damaged, the loss of GNP due to disasters is estimated to be about twenty times greater in developing countries than in developed countries.[7] Thus, one basic aspect of the relationship between disasters and development lies in the fact that poverty increases the likelihood that any crisis event will become a disaster.

2. Development can increase disaster proneness.

The second reason for integrating disaster awareness into development planning is that, under some circumstances, development itself can increase the likelihood of disasters. Given the relationship between poverty and disaster proneness, one might have assumed that any dollar spent on decreasing poverty--that is, on development--could be thought of as a dollar spent on disaster prevention. While this is largely true, the opposite also occurs. For example, the development of industry increases the possibility of industrial accidents, some of which, such as that which occurred in Bophal, India, are disasters. Some development projects, planned without recognition of local natural hazards, directly contribute to increased disaster proneness without any consideration of this fact. Examples include projects to construct human settlements in earthquake prone regions without an adequate understanding of the seismic activity in the area or without inclusion of earthquake resistant building techniques.[8] And, development sometimes leads indirectly to an increase in disaster probability. For example, improved human and animal health and nutrition have been one cause of overpopulation in some regions, resulting in overgrazing and land depletion to the point of environmental deterioration and ecological crisis. Or, populations have moved to urban areas for productive employment but, because of a lack of planning, they have inhabited lands which are susceptible to flooding and/or mudslides. As these examples illustrate, the environment is often the point of interface between developmental programming and disaster vulnerability.

---

[6]. Anderson, Mary B., "A Reconceptualization of the Linkages between Disasters and Development," Disasters: The International Journal of Disaster Studies and Practice., Harvard Supplement, Vol.9, 1985, p.46.

[7] Funaro-Curtis, Rita, "Natural Disasters and the Development Process: A Discussion of Issues," Office of Foreign Disaster Assistance, U.S. Agency for International Development, Washington, D.C., July 1982, p. 1.

[8] Kreimer, Alcira, "Reconstruction after Earthquakes: Sustainability and Development," Divisional Paper No. 1989-3, Environment Department, Policy and Research Division, the World Bank, Washington, D.C., July 1989, p.2.

It is a fact that every development program or project in disaster prone countries either increases or decreases the likelihood of disasters. On the one hand, when development investments increase a country's capacities to cope with natural hazards (to predict, manage, insure against or shore up against them), they contribute to disaster prevention. On the other hand, when development spending is undertaken without an awareness of disaster proneness, it may create the possibility of a new disaster or increase the potential negative impact of existing natural crises.

3. Development resources are frequently wasted through failure to consider disaster proneness.

This leads us to the third and, in terms of development assistance, the most important reason for understanding the linkages between development and disasters. This is, when development projects are undertaken without regard for disaster potential, scarce development resources are frequently inefficiently allocated Investment dollars are lost when a project is financed which is later wiped out by a (predictable) typhoon, earthquake or mudslide. Disasters shorten the economic life of development investments. Yet, there are many examples of donor-funded development projects in disaster prone areas, in which this has occurred[9] or in which a development investment has increased the likelihood of disaster. Even more common is the experience of development planners that a disaster interrupts ongoing programs and diverts resources from their originally planned use.[10] When disaster proneness is well known, failure to factor the likelihood of natural crisis events into planning can represent a serious mismanagement of resources.

Between fiscal years 1987-88 and 1988-89, the World Bank provided just under $2 billion to reconstruction and rehabilitation in new emergency funds and reallocations of existing loans following natural disasters in recipient countries. This amounted to just under 4% of the total portfolio in those two years. While the precise disasters requiring such adjustments could not have been predicted, a review of Bank funding shows that most such funding occurs in countries which are known to be disaster prone. Of the total of disaster response loans provided by the Bank between 1947 and 1989, just over 80% were to countries receiving more than one such loan. Eighteen of the fifty-seven countries receiving these loans, or over one-third, were the recipients of loans for more than one type of disaster and three received

---

[9]. Community built centers and newly acquired livestock wiped out by a typhoon in Asia; export crops, requiring fairly lengthy cultivation period, prone to wind and rain damage from tropical storms in Central America; housing projects built on unstable lands destroyed by earthquake in the Middle East; irrigation projects which increase soil salinity threatening subsistence agriculture in Africa.

[10]. Jovel, J. 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, n.d., p.18.

assistance for three different disaster types. In addition, certain types of disasters consistently received the greatest proportion of emergency assistance. Discounting war emergencies which, since 1947, received a large number of emergency loans, floods and droughts accounted for over one-half the emergency assistance disaster types since the early 1970s.[11] The point here is that a lending institution, such as the World Bank, can with some accuracy predict which of the countries with which it is engaged are most likely to experience severe disruptions of their planned economic activity as a result of natural events and, furthermore, it can predict which types of natural crises will be most apt to cause these disruptions.[12] Because, the occurrence of such disasters affects the returns to investment of any lending venture, rational economic analysis would seem to require recognition of the likelihood of such events.[13] Frequent loan reallocations also represent inefficient resource use, if for no other reason than that the reallocation decisions take time and money and, with straightforward recognition of the disaster proneness of an area, would not have been necessary.

Project documents of a range of donor agencies reveal a mixed record in terms of acknowledging the importance of disaster proneness in making decisions about the economic viability of development projects. Seldom is disaster potential included in the economic analysis sections of project design. In some project papers, the discussion of the potential impact of a disaster appears under the "social analysis" section. One, for example, which dealt with the decision to construct a hydroelectric dam in an area where seismic activity was common, noted that the project should "pay special attention to the social and environmental effects of a major accident at the hydroelectric site." No mention was made of the potential economic effects of damage to the dam from seismic activity nor was the probability of an earthquake considered in the analysis of the project's profitability in the first place.

The third point to be made about the connection between development and disasters, then, is that failure to recognize the linkage often results in

---

[11]. Derived from statistics prepared by Michele Zador of the Environment Department, The World Bank.

[12]. Below, we shall distinguish among disaster types and their predictability as this is important for analyzing benefits and costs of disaster prevention. Here it is important to note that even without full-scale probability analysis, in many countries one can make very accurate assumptions about the likelihood of some degree of destruction of productive resources resulting from natural hazards.

[13]. One way to handle inclusion of likely disasters into analysis of returns on investment would be to use a discount rate that ensured that the returns would be realized shortly after the investment and, therefore, before any disaster could wipe them out. Below, we shall discuss a series of other factors that are peculiar to issues of development that argue for incorporating disaster proneness into development planning in more programmatic ways.

the waste of development resources. **The basic argument for integrating disaster awareness into development planning is that it is wasteful not to do so.**

## III: Consideration of the Cost Effectiveness of Disaster Response Options: The Context of Developing Countries

Given the linkages between disasters and development and the resultant importance of integrating disaster awareness into efficient development planning, questions remain about how to do so. In order to assess the relative cost effectiveness of spending for disaster prevention compared with spending for disaster recovery, we should specify what we mean by prevention and recovery and identify the costs and benefits that should be considered. However, as we shall see, there are problems in establishing clear definitions and in identifying costs and benefits.

### III.1. Definitions of Prevention and Recovery

In principle, we should include in "disaster prevention," the activities which are undertaken before a crisis event to control or mitigate its impact so that damage is prevented or reduced to a level with which the society can cope. In "recovery," we should include only those activities undertaken after a disaster which rebuild the economy/society to its pre-disaster condition or which, as is often said, "get things back to normal." However, in the real world, activities for prevention and recovery overlap making it impossible to achieve such a clear demarcation between them. For example, most governments maintain, on a permanent basis, disaster recovery institutions to mitigate the negative impacts of disasters through rescue and relief. While these operations occur after a disaster, they receive funding and organizational support before and between disasters. In this sense, disaster preparedness is a form of disaster prevention because it is focussed on keeping the impact of a crisis event within the bounds of the society's ability to cope. Similarly, recovery expenditures are seldom intended only to get things back to normal because "normal" was that set of conditions that gave rise to the disaster in the first place. Usually, rebuilding in a recovery phase involves making basic improvements in the capital stock which are designed to prevent or mitigate future disasters. For example, earthquake destroyed housing may be replaced with earthquake resistent housing. The World Bank's recovery and rehabilitation projects almost uniformly include improvement of stock for the explicit purpose of lessening the probable negative impacts of future natural events. The overlapping of the activities of disaster prevention and recovery complicates the analysis of their relative cost effectiveness.

In addition, societies do not, in fact, choose between all prevention or all recovery. In the real world, they allocate their disaster response resources to "buy" some prevention and some recovery, and the real decision for governments is the decision of how much prevention to buy vis a vis recovery. From an economic point of view, the amount of disaster mitigation which is warranted is that amount that can be bought for less than the

costs of the expected losses which are averted through the mitigation efforts.[14] Governments must make a marginal decision and, for this, they need to be able to assess the benefits and costs of the options among which they choose.

## III.2. Benefit-Cost Analysis in the Disaster Context

Benefit/cost analysis involves three basic steps.[15] First, one enumerates all the benefits and costs of an expected activity; second, one puts monetary values on all of these; and, third, one discounts all future benefits and costs into present value terms. Based on these three steps, one would then choose the option in which the net present value of the action is both positive and greater than that of all available alternative actions. In situations where there are known risks of natural hazards, the inclusion of the probability of a crisis event's occurring is essential to solving the problem.[16]

There are important methodological problems in each of these steps. It is not our purpose here to attempt to resolve these. We must, however, mention a few issues of special importance to the questions we have raised about the relationships of disaster responses to sustainable development.

First, not all benefits or costs related to disaster responses are quantifiable. It is particularly difficult, for example, to "price" those which are realized in social, political and psychological terms. While one might be able to estimate the future income which may be lost due to injury or death from disaster, it is impossible to quantify with any precision the emotional losses incurred. When a great deal of economic activity occurs in the nonformal economy (a discussion to which we will return below), even estimating loss of "income" becomes difficult. It is equally difficult to price benefits. For example, how much, precisely, is the sense of security which comes from living in earthquake resistant housing worth? And, even if this can be measured for any individual, what is the political benefit derived by a government which imposes building codes on groups of people (or, conversely, the political cost to a government which does not do so)?

---

[14] Milliman, Jerry W. "A Needed Economic Framework for Flood Plain Management," Water International, 9, 1984, The Netherlands, p.120.

[15] This discussion is based largely on the clear exposition of benefit/cost analysis, including hazard risk, provided by Kramer, Randall A. and Anna Lea Florey, in "Use of Natural Hazard Information in the Economic Analysis of Agricultural Sector Projects," from Course Manual for the Course on the Use of Natural Hazards Information in the Preparation of Investment Projects, Department of Regional Development, Organization of American States, n.d.

[16] Schulze, William D., and D.S. Brookshire, R.K. Hageman, and J. Tschirhart, "Benefits and Costs of Earthquake Resistant Buildings," April 1987, p.935.

Second, as the literature on ecological and environmental impacts of development and disasters notes, it is operationally difficult to add geological outcomes (such as acres lost to desertification or extinction of a species) with economic ones. The costs associated with the loss of non-renewable physical resources are not adequately captured by attempts to price them according to lost production (over infinity?). And, one cannot add acres, ozone and lost income.

Third, a major methodological problem is encountered in the attempt to discount future benefits and costs and to incorporate natural hazard risk into the analysis. Discount rates are the subject of much debate in the literature as is the variety of ways of incorporating risk into benefit/cost analysis. Again, we shall not try to review all of these here. It is important, however, to note an inherent problem in the way some methodologies handle future, uncertain outcomes. Some methods (such as the use of a cutoff period or the adjustment of the discount rate to include a "risk premium") incorporate risk into benefit/cost analysis through statistical manipulations that, in effect, decrease the importance of future events on present decisions. The effect of these approaches is to obscure the differences in long term developmental impacts of different present-day courses of action. On the other hand, game theory and sensitivity analysis, also used to incorporate risk into benefit-cost analysis, tend to highlight potential differences in such outcomes and because of this are, for our purposes, more useful.[17] This is because, in disaster response (as in environmental planning), we are concerned both with the measurable economic benefits and costs of different courses of action and with a host of other realities that affect human existence. Even if it is "cheaper" to let disasters happen than it is to prevent them, it is generally agreed that wide-spread human suffering should be prevented when it is possible to do so. That is, in assessing alternative courses of action to respond to disasters, methodologies which acknowledge and assess the actual outcomes of different courses of action are preferable to those which "handle" these through a mathematical manipulation.

### III.3. Tacit Models in the "Developed" World.

Tacit models exist in today's world in which economic rationality underlies the choice between disaster prevention and recovery. The wealthier countries which consider marginal costs and returns in their decisions do, by and large, prevent disasters. The statistics cited above about the incidence of deaths from disasters in the developing versus the developed world attest to this fact.

A major disaster prevention project to prevent flooding by the Thames River provides a case in point. A headline (December 16, 1982) in the Financial Times of London reported an "End to (the) Threat of Catastrophe" from flooding of the river through construction of the Thames Barrier. The article went on to report that the security against "the disaster that could not now hit London" had been bought at a price of L730 million, but that the

---

[17] Kramer and Florey, op. cit. pp.13 ff.

estimated potential loss of property, if the "demonstrably mathematically certain" flood were not prevented, would have been L3 5 billion. Even with a very long disaster horizon,[18] the decision was made to undertake a major and costly investment in disaster prevention because, though it was unlikely that the generations who paid for the prevention would have suffered from the predicted disaster, the losses when the disaster occurred would be great enough to justify the investment in prevention.

Similarly, as the results of the earthquake in San Francisco in October 1989 illustrated, major investments in disaster prevention had been undertaken in that region's construction industry. The event did not become a disaster (though it had disastrous impacts on some individuals) in that it did not outstrip the capacity of the region to cope. Adherence to building codes which ensured earthquake resistance had added an average of about 4% to building costs, a sizable investment over the years prior to the earthquake.[19] The society judged that these costs were justified to prevent losses of both life and property in the event of an earthquake.

In both this and the Thames project situation, a public was convinced to allocate major resources to disaster prevention. The calculations on which the decisions were made involved marginal economic analysis.[20] However, the decisions have important political and social bases as well. In both situations, it would have been politically unthinkable for the governments not to have undertaken actions to prevent (or mitigate) the disastrous consequences of natural hazards that experts predicted as "certain."

What we have in the models of choice (between prevention and recovery) represented in the richer countries is a calculation that the sum of the economic and political/social costs of destruction from a disaster would be such that some significant investment in prevention/mitigation is justified. The decisions about how much prevention to "buy" are, then, made

---

[18]. The mathematical "certainty" of a disastrous flood was an event predicted for every 2000 years though, according to the mathematician (who subsequently was knighted) who calculated the benefit-cost ratio for the project, the environment of the Thames was changing so that the probability of disastrous flooding was increasing to an event every 1000 years (the probability would reach this frequency by the year 2030).

[19]. Private conversation, November 1989, with James Polshek, architect and designer of earthquake resistant buildings. Schulze, et. al., op. cit., p. 934, estimate that the cost of adding earthquake resistance to the buildings now unprotected in Los Angeles County would be seven billion dollars.

[20]. Marginal economic analysis also has been used, of course, as the basis for decisions not to undertake major investments for disaster prevention. For example, see Holden, Richard, Lee, Richard and Reichle, Michael, "Technical and Economic Feasibility of an Earthquake Warning System in California: A Report to the California Legislature," February 28, 1989, California Department of Conservation, Division of Mines and Geology, Sacramento, California.

with a number of considerations in mind which also have both economic and noneconomic elements. One factor which affects decisions about disaster prevention is, clearly, the state of the art in terms of available technologies for prevention/mitigation. One could not have built the Thames Barrier until certain technologies (engineering knowledge, materials, construction techniques) existed. Once a technology exists, then the degree of its reliability, as well as its cost, affect the choice to use it. The state of the art for predicting natural crisis events also affects decisions about prevention versus recovery.[21]

Opportunities for funding preventive action also affect the decision about whether or not to undertake it. These involve who will pay, under what circumstances and over what time period.[22] The issues are those of the distribution of cost of prevention. Equally important are the distributional issues associated with the costs of not preventing a disaster (i.e., the distribution of the costs of the recovery strategy). These involve the expected severity and extensiveness of damage of any disaster (e.g., volcanic damage can be predicted to remain fairly localized and, depending on what is built at the bottom of the volcano, would have lesser or greater impacts; the impacts of a major Thames flood could be expected to be very widespread). Both the economic and the political perception of the "right" choice is influenced by the public's awareness of the availability of technologies (even if they are expensive as in the Thames) and by the expectation of people that they, or someone they know, may be victimized by a disaster that could have been prevented. In fact, it was a major Thames flood which occurred in 1953, causing extensive property destruction and the deaths of 300 people, that provided the impetus for the decision to build the elaborate Thames Barrier.[23] In fact, very often it is the occurrence of a catastrophic event that leads to a decision to invest in disaster prevention rather than recovery[24], even though for many disasters (such as earthquakes and volcanos), likelihood of a repeat catastrophe is least immediately after an event.

The models provided by the more developed countries lead us to an important conclusion that, very often, sizable investments in disaster prevention are economically and politically justified, even when the potential disaster event cannot be predicted with precision. Under the circumstances which these countries face, such investments are seen as sound and to be preferred to recovery.

---

[21] Holden, R et al, , op. cit., p.2.

[22]. In terms of earthquake resistant building in San Francisco, the costs were spread among all builders or buyers of buildings; the Thames projects was funded through the sale of bonds--a decision to increase the public debt.

[23]. All benefits from these investments are not passed on to future generations; the current generations enjoy "psychic" security from the investments in disaster prevention.

[24]. Dr. Michael H. Glantz, National Center for Atmospheric Research, Boulder, Colorado, quoted in The New York Times, November 14, 1989.

This conclusion could be assumed to apply to all countries unless there were some differences in circumstances to be found among the developing countries which would basically alter the economics and/or politics of the calculations. Thus, we turn now to consider whether and how the circumstances faced by the developing countries differ from those faced by the more developed countries.

III.4. A Consideration of Costs of Disasters: A Comparison between Developed and Developing Countries

Disasters in all countries are costly, both in immediate losses and in longer term consequences. Though it is difficult to assemble data across countries, one report[25] indicates that, between 1970-85, disasters of only three types (windstorms, floods and earthquakes) cost on average US $18.8 million per day and, between 1980 and 1985, affected 216.8 million people or almost 5% of the worlds' population. Another report calculates that, between 1900 and 1976, on average about 60,000 persons were killed and 3 million injured or left homeless by natural disasters each year.[26] Reflecting the disproportionate impact of disasters on countries which are less developed, Jovel[27] reports that in Latin America and the Caribbean region, more than 6,000 lives and more than 1.5 billion dollars are lost to disasters each year.

Assessments of the costs of disasters include consideration of both the actual immediate impact on physical assets, employment and output as well as the impact on future economic prospects.[28] Costs of disasters are assessed in three categories: direct costs, indirect costs, and secondary costs. Direct costs include losses of capital stock and inventories and are valued, by most of the reports on disaster costs, as the costs of replacement. Indirect costs are those reflected in lost income, employment or services which result from lost productive capacity. Secondary costs are those which come as a result of decreases in economic growth and development, such as increased national indebtedness, inflation, and balance of trade deficits.

---

[25] Zupka, Dusan, "Economic Impact of Disasters," UNDRO News., Jan./Feb. 1988, p.19.

[26]. UNDRO, Disaster Prevention and Mitigation: A Compendium of Current Knowledge, Vol. 7, Economic Aspects, New York, 1979, p.57, using data provided from the International Red Cross.

[27]. Jovel, op. cit., p 18.

[28] Latin America and the Caribbean Regional Office of the World Bank, "The Effects of the December 23 Earthquake upon the Economic Position and Prospects of Nicaragua," internal Bank document, April, 1973.

Secondary effects also include costs associated with income or welfare redistribution effects due to price changes and/or which result from the actual disaster response approaches taken.[29]

Because in this paper we are concerned with the question of the best allocation of limited development resources, we must consider whether there are special circumstances that cause disaster costs to be different for developing versus developed countries. In particular, we are interested in whether consideration of the impacts of different disaster response strategies on long term development affects the calculations of their relative cost effectiveness.

The value of property which can be lost through disasters is higher in more developed countries than in less developed countries. Thus, the absolute value of direct disaster costs is usually higher in richer countries. One could conclude, then, that it makes more sense for richer countries to invest more in disaster prevention than poorer countries. (People buy more insurance coverage for more expensive items.) This conclusion would, however, fail to take account of the very important fact that special circumstances faced by developing countries cause the indirect and secondary costs of disasters to be significantly higher there than they are in wealthier countries. These special circumstances can be categorized into four groups.

1. Losses as a percentage of national wealth are higher in developing countries.

First is the fact, mentioned above, that, though absolute costs from disaster losses may be higher in developed countries, the costs of losses as a percent of total assets or of national wealth are higher in developing countries. In addition, the marginal utility of any unit of currency would presumably be less in richer countries.[30] Thus, the impact of the direct losses, as well as the secondary and indirect effects, will be greater the poorer the country. In some instances, 100% of a given asset of national importance could be destroyed (as when a cyclone or earthquake would cause the destruction of a single national university). Estimates are that, as a percent of GNP, disaster losses are overall 20% higher in developing, as compared to more developed, countries.

---

[29] Jovel, op. cit. p. 5, Funaro-Curtis, op. cit., UNDRO, Disaster Prevention and Mitigation: A Compendium of Current Knowledge Vol. 7, "Economics" New York, 1979, pp. 3 ff. and others. Some writers argue that better cost assessment methods are needed to avoid double-counting involved in these three categories which include both "stock" and "flow" concepts. While for accounting purposes this is true, for us, in this paper, the designation of these categories serves the useful purpose of calling attention to both immediate and subsequent, often long term, negative economic effects of disaster losses. See Milliman, op. cit., 1984.

[30]. Herman Daly, The World Bank, personal note.

The proportional impact of a disaster on national wealth varies with the size of the country and population density, with the type of disaster (how localized or generalized it is), with the relationship between disaster type and the economic base of the nation, and with the general level of national assets. Thus, a small island nation, dependant on agricultural exports and susceptible to regular and severe tropical storms that cross the entire island, would experience higher proportional losses than a country where a small group of poor, subsistence farmers lived at the base of a volcano which erupted infrequently. A report of the National Academy of Sciences (1989) noted that a one-meter rise in sea level, which is expected as a result of global warming by the end of the next century, will cover broad areas of Bangladesh, Indonesia and Southeast Asia. These areas are highly populated and depend largely on an agricultural economic base.[31]

The differences in impacts of different types of disasters and the importance of indirect and secondary effects in developing countries are illustrated in the Table below. Hurricanes and floods and drought (affecting the agricultural economic base) can be seen to have higher indirect and secondary effects than the regionally more limited disasters of earthquakes and volcanic eruptions. In three cases (excepting volcanic eruptions), indirect losses and secondary effects are higher than the direct costs due to disasters. Where we have the information, secondary effects are more than double the direct losses from disasters.

Table: Economic Losses of Natural Disasters in Latin America and the Caribbean (Million U.S. Dollars, 1987)[32]

| Losses/ Effects | Earthquakes | Eruptions | Hurricanes | Floods/Drought |
|---|---|---|---|---|
| Total Losses | 9,679 | 224 | 2,485 | 3,970 |
| Direct | 7,671 | 154 | 1,975 | 1,311 |
| Indirect | 2,008 | 70 | 510 | 2,659 |
| Secondary Effects | | | | |
| Public Finances | 4,286 | ... | 1,132 | n.a. |
| Exports/ Imports | 12,567 | ... | 1,076 | 621 |

[31]. Stevens, William K., "Governments Start Preparing for Global Warming Disasters," The New York Times, November 14, 1989.

[32]. Jovel, op. cit., pp.21-22. Source: UN-ECLAC; figures adjusted for inflation through 1987 and secondary effects estimated for 1985 through 1987 and projected through 1990.

2. Disasters and poverty are mutually reinforcing.

The second set of circumstances that alters the calculus of benefits and costs for developing vs. developed countries is the fact that there is a reinforcing cycle of poverty which is exacerbated by the frequent and repeated experience of disasters. As the environmental management experts have noted, "some of the most serious and pervasive environmental problems facing developing countries tend to be both a cause and effect of poverty."[33] Similarly, poverty increases vulnerability to disasters and disasters contribute to the continuation of poverty (often through effects on and from the environment). If the cycle is never broken through the prevention or mitigation of disaster impacts, there is little prospect for effective long term and sustainable development.

Again, this cycle is perpetuated as much or more through indirect and secondary losses and effects as through direct losses. For example, the Economic Commission for Latin America has estimated that, between 1960 and 1974, the damage caused by natural disasters in the five countries of the Central American Common Market resulted in reductions of their average annual growth rates of GDP by about 2.3 per cent.[34] Quite frequently, the poverty/disaster cycle is perpetuated by the impact of a disaster on a country's debt position. When local products, goods or infrastructure are destroyed so that they must be purchased or financed on the international market, the indebtedness of a poor country can be seriously affected. As their debt service burdens increase, countries have fewer resources for investing in productive enterprises which are necessary for breaking out of poverty. Data reflecting these impacts are incomplete and scattered, but those that exist suggest that the impacts of disasters on growth are significant and long-lasting.

3. Disasters undermine incentives for development.

Related to this, but deserving explicit recognition is a third point about the special circumstances which exaggerate the influence of the secondary costs of disasters in developing countries. A climate for development requires sufficient stability and certainty to encourage investment and entrepreneurial activity. The experience of repeated and frequent losses from natural events creates disincentives for investment, creativity and hard work. Repeated losses from disasters, were they to occur, would create similar disincentives and losses in productive investment in wealthier countries. However, as we have seen, control and limitation of disaster impacts in wealthier countries also limit the negative impacts on

---

[33]. Gunter Schramm and Jeremy J. Warford, "Introduction" to volume on Environmental Management and Economic Development., A World Bank Publication, Johns Hopkins University Press, Baltimore, 1989, p.1 (emphasis mine).

[34]. UNDRO, Disaster Prevention and Mitigation, op. cit., p.1.

incentives. For developing countries, the ability to attract both domestic and foreign investment and to encourage entrepreneurial activity is undermined by repeated disasters.

One example of the negative impact of repeated disasters on the climate for business and investment is provided by the experience of insurance agents in Fiji. A business report written in March 1985[35] noted that "Fiji's twin hurricanes left much more than $80 million damage. They put the nation's future in jeopardy...Put bluntly, Fiji at present is virtually uninsurable against hurricanes. After 17 of them in nine years, and three in less than two years with a total of more the $130 million in insurance claims, the international reinsurers and the six companies who provide cover in Fiji have decided that the rewards are too small and the risks too great." The insurance sector had concluded that much of the loss incurred through these repeated hurricanes could have been prevented through different building techniques and stricter building codes. They refused to continue to insure unsound buildings.

World Bank reports on Bangladesh, the Philippines and Sudan also illustrate the impacts of disasters on the overall investment and entrepreneurial climate.[36] For example, it is worth quoting the report on Bangladesh at some length as it clearly illustrates how the immediate effects of the floods reverberate through the economy in such as way as to alter the entire outlook for the immediate future, affecting overall incentives. The authors of this report note:

> The floods have necessitated significant revisions in the Government's economic goals and targets for the current year. Before the floods, 6% overall economic growth was envisaged, with substantial increases in agricultural production (6%) and manufacturing (7%). A recovery of crop production from the disruptions created by the 1987 floods, an expansionary public expenditure policy which aimed at stimulating economic activity and raising investment levels (supported by a significant new tax effort), and a revival in demand for manufacturing production as a result of these factors were expected to provide the basis for higher growth.
>
> It is now clear that many of these targets will not be realized. Despite the crop recovery and rehabilitation effort, agricultural production will be sub-

---

[35]. Richardson, John, "An Insurance Nightmare," Islands Business, March 1985, pp.10 ff.

[36]. See: "Bangladesh: Recent Economic Developments and Short-Term Prospects," March 13, 1989, Report No. 7596-BD; "Sudan: Problems of Economic Adjustment," Volume I: Summary Report, June 19, 1987 Report No. 6491-SU; "Philippines: Toward Sustaining the Economic Recovery: Country Economic Memorandum," January 30, 1989, Report No. 7438-PH, The World Bank, Washington.

> stantially less this year. Income losses associated with this setback and reduction in gainful employment opportunities will have a depressing effect on demand (which is unlikely to be offset by public expenditure policy), on the manufacturing sector which has also been directly affected by closure of factories during the floods and damage to equipment and inventories. The stagnation and even decline in the key productive sectors will limit the overall growth of the economy to about 1 - 2% in FY89, even though reconstruction and rehabilitation activities in the public and private sectors will help increase activity levels in construction and services sectors.[37]

The negative impact of disasters on investment and entrepreneurial incentives, alone, may effectively constrain all efforts toward development. Unless disaster prevention strategies can convince investors and entrepreneurs that sufficient stability exists for productive investment and activity, prospects for development are repeatedly undermined by recurrent disasters.

4. Disasters have special impacts on the nonformal economy.

Fourth and finally, the impacts of disasters in developing countries are often felt disproportionately by people who live at the margins and who subsist in the nonformal economy. Nonformal activities are truly economic in that they have to do with the production, consumption and distribution of goods and services within the society, and in many countries they represent a significant portion of economic activity in terms of the numbers of people who live by them. They are, however, not included in the usual systems for quantifying national economic activity. Costs of losses in the nonformal market would include direct costs of lost equipment, houses (which serve also as business centers), and supplies and also indirect costs of lost employment and income which cannot be made up. These losses are liable to be substantial.[38]

One report estimating the impacts of Hurricane Gilbert on Jamaica, noted that over 157,000 acres of crops were affected, "the largest area being under domestic crops."[39] Even when relief supplies are available to make up the short-fall of crops grown for domestic consumption, the impact of this aid on incentives in the nonformal market may be sharply negative. The report

---

[37]. pp. 41-42.

[38] UNDRO, Disaster Prevention and Mitigation, op. cit., p 9.

[39]. Collymore, Jeremy McA., "The Impacts of Hurricane Gilbert on Jamaica: An Assessment of Response and Relief Measures," A Report Prepared for the Pan Caribbean Disaster Preparedness and Prevention Project/UNDRO, December 12, 1988, Barbados Printing Department for the Central Emergency Relief Organisation, Barbados, p.5.

quoted above on Bangladesh notes also that the imports of relief foods, along with the increases in post-flood crops encouraged by government emergency policies, may be excessive to the extent of creating serious disincentives for small, agricultural producers.[40] On the other side, a number of post-disaster reports note that increases in prices which result from shortages due to disasters affect poorer segments of the community the most. When these involve inputs for nonformal small enterprise, the impacts can be especially difficult for these producers.

In theory, one could impute prices to all nonformal economic activities but, since many of them remain "invisible" to the analyst, any attempt to do so is far fetched. This fact makes it difficult to assess with any degree of accuracy the actual total direct, as well as indirect, costs of disasters in countries where the nonformal market is significant.[41] Were the losses in this sector added to the calculations of disaster costs, these costs would rise dramatically both in absolute terms and as a percentage of national wealth.[42]

Where the nonformal economy is important, an additional secondary cost of disasters arises. A fundamental element in successful development is the existence among the people of a strong sense of efficacy,[43] i.e., of the ability to affect and manage outcomes. When people in a developing society have this sense, they will produce more with a given set of physical resources than when they do not have it. One of the highest costs of disasters in developing countries is the effective undermining of any sense that people have of their ability to control and manage their environments or their lives.[44] When disasters are repeated, the effect is compounded.

---

[40]. Bangladesh, ibid., p.43.

[41] Peskin, Henry M., "Accounting for Natural Resource Depletion and Degradation in Developing Countries," World Bank Environment Department Working Paper No. 13, The World Bank, Washington, D.C., January 1989, pp. 47 and 49.

[42] When prevention actions are taken without regard for their impact on nonformal economic activities of the poor, they too can incur significant costs in this area. An example of this might be the construction of a flood control system which affected the access of fishing communities to river canals on which they had previously depended for their subsistence existence.

[43]. This concept bears some similarity to David McClelland's "achievement motivation" but we do not mean to limit it to entrepreneurs only. In the broader population, it is the opposite of a dependency syndrome or the malaise of victimization.

[44]. Often, lamentably, relief assistance which follows a disaster further adds to a sense of helpless victimization on the part of those who have experienced the disaster. This is because it is too often completely "managed" by outsiders who wrongly assume that disaster victims have no competencies left.