Environmental Degradation and Disaster Risk

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Asian Disaster Preparedness Center
For Embassy of Sweden/Sida Bangkok

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Executive Summary

The Embassy of Sweden/Sida Bangkok's interest in the *prevention dividends* associated with environmental management touches on three key issues facing contemporary disaster managers.

1. What is the value of prevention?
2. How can we achieve synergy and integration across sectors such as disaster risk reduction and environmental management?
3. What scientific evidence and decision support tools are available to help operationalize the integration?

Prevention's Worth

Great strides have been made in mainstreaming a "culture of prevention" in Asian disaster management. Most National Disaster Management Organizations (NDMO's) have, at least nominally, embraced the need for preparedness. Still, preparedness and prevention activities are generally low in domestic budget priorities and only a handful of international/bilateral donor agencies have committed to the ongoing support of prevention initiatives.

While those who work closely with disaster preparedness, believe that preparedness is more cost effective than emergency response, it is difficult to sustain the commitment of people whose appreciation of risk is balanced by other apparently more pressing concerns.

Communicating disaster risk includes conveying an accurate picture of the benefits of prevention. The language we use, the arguments we forward, the visual aids and the maps, all make a difference in the convincing people of the magnitude of risks.

Reliable and quantifiable information allows disaster managers to communicate more effectively and argue more convincingly for investment in risk reduction. It also helps international donors to demonstrate the relevance of their programs to the taxpayers and governments at home. More importantly, this information helps disaster managers, planners, development specialists and community leaders to plan the most effective programs possible and to have the greatest impact on improving livelihoods.

In seeking to identify the *prevention dividend,* Embassy of Sweden/Sida Bangkok moves the discussion forward.

Synergies and Integration

This desk study looks for possible synergies between environmental management and disaster management. Planners and practitioners are recognizing that the overall objectives of these fields are closely related – both ultimately aim to promote sustainable communities. They also recognize that these problems share some common roots. Not surprisingly then, many of initiatives undertaken for environmental management, poverty alleviation and disaster risk

[1] *The Swedish Environmental Secretariat in Bangkok (SENSA) and the Sida Regional Humanitarian Advisor at the Sida office in Bangkok (Sida Bangkok) jointly supported the development of this desk study with the purpose of reviewing the links between natural disasters and environmental issues.*
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management aim to manage the physical environment as well as support sustainable and resilient livelihoods at the community level. This creates possibilities for overlap and redundancies in government and NGO program activities. While redundancy poses certain risks, the greater danger is in the lack of coordination among these efforts, which can at times undermine each other and confuse the stakeholders.

Building synergy among issue-based initiatives also strengthens vertical and horizontal integration by engaging related sectors and departments at the same scale of organization and acknowledging the linkages across scales so that local communities are working towards the same ends as national and provincial governments while each draws on it's own comparative strengths.

Finding these synergies requires that the fundamental linkages between the root causes of common problems be understood. What are the interactions between water resources and fisheries, between drought and crop production? Between environmental degradation and disaster risk, between environmental management and vulnerability? A final source of synergy is between the research, policy and operational communities.

Applications and operations

Once the conceptual relationships are understood, specific interactions need to be revealed at operational levels; for instance, the level at which decisions are made to release water, to plant or harvest, or to allow concessions in an upstream region. These decisions need to be supported not just be generalities but by the best information available. If the skilled forecasts of upcoming rains are available, decision makers should use them. If models of the hydrological impacts of road construction are available, decision makers should utilize them. This suggests that decision support tools should continue to be developed and tailored to the needs of a range of decision makers, and that decision makers should also have a say in the types of decisions support tools (DST's) being developed. Further, the users of these DST's should have some understanding of the skill, validity, limitations and assumptions of the DST's.

This Review Paper

This study sets out to find the empirical evidence for environmental degradation's impact on disaster risk, and finds that the theoretical relationships seem indisputable. However, the location specific impacts of environmental protection on hazard risk are only describable in the few locations where data and models are available at appropriate scales and resolutions. Without this information it is nearly impossible to describe the cost savings in terms of either probabilities or risk. Nevertheless, prevention dividends may still be achieved by emphasizing the role of environmental management in poverty alleviation and generally promoting sustainable, resilient communities.

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Cover Photo: Flooded forest on the Mekong River in Stoeng Treng, Cambodia
by Glenn Dolcemascolo

1. Introduction

> *Around the world, a growing share of the devastation triggered by 'natural' disasters stems from ecologically destructive practices and from putting ourselves in harm's way. Many ecosystems have been frayed to the point where they are no longer resilient and able to withstand natural disturbances, setting the stage for 'unnatural disasters' – those made more frequent or more severe due to human actions. By degrading forests, engineering rivers, filling in wetlands, and destabilizing the climate, we are unraveling the strands of a complex ecological safety net. (Abramovitz, 2001)*

> *Although the inherent links between disaster reduction and environmental management are recognized, little research and policy work has been undertaken on the subject. The intriguing concept of using environmental tools for disaster reduction has not yet been widely applied by many practitioners. (ISDR 2002)*

With an estimated 26 million people in Southeast Asia live below the poverty line, environmental degradation continues to pose formidable challenges to poverty reduction and the achievement of the millennium development goals throughout Asia. The region is home to about half the world's terrestrial and aquatic resources; but alarming rates of deforestation, degradation of reefs and coastal ecosystems, atmospheric pollution and depletion of freshwater resources continue to lock vast populations in downward spiraling cycles of poverty in which the poor pursue unsustainable resource management practices in increasingly fragile environments.

The poverty cycle is exacerbated by frequent natural disasters. In all, 80% of the natural disasters worldwide occur in Asia; and of these, 80% are hydro-meteorological or climate-related. In the decade from 1991 to 2001, natural disasters affected over 1.7 million Asians, costing 369 billion dollars in damage to hard won assets (See Appendix A). It is widely accepted that the poor are the most vulnerable; they suffer the highest number of casualties and have the least capacity to recover. Moreover, costly emergency responses divert limited funds from important environmental management and poverty alleviation initiatives.

Meeting the challenges of both environmental degradation and disaster risk remain high on the regional agenda and, more recently, researchers, planners and policy makers have come to recognize how intricately these two factors are related. The International Decade of Natural Disaster Reduction (IDNDR) concluded that "environmental protection, as a component of sustainable development and consistent with poverty alleviation, is imperative in the prevention and mitigation of natural disasters" (ISDR 2002). Similarly, in 2002, a group of experts from the global change and disaster management communities met in Berlin and prepared a declaration that was presented at the World Summit on Sustainable Development in Johannesburg, South Africa. The declaration pointed to increasing evidence that global environmental change and natural disasters are linked.

In 2003, colleagues at the Swedish Embassy in Bangkok sought documentation of this evidence in order to better understand the nature of the linkages and to identify potential synergies between environmental programs and efforts to reduce disaster risk. More specifically, they ask:

- How can investments in environmental management and sustainable development also reduce disaster risk?

- Is there a *prevention dividend* that accrues from wise land use planning and development programs?
- Can *prevention dividends* be measured; and, how might the ability to estimate these added values enhance policy and program planning?

1.1 Investing in Prevention

The Swedish Environmental Secretariat in Bangkok (SENSA) and the Sida Regional Humanitarian Advisor at the Sida office in Bangkok (Sida Bangkok) are not alone in seeking answers to these questions. While recognizing the many obstacles to supporting sustainable development, planners, program managers and development practitioners are under increasing pressure to find synergy between the initiatives undertaken to improve the quality of life and to mitigate humanitarian crises. In deciding where best to invest development dollars, preference is given to those projects that adopt an integrated approach to risk reduction and provide the greatest opportunities for enhancing the resilience of the communities they serve.

Likewise, the many organizations involved in promoting "a culture of prevention" seek empirical evidence and concrete methods for demonstrating the value of investing in preventive measures. The ProVention Consortium[3], for instance, is currently developing guidelines for monitoring the impact of risk reduction programs and for addressing disaster risk in project appraisal methodologies. Similarly, the Canadian Institute for Economic Evaluation has initiated the Prevention Dividend Project[4] to evaluate the benefits of prevention in health care and substance abuse.

This paper reviews the literature on environmental aspects of disaster risk and examines the possibility of finding the *prevention dividends* associated with environmental management initiatives.

In the end this study suggests that while environmental management is an important tool for disaster risk reduction, the ability to quantify the *prevention dividends* accruing from investment in environmental management is highly dependent on local models of disaster risk, which are not widely available at present. Further development of local models is desirable and could become an important component of environmental impact assessments. In the meantime, *prevention dividends* may be achieved by emphasizing the role of environmental management in poverty alleviation and enhancing community resilience.

1.2 What is the prevention dividend?

The concept of a *prevention dividend*, as proposed by Eva Mellgren of Sida Bangkok, builds on the notion of the "Peace Dividend" which represents the value of resources previously committed to military endeavors that become available for more productive uses during times of peace.

As a working definition, the prevention dividend might be thought of as the values of foregone disaster losses that accrue from well designed and implemented disaster risk reduction measures, including environmental management and sustainable development initiatives.

2. Risk and Risk Reduction

Disaster Risk Reduction represents an important development in both disaster management and sustainable development paradigms. Whereas earlier generations of disaster managers

[3] *For more information on the ProVention Consortium, see: http://www.proventionconsortium.org/*
[4] *For more information on the Canadian Institute for Economic Evaluation and the Prevention Dividend Project see: http://www.prevention dividend.com/en/welcome/index.htm*

focused primary attention on the delivery of emergency relief in the aftermath of catastrophes, today increasing attention is given to disaster preparedness. Risk may be reduced through a variety of pathways that either target the physical hazard or the underlying socio-economic conditions that create vulnerability. Understanding the interaction of physical and social processes is fundamental to estimating future risk and the value of prevention. The following equation is commonly used to reflect the components of risk:

$$\textbf{Risk} = \frac{\textbf{Hazards x Vulnerability}}{\textbf{Capacity}}$$

Risk: The probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable/capable conditions.

Hazard: A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hazards can include latent conditions that may represent future threats. They can be natural in origin (geological, hydro-meteorological and biological) and/or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity and probability.

Vulnerability: A set of conditions and processes resulting from physical, social, economic and environmental factors, which increase the susceptibility of a community to the impact of hazards.

Positive factors that increase the ability of people and the society they live in to cope effectively with hazards, that increase their resilience, or that otherwise reduce their susceptibility, are considered as capacities.

Capacity: The manner in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process. *The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards.*

Resilience: The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure. This is determined by the degree to which the social system is capable of organizing itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

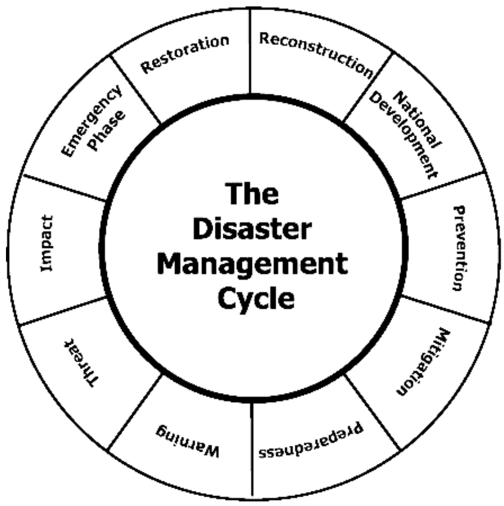
International Strategy for Disaster Reduction 2002

By way of example, buildings may vary in their vulnerability and resilience based on the materials and standards used in construction. For instance, concrete houses are less vulnerable to windstorms and buildings reinforced with brackets are less vulnerable to earthquakes. The choice of building materials is influenced by socio-economic and cultural factors.

In human communities, vulnerability is distributed unequally throughout the population. In measuring vulnerability to drought in East Timor, for instance, female headed households are thought to be more vulnerable because in times of food scarcity they have less labor or other resources to fall back on (FAO 2001). In general the poor are more vulnerable, that is less resilient and often the least able to recover from a disaster.

Communities respond to risk in very diverse ways. Among the international aid and development community, the primary response for many years has been reactive rather than proactive. Accordingly, the provision of emergency relief has assumed high priority in disaster management programs. Over the past two decades this approach has begun to shift towards increased awareness of the benefits of preparedness and prevention. Carter (1998) argues persuasively that to be effective, disaster management should be implemented as a comprehensive and continuous activity, not as a periodic reaction to individual disaster circumstances (see Figure 1 below).

Figure 1: The Disaster Management Cycle



National development occupies a pivotal position in the cycle as it establishes the underlying socio-economic conditions that determine resilience or vulnerability. Disaster's impacts and the recovery process also affect national development. Accordingly, development is an integral part of disaster reduction programs.

2.1 Reducing Risk

In some countries and in many communities, particularly in disaster prone areas, prevention has, for generations, been one of the coping strategies for living with risk. Traditional coping strategies are important assets to disaster management programs. In rural Vietnam, spring planting is timed to bring crops to harvest before the onset of annual flooding. Historically, some governments have also invested heavily in prevention as demonstrated by elaborate system of dykes in Vietnam, which span over 1000 kilometers and were erected over the course of thousands of years.

While, in theory, some disasters may be prevented entirely (for example some classes of forest fires, landslides and floods), in most cases disaster managers aim to prevent the negative impacts of the hazard rather than eliminating the hazard. An important terminological distinction is made between prevention and mitigation.

> **Prevention:** Activities to provide outright avoidance of the adverse impact of hazards and related environmental, technological and biological disasters.
>
> **Mitigation**: Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.
>
> *ISDR 2002*

Mitigation presumes that the hazard will occur but aims to reduce losses through a variety of interventions. These interventions are generally characterized as either structural or non-structural. Careful timing of agricultural activities is an example of non-structural mitigation, while the construction of dykes is an example of a structural measure. **Collectively, these structural and nonstructural mitigation and prevention measures may be described as risk reduction.**

The question remains whether environmental management may be counted among effective risk reduction measures.

Environmental management, which encompasses a broad range of activities, is poised to make significant contributions to disaster risk reduction efforts as well. Advances in both socio-economic and technical approaches to conservation and development have brought some measurable successes in managing forests, wetlands and agricultural lands, water resources and air quality.

While some environmental management initiatives aim to control the environment directly, such as reforestation and ecological restoration programs, most aim to influence the attitudes and behaviors of human communities to engender a culture of sustainability. In many ways the approach parallels disaster management in acknowledging both the social and physical dimensions of risk and the critical role of public participation.

Contemporary environmental management is often characterized by a diverse array of managing partners including local villagers, national, provincial and local government agencies, scientists and researchers, NGO’s and the international donor community thus providing for vertical integration. Similarly, horizontal integration of management regimes incorporates the interests and dynamics of multiple sectors such as agriculture, environment, disaster management, tourism and health. Integrated approaches have become widely accepted through the development of new planning paradigms, such as integrated water resources management (IWRM) and Integrated Coastal Zone management (ICZM). Both of these approaches adopt a regional perspective, by taking a watershed, river basin or other ecological region as the basic management unit.

Integrated approaches to environmental management are, in principle, well positioned to incorporate disaster risk reduction in the framework of environmental management and development plans. While the relationship is generally accepted at the conceptual level, more subtle analysis is needed identify critical thresholds of vulnerability and specific opportunities for synergy.

The following section looks more closely at the relationship between environmental conditions and hazard risk. Substantial attention is given to floods, which affect more people in Asia than any other type of hazard. Droughts and associated fire risk are also considered as these risks have strong correlations with environmental conditions. The linkages between environmental degradation and vulnerability are also explored.

3. Empirical Studies of Hazard Risk

> *Environment and disasters are inherently linked. Environmental degradation exacerbates the impact of natural disasters. It affects natural processes, alters humanity's resource base and increases vulnerability. The degree to which environment can absorb impacts, increase overall resilience and provide effective and economical solutions to reduce disaster risks is therefore jeopardized. Furthermore, societies' traditional coping strategies are challenged. (ISDR 2002)*
>
> *Adaptive capacities of ecosystems to absorb sudden shifts in climatic, geological or biological components are a key feature increasing disaster resilience. (ISDR 2002)*

The ecosystem approach offers general appreciation of the role of natural systems in buffering communities from natural hazards (Table 1). However, more subtle analysis is needed to understand how much change an ecosystem can absorb before disaster risk increases. Understanding these critical thresholds is crucial for estimating site-specific impacts of environmental change and evaluating the potential *prevention dividends* associated with environmental management. The following sections take a closer look at physical parameters of hazard risk.

Table 1: Ecosystem Functions for Disaster Risk Reduction

Wetlands	Important wetland functions include water storage, storm protection, flood mitigation, shoreline stabilization and erosion control. These functions are also essential for sustainable development.
Forests	Forests play an important role in protecting against landslides, erosion, floods and avalanches. They also safeguard against drought.
Coastal Zones	Barrier reefs, barrier islands and mangroves contribute significantly to the mitigation of hurricane risk, storms and tidal surges

ISDR 2002

3.1 Flood Risk

The IFRC reports that floods affected 1.2 billion people in Asia between 1992 and 2001 – that is nearly 70% of the total number of people affected by all hazards during that period. Environmental conditions are a critical determinant of flood risk and a review of key hydrological journals confirms a broad interest in the effects of environmental degradation on floods in Asia.

Cai and others (2001) argue that changes in the Yangtze basin have led to increased severity of flood hazards. The authors draw attention to the effects of deforestation upstream, reduction in the area and number of lakes, encroachment on flood plains and lakes by farmers and destruction of wetlands. Deforestation is believed to have had such a pronounced affect on sediment loads, and hence flood levels, that in 1998, during the height of flooding, China's State Council issued a emergency order calling for an immediate halt to all illegal logging and a one-year moratorium on all conversion of forest land.

Yin and Li (2001), on the other hand, point out that there is considerable disagreement over the role of deforestation in flood disasters on the Yangtze River. For instance, based on evidence from six paired sites in the Yangtze basin, Cheng and others (1998) argue that, in the case of continuous rather than short-term heavy rain, the retaining ability of the forest is inconspicuous. Moreover, Yin and Li (2001) point out that while forest cover in the Yangtze Basin was reduced by half between 1957 and 1986, the silt discharge at the head of the middle Yangtze remained comparable, thus suggesting that deforestation in the basin may not influence short or medium term silt discharge. Although, Yin and Li concede there is no doubt of the long-term influence of deforestation and erosion on the flood disasters.

Similarly, in reviewing the evidence of changing flood risk in the Ganges, Brahmaputra and Meghna Basins in South Asia, Mirza and others (2001) resolve that the role of deforestation in South Asian sedimentation and flooding processes remains highly contentious and requires further research. This conclusion is based on the conflicting findings (BWDB 1987, Carson, 1985, Thompson and Warburton 1985, Hamilton, 1987, Hoffer 1998, Ives and Messerli 1989, Messerli and Hoffer 1995, Rogers et al 1989). For instance, the Bangladesh Water Development Board (BWDB 1987) suggests that upstream deforestation contributes significantly to increased rates of sediment supply and accretion. But, in 1989, Ives and Messerli reviewed relevant published reports and found no evidence of significant increases in the sediment load of large rivers or their tributaries; nor did they find any evidence of significant changes in the magnitude of annual flooding or levels of river discharge.

Other noted investigations concur “deforestation plays a minor role, if any in the major monsoon flood events on the Lower Ganges” (Carson 1985). Rather, Carson suggests that flooding and sediment problems in India and Bangladesh are the result of the geomorphic character of the rivers and man’s attempt to contain the rivers. In the aftermath of the devastating 1988 floods, Rodgers (1989) remarked that there are no grounds for considering deforestation in the Himalayas as a significant cause of the flooding in the delta of the river system.

Contradictory arguments such as these are common in the literature reviewed for this desk study. It should be noted that studies of transboundary flooding are highly politicized and closely scrutinized because demonstrated culpability for increased flood risk could lead to calls for damage settlements or other politically unpalatable actions. Political factors aside, scientific understanding of flood hydrology has become increasingly sophisticated in recent decades.

3.1.1 Physical parameters of flood hazards

From a physical perspective, the key factors contributing to flooding generally fall within one of the following main categories:

- Excessive quantities of water
- Blockages within the drainage network
- High tides and onshore winds

While each these fundamental dimensions of flood hazards occur naturally, they are also heavily influenced by human activities. Given this study’s focus on the effects of environmental degradation on disaster risk, the following section outlines the physical parameters of flood risk while considering anthropogenic influences on those parameters.

3.1.1.1 Excessive Quantities of Water: Rainfall

While it may seem that rainfall patterns are not affected by human activities, several productive areas of research have sought to establish causal association between climate change and flood risk at a variety of scales.

It has been established that human activities, particularly emissions of greenhouse gases are affecting the global climate. Such changes will affect local rainfall patterns. However, developing predictive models of changing precipitation has proven challenging, especially in Asia (IPCC, 2000). Nevertheless, the table below illustrates projected changes in temperature and precipitation in the region. Projected temperature and precipitation for Southeast Asia are both consistently below the Asian averages. Similarly, the changes are generally most pronounced during the winter season except in the 2020's when summer rains are expected to increase more dramatically than winter rains. The seasonality of precipitation changes is of critical importance in Southeast Asia where the vast majority of the population is rural and agrarian.

Table 2: Projected Temperature and Precipitation Changes (Double CO_2)

	Averaged Temperature Changes in Degrees Celsius								
	2020's			2050's			2080's		
	Ann.	Wint	Sum	Ann.	Wint	Sum	Ann.	Wint	Sum
Asia	1.58	1.71	1.45	3.14	3.43	2.87	4.61	5.07	4.23
SEAsia	1.05	1.12	1.01	2.15	2.28	2.01	3.03	3.23	2.82
	Averaged Precipitation Change as % of Normal								
	2020's			2050's			2080's		
	Ann.	Wint	Sum	Ann.	Wint	Sum	Ann.	Wint	Sum
Asia	3.6	5.6	2.4	7.1	10.9	4.1	11.3	18.0	5.5
SEAsia	2.4	1.4	2.1	4.6	3.5	3.4	8.5	7.3	6.1

IPCC 2002

There is substantial evidence that global climate change will affect the timing and trajectory of monsoons. The change is generally characterized as a pole-ward migration in monsoon drivers. Much more work is needed in order to link global and regional climate change to local changes in temperature and rainfall. It should be noted that the linkage between El Niño and incidence and trajectories of typhoons in Vietnam have been well documented. Climate models generally characterize future climate (under doubling of CO_2) as being similar to persistent El Niño like events.

Deforestation may have an impact on rainfall as well, though the evidence is anecdotal, Jones (2001b) reports a 120% decrease in Amazon rainfall after a generation of land clearance. In general, however, topography, storm motion and other climate drivers are the predominant influences on rainfall. Similarly, urbanization is believed to have an impact on rainfall regimes.

3.1.1.2 Excessive Quantities of Water: Discharge

River floods are said to result from hill slopes yielding runoff to rapidly for channels to hold. Jones (2001) argues that the conventional treatment of channels addresses only symptoms of floods but not the root causes. He challenges investigators to assess runoff rates from upslope areas in their studies.

To understand discharge or storm flow in a river system it is essential to consider the characteristics of the basin that affect the flow of water. These include: slope of the basin, hill slope properties (such as the form of the hill), channel networks, surface or channel roughness, and materials properties of the soil and debris (See Figure 3).

Models of water discharge will vary based on the assumptions about runoff that are used in the model. Until recently, the theories of Ian Horton have predominated. According to Horton's Theory of Runoff (1945), once the rate of supply exceeds the capacity of the surface materials to absorb it, then the water begins to accumulate in surface depressions and to flow down hill slopes.

This theory has been revised considerably in subsequent decades, particularly with reference to two key points. First, the hegemony of overland flow is well demonstrated in the more extreme events; however, in lesser flow events, when soil does not reach the same level of saturation, it is argued that other process may be at work. Also, as Jones (2001) argues, Horton's assumptions about the uniformity of catchments areas are disputable since infiltration capacities vary considerable over relatively short distances.

With regards to other forms of runoff that may be relevant, particularly in tropical Asia, subsurface flow and pipe flow should also be considered as factors that will affect the skill of hydrological models (Jones 2001).

3.1.1.3 Blockages

The shape and form of catchment basins and channel systems are key parameters in understanding flood risk. Jones notes that area, slope, shape and density of the drainage system can all effect the runoff time that contributes to flooding. In specific channels, siltation can fundamentally alter the channel's holding capacity.

Rilling, gullying and other forms of accelerated soil erosion have frequently aggravated flooding problems by choking the channels. Moreover, the increased volume and velocity of runoff is often accompanied by increased erosivity and erodability of the soil through the loss of soil-retaining roots, organic matter or leaching of binding base cations.

3.1.1.4 Human Activities

The above discussion outlines the complex factors that can contribute to flood events. Figure 3 (below) renders these interactions graphically. In addition to the fundamental physical properties underlying flood generation, human activities can have substantial affects as well. Though many activities have negative impacts on flood risk, Jones (2001 a) points out that other activities, quite unintentionally can act to reduce the incidence of flooding.

Four distinct domains of human activity are influential in modifying hydrological cycles: water supply/engineering; land surface changes; channel modification and weather modification. In the section that follows we look more closely at one form of land cover change that is frequently implicated in flood events – deforestation.

3.1.2 Impacts of Deforestation

The case for establishing a causal connection between deforestation and flood risk is supported by the following theoretical relationships:

1. Removal of natural vegetation tends to reduce evapotranspiration losses
2. Exposure of soil surface to the full kinetic energy of falling rain causes the break up of soil crumbs, clogging of pores, reduction of infiltration capacity and creation of splash plans
3. Sun baking the soil leads to cracks that can speed drainage
4. Vegetation reduces water loss through transpiration and interception

The evidence for the above comes from decades of experimental hydrological research. Studies of the impact of forest cover have become increasing sophisticated over the past century. The more recent studies are characterized by a shift from approaches that focused on input-output balances to an emphasis on the various processes at work within the catchment area.

In a review of 94 experiments on water balance and flow routing, Bosch and Hewlett reported the following findings:

- Deforestation tends to increase runoff and flood peaks
- None of the models were either predictive or transferable because each catchment is unique. More specifically, changes in runoff differ with the character of the forest cover, climate and physical parameters of the basin.
- Poorly designed experiments generally disregard the multiple processes at work in any catchment area.

Jones (2001b) contends that although long-term land use experiments will remain the cornerstone of hydrological research, the future of these experiments lies in elaborating the individual processes as the sub-catchment level. The research designs, however, must be examined critically. Sequential studies of changes in the same basin over a period of land use changes run the risk of discounting variability in climate parameters such as changes in the distribution or intensity of rainfall. Similarly, paired catchment experiments would rely on finding two catchments that are alike in every aspect except for vegetation cover (Jones 2001b).

Some general conclusions, however, are discernable from the existing literature. Jones (2001a) offers the following insights:

- Removal of forest cover leads to a decrease in evapotranspiration losses and runoff concentration times and thereby increases annual runoff and peak discharges (Jones and Grant 1996)
- Net effects of vegetation removal differ from one species to another (Dunne and Leopold 1978; Calder 1986, 1990; Hudson 1988; Geiger 1957; Swanson 1987)
- High-rainfall areas also allow for more rapid regeneration of the vegetation which soon retards runoff (Hibbert 1971; Calder 1985; Newson and Calder 1989)
- Heavy logging vehicles can compact soil thus concentrating overland flow and affecting peak discharges (Wemple 1994) however in some cases roads have had no net effect or even decreased peak runoff (Wright et al 1990)
- Infiltration rates will decline as result of the removal trunks and roots as stem flow may account for up to one-third of incident rainfall in tropical rainforests.
- *The net effect of greater water surpluses and more rapid runoff is increased flood risk.* Significant increases in peak discharge levels have been reported in Canada (Henderson and Golding 1987); the United States (Hibbert 1971) and Malaysia (Abdul Rahim and Harding 1993; Chan 1998)

Regarding the tropics, in a review of twenty experiments on annual water yield and twelve studies on flood magnitude, Bruijnzeel (1990) reports the following general conclusions:

- The effects increase along with the amount of timber removed
- There tends to be a large initial increase of maybe 800 mm per year (or more)
- The initial increase is followed by a gradual reduction, perhaps returning to prior levels after some years of re-growth (See Bailey et al 1974)
- Sometimes discharges remain high even after maturation of new vegetation
- Burning of grassland can increase flows, but can also decrease them if subsequent re-growth results in high water uptake
- Peak flows increase most dramatically in smaller events since larger events are associated with heavier rainfall that would be most likely to generate floods even in a forested area.

In Guyana, storm flow volumes are reported to increase at a rate of 230-495 mm per year after forest clearance (Fritsch 1987).

Evidence from Malaysia indicates 19-37% increases in total storm flow volumes in the first three years following conversion from forest to oil palm plantations (at a 60% conversion rate) and a 38% increase in peak discharge after logging; however, channel realignment has nearly twice the effect -- that is a 65% increase in peak flow volumes (Bruijenzeel 1990).

Still, Bruijenzeel (1990) expressed his concerns over the "widespread lack of vigor" in hydrological experiments.

Chan and Parker (1996) suggest that accelerated soil erosion, channel siltation and landslides caused by inappropriate clear-felling and logging techniques exacerbate the problem.

Bruijnzeel (1990) cites reports of debris dams, caused by landslides, bursting and creating flood surges 15-20 meters high that last for hundreds of kilometers downstream.

The above discussion outlines the state of knowledge in quantifying the effects of deforestation on hydrological systems and storm discharge. In summary, Jones (2001) reminds that the impact varies widely depending on:

- The storm flow generating mechanisms that are dominant in a given catchment area
- The species of trees removed
- Method of removal and subsequent treatments

This section has drawn attention to deforestation and it's impact on flood risk, there are, however other forms of environmental degradation or change that can affect flood risk. Riverine flooding, as noted earlier may also be affected by such activities as farm management practices, roads, and water supply and delivery infrastructure. There are also other forms of flooding. Coastal and estuarine flooding, for instance is affected by tidal surges and, thus, the degradation of coastal mangroves and wetlands must be counted among the factors affecting risk.

3.2 Floods and Vulnerability

The Asian Disaster Preparedness Center (ADPC) draws attention to the progression of vulnerability from unsafe conditions, to dynamic pressures and root causes (see Appendix D). For example, some flood damages may be attributed to unsafe buildings and infrastructure. The reasons for the choice of building material may be related to traditional values and perceptions of risk but it may also be a function of financial resources, cost cutting measures during the construction process or the lack of government investment in poor communities. Similarly, fragile economic systems are especially vulnerable to disasters. Rural communities for instance are highly reliant on agriculture, which is directly affected by extreme climate conditions, the lack of diversity in local economies means that rural communities suffer substantial impacts to their livelihoods and food security.

Environmental management can play an important role in reducing vulnerability and enhancing resilience in local communities. The linkages between poverty and environmental degradation are already well documented. Less well understood is the role of environmental management in supporting local coping strategies. Consider that in the aftermath of disaster communities in Cambodia rely on fishery resources for subsistence and supplemental income. Poor fisheries management however has led to increased pressure on the resources by outsiders, in the aftermath of disaster even more people turn to these resources. As a result, the viability of fishing as a coping strategy is jeopardized by environmental management capacities. Weak institutions are often cited as another cause of vulnerability. Environmental management institutions that include monitoring components could play a role in alerting local community members and decision makers to changing hazard risk.

The Viet Nam Red Cross Society conducted an environmental preservation project in Thai Binh province to address different aspects of risk relating to typhoon occurrence that threatens the people living on the coast. Two thousand hectares of mangrove plantation were created along the coastline serving to reduce wind and wave velocity and action, thereby protecting landscape, human life and local development assets. Resource opportunities for improving livelihoods were provided by a healthier natural environment. The limited damage provoked by the worst typhoon in a decade provided the best possible indication of the effectiveness of the plantation in reducing risks and its ability to enhance the resiliency of local communities (IFRC 2002).

3.3 Drought and Fire Risk

Drought and fires are closely related since droughts conditions are a key factor in fire risk. While both can have disastrous effects, drought generally has direct and often dire impacts on human communities; wildland fires generally affect ecological communities and broader economic systems.

3.3.1 Physical parameters of drought

Second only to floods, droughts affect the largest number of people in Asia. Moreover, droughts and related famines claimed, by far, the largest number of disaster related fatalities in Asia during the period 1992-2002 (IFRC 2002).

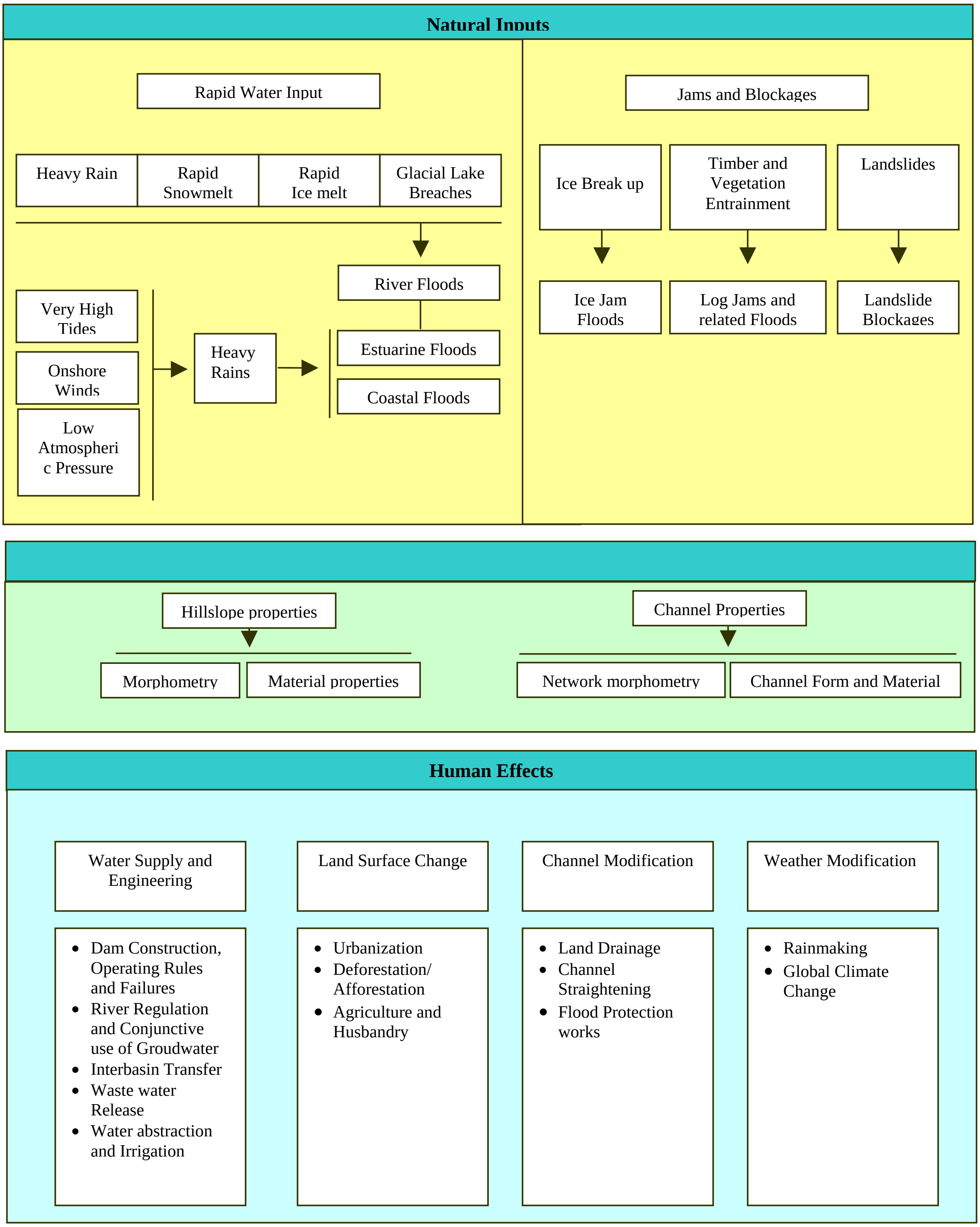
The disaster management community conventionally distinguishes between various forms of drought. Meteorological drought refers to a departure from anticipated mean rainfall but generally does note connote a disaster in itself. Hydrological drought and agricultural drought, on the other hand, both have devastating impacts on human populations. Hydrological drought concerns a reduction in available water but the critical thresholds are relative to local demandsS. Agricultural drought refers to changes in timing, frequency or intensity of the rainfall that have specific implications for crop yield.

The role of environmental degradation or, more broadly, human modification of the natural environment, plays an important role in agricultural and meteorological droughts.

Land use practices, including settlement patterns and farm management systems can significantly affect the onset of drought conditions. Water use and water management practices directly affect the preconditions for hydrological drought. There is a great deal of literature that links water diversion, such as inter-basin transfers with drought in the “donor basin. Likewise, damns frequently lead to hydrological and agricultural drought in down stream systems.

Over use of water, or wastage, can lead to hydrological drought when combined with insufficient rainfall to recharge the aquifers or maintain stream flow. Similarly, water pollution reduces the amount available for human consumption and hence lowers the threshold for determining drought conditions in urban communities for example.

Figure 3: Physical Parameters of Flood Risk



Adapted from Jones 2001

3.3.2 Physical Parameters of Wildland Fire Risk

In Indonesia an estimated 500,000 hectares burn annually; but in 1997 and 1998, eight million hectares of forest and land went up in flames. Using various methods of assigning value to environmental losses, James Schweithelm and David Glover (1999) attempted to capture some of the downstream costs of fire and haze and provided perhaps the most thorough damage assessment to date. They estimate that Indonesia suffered 2.7 billion in fire related damage and additional 1 billion dollars in haze related damages.

Fire risk is a function of fire weather, fuel load and the presence of an ignition source. Forest fires are directly linked to environmental degradation through a number of undisputed pathways. Substantial evidence suggests that logged over forest is at greatest risk for fire; this is because the debris left behind in the open, dries out rapidly and serves as an excellent fuel source.

While lightning is a potential ignition source, in tropical forest ecosystems, this is generally a rare occurrence; it is widely held that most wildland fires are the direct result of either accidental or intentional use of fire (Bapedal 1999). Fire remains the predominant technology for land clearance throughout much of Asia. This is true for swidden horticulturalists, so-called slash and burn farmers, as well as for large-scale plantation agriculture. In Indonesia during the conflagrations of 1997-1998, and in 1982-84, land clearance was the direct cause of most of the fires (Bapedal 1999). It is also generally accepted that many fires are the result of arson associated with contested land use claims or other contests over natural resources.

4. Counting the Prevention Dividends

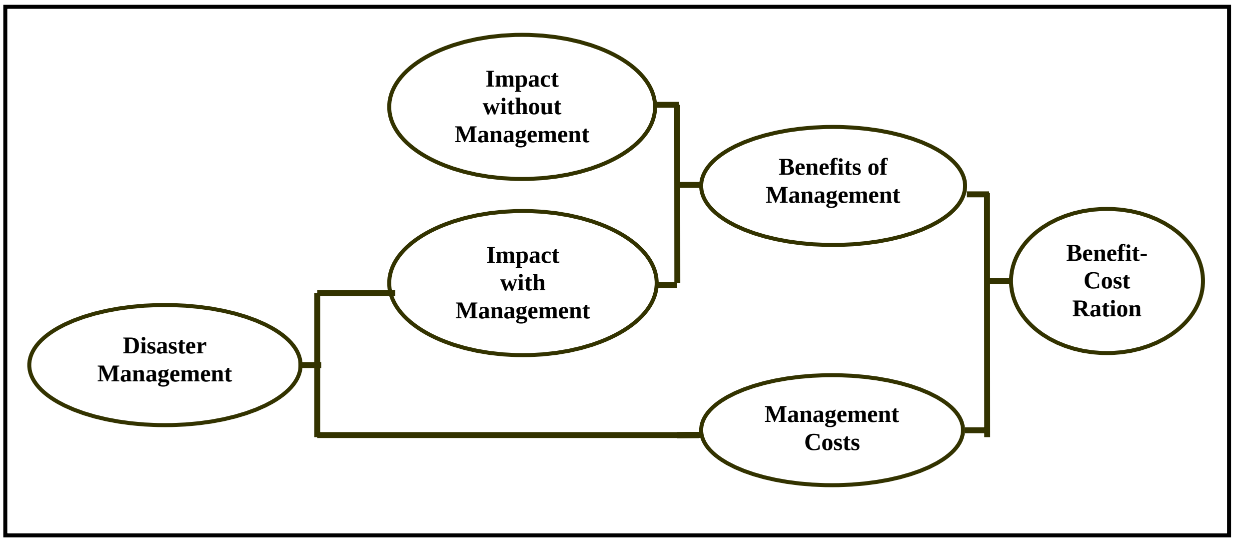
The above discussion of environmental factors in disaster risk established the foundation for an assessment of the possibility of calculating prevention dividends associated with environmental management.

In the course of designing infrastructure projects, planners are faced with difficult decisions regarding how much to invest in prevention. Often, there are several potential designs to choose from and a decision must be made as to which level of prevention is most cost effective. Cost-Benefit Analyses (CBA) often support such decisions.

Dedeurwaerdre (1998) argues that cost-benefit analysis is a powerful decision support tool for two reasons. By incorporating all benefits into a single measure (i.e. monetary values), it allows activities with different forms of benefit to be compared. Furthermore, by using a monetary valuation of benefits they can be compared directly with costs. This gives answers not only to the question “Which alternative is better?” but also to the more difficult question, “Is it worth doing” (Green 1994).

While the economic impact of natural disasters has been frequently addressed in natural disaster-related literature, fewer analyses propose CBA models for natural disaster preparedness and non-structural forms of risk reduction. In a review that draws heavily on literature originating from the IDNDR (International Decade for Natural Disaster Reduction) conferences, Dedeurwaerdere (1998) outlines general principles of a CBA model for natural disaster management (Figure 4).

Figure 4: Cost Benefit Analysis for Disaster Management



Cited in Dedeurwaerdere 1998

The aim of natural disaster reduction and prevention is to decrease and possibly eliminate the negative impact of natural hazards. The benefits of natural disaster preparedness, mitigation and prevention are therefore equivalent to the savings of the damages that would be incurred in the event of a future disaster.

CBA's are based on an assessment of risk, which typically includes the following components:

1. ***Hazard Occurrence Probability****:* the likelihood of experiencing any natural or technological hazard at a location or in a region
2. ***Elements at Risk****:* identifying and making an inventory of people or buildings or other elements which would be affected by the hazard if it occurred, and where required estimating their economic value
3. ***Vulnerability*** of the elements at risk: how damaged the buildings or people or other elements would be if they experienced some level of hazard (UN OCHA 1991)

In outlining various techniques for conducting cost benefit analyses, Kramer (1994) points out that all the techniques presume that the analyst has enough information to estimate probability distributions of natural disaster events. The inclusion of the probability of a crisis event's occurring is essential to solving the problem. That, of course, restricts the analysis to situations where risks of natural hazards are known (Anderson 1990).

The determination of benefits is generally limited to calculations of damages averted, quantifiable in monetary terms. The methodology developed by ECLAC (Economic Commission for Latin America and the Caribbean), for example, estimates the economic impacts of disasters and is a good indicator of the level of damages likely to be avoided though risks reduction measures (ECLAC 1994). In general, economic damages are assessed in three categories: direct, indirect and secondary.

While cost-benefit analysis may be appropriate for some tangible losses, the intangible costs of having lost a bridge or a historic site or a tourist destination are not always so easily converted into economic terms. Although multiple criteria may be used, especially when looking at the humanitarian and ecological aspects of disaster risk, these tools remain underdeveloped

Direct damage refers to all damage to fixed assets, capital, and inventories of finished and semi-finished goods, raw materials, and spare parts. It includes total or partial destruction of physical infrastructure, buildings, machinery, and equipment, transport and storage facilities, and furniture as well as damage to farmland and soils, irrigation and drainage works, dams, and so forth. In the particular case of agriculture, the destruction of crops ready to harvest is considered direct damage.

Indirect damage refers to damage to the flow of goods that will not be produced and of services that will not be provided after the disaster strikes. The period of time covered begins immediately after the disaster and may last several months or years, depending on the type and characteristics of the disaster. Indirect measures are measured in monetary - not physical terms.

Secondary effects refer to the impact of the disaster on the overall economic performance of a country as measured by the most significant macroeconomic variables. The estimated changes in these variables due to the disaster complement the estimated direct and indirect damages, although they cannot be added to express the total amount of damage inflicted.

ECLAC 1994

Assessing the costs of risk reduction measures is challenging as well. In general, natural disaster management costs include the expenditures (i.e. initial capital outlay plus maintenance), which are undertaken to control or mitigate the impacts of any natural crisis event that could result in a disaster as well as the opportunity costs. The costs of prevention differ significantly based the types of potential disasters faced and the technologies available for projects (Anderson 1990).

Despite methodological advances, CBA remains controversial because of problems such as data availability, challenges in pricing the benefits and costs associated with nonstructural disaster management (including challenges of multivariate analysis which attempt to attribute value to such intangibles as ecological functions, psychological sense of security and human life) and methodological difficulties in discounting future benefits and costs (Dedeurwaerdre 1998).

Even if the methodological challenges of CBA were overcome, it would still not be a prescriptive tool. Because of the wide range of values and aspirations of the various stake-holding groups, it must be recognized that the value of prevention is intrinsically linked with socially negotiated levels of acceptable loss or acceptable risk. Evaluative tools, such as CBA, that render relative risks in economic terms are meant to facilitate discussion and inform negotiations.

4.1.1 Calculating Flood Risk

This section returns to the question of risk assessment and the search for the *prevention dividend* in the context of floods. Recalling that the three components of risk assessment are hazard occurrence probability, elements at risk and vulnerability. Hazard occurrence probability for flood risk is generally developed using the following techniques:

- A digital elevation model (DEM) of the study area [5]
- Flood levels for different return periods based on frequency analysis of available river gauge data.
- Inundation maps of the study area with levels computed from frequency analysis and using the DEM, in case of embankment failure
- Calculations of the area at risk of flooding in the event of a hazard of selected magnitudes.

Upstream water levels and river flows are used as the starting point of flood risk models. The factors that lead to that particular water level (such as those described in the preceding sections) are generally not considered within the assessment. If these associations could be calculated and factored into flood risk modeling, and subsequently linked to a range of potential impacts, then planners would have a additional tool with which to calculate the contributions of land use changes to specified levels of potential losses and estimate the *prevention dividends* that would accrue from environmental management.

During the 1960's a number of process based simulation models were developed which held some promise of transferability to other catchment areas. Most notable among these are the Système Hydrologique Européen (SHE) model and the UK Institute of Hydrology Integrated Model (IHDM). In principle these models could be altered to predict the affects of land use change on the hydrological system, however, this would require a vast amount of data on basin characteristics. Some of which is simply not available, particularly in less developed countries.

4.1.2 Calculating Drought Risk

The Drought Monitoring Center in Nairobi provides drought early warning services based on regular monitoring of the physical parameters of drought risk including near real time climate data, numerical weather prediction models and vegetative conditions derived from remotely sensed images[6]. Similarly, the International Research Institute for Climate Prediction[7], in collaboration with the Asian Disaster Preparedness Center, provides seasonal forecasts that include drought probability. However, neither of these processes explicitly calculates the contribution of environmental degradation to drought risk.

Because drought is a slow onset phenomenon, it is notoriously difficult to project losses from specific drought event (in part because the beginning and end of the event are not easily determined). This step would be necessary in order to calculate the value of a specific intervention. Further, there are several significant intervening variables such as farm management strategies, farmers risk aversion strategies which affect vulnerability. None of the literature reviewed in this study indicated the availability of tools for quantifying *prevention dividends*. However, the UNDP (2004) provides an overview of the methodological constraints to projecting drought losses.

While it is possible to estimate hazard occurrence probabilities for drought and likewise possible to incorporate the impacts of environmental degradation (through water resource management data and land cover data); it is difficult to project droughts damage and hence calculate anticipated dividends.

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[5] The use of Digital Elevation Models may have limited values in some locales, particularly low lying areas subject to siltation (such as Bangladesh) where modest shifts in elevation are common and can dramatically affect flood risk for the local population. In such situations any Digital Elevation Model is outdated even weeks or months after it is produced. Other methods of flood risk mapping may be employed such as calibrating local markers to river levels.

[6] For more information on the Drought Monitoring Center see http://www.dmcn.org

[7] For more information on the International Research Institute for Climate Prediction see http://iri.columbia.edu/

In general, Integrated Water Resources Management holds potential to yield *prevention dividends* by improving the general resilience of communities. In India, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)[8] has pursued such an approach through crop diversification, soil and water conservation initiatives that aim to "green" drought prone areas. Lessons learned from these activities may be replicable in other parts of Asia.

4.1.3 Calculating Wildfire Risk

The Southeast Asia Fire Danger Rating System Program being developed by the Canadian International Development Agency (CIDA)[9] provides accurate assessments of fire weather and fuel load; however, because the probability of ignition is difficult to ascertain and fire risk is not explicitly correlated with the social and ecological values of lands at risk, the calculation of cost savings resulting from environmental management is difficult.

Some ignition sources, in theory, may be controlled though regulatory standards set by mandated authorities but challenges of enforcing these regulations remain daunting. *Prevention dividends*, in general may accrue from improved fire management capacity within the forest management, plantation management and farm management initiatives. These can mitigate against some of the larger scale incidents, reducing the probability of widespread conflagrations and limiting the impacts to more manageable sizes.

5. Concluding Thoughts

This study was initiated with two goals in mind. First, to determine whether empirical evidence is available to support the supposition that environmental degradation and disaster management are linked and; second, to determine whether the *prevention dividends* associated with wise environmental management are measurable.

With regard to the first question, the answer is certainly yes! The evidence suggests that the physical properties underlying hazard risk are fundamentally affected by environmental change.

In the context of floods, for instance, soil erosion contributes to sedimentation, which alters flow regimes and hence flood-risk. However, it should be further noted that the ability to associate environmental change with site-specific flood risk is limited. At the local level, local soil, topographic and hydrological properties need to be considered. Some hydrological models are being developed to include land use/land cover changes, but at present these are still at a relatively large scale. The inability to calculate changes in hazard risk probability at specific locations makes it impossible to calculate the costs and benefits of prevention initiatives.

Until site-specific information about the impacts of environmental changes on hazard probabilities are available, quantification of the benefits of environmental management will continue to be elusive. Even when such information is available, cost-benefit analyses will

[8] *For more information on International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) see http://www.icrisat.org*
[9] *For more information on Southeast Asia Fire Danger Rating System Program see http://nofc.cfs.nrcan.gc.ca/seasia/*

only reflect a portion of the benefits of prevention since methodological approaches of capturing intangible and indirect costs remain underdeveloped.

While models are being refined, we can promote general interest in the potential linkage between disaster risk and environmental degradation. Project developers might support ecological assessments in the vicinity of disaster management initiatives and disaster management initiatives might incorporate more ecological information in the assessment of risk and vulnerability.

Further investigations might document evidence of the linkage between poverty and vulnerability and seek specific case studies and lessons learned from those programs that have used environmental management as a strategy for poverty alleviation. Environmental management initiative that includes monitoring of environmental conditions could be expanded to monitor for hazard risk. Likewise, community based disaster management programs that integrate awareness of environmental condition could further enhance resilience. Risk reduction objectives may be also be achieved through engagement in the process of planning Integrated Water Resource Management or River Basin Development plans.

"Living with Risk" outlines the following key areas of environmental management that could serve to support disaster risk management (ISDR2002):

- Environmental legislation
- Environmental policies and planning
- Institutional arrangements
- Environmental impact assessments
- Reporting on the state of the environment
- Ecological and environmental economics
- Environmental codes and standards

The fact that program planners are asking for empirical evidence to support decision making points to a gap in communication between the users and producers of scientific information. The research community should be sensitive to the possible applications of their work. Opportunities should be sought to establish ongoing dialogue between developers of decision support tools and decision makers. Similar initiatives have proven valuable in the context of climate information wherein the user and producers of climate information meet to promote the development of relevant forecasts and projections. Similarly, the ongoing Initiative on Science and Technology for Sustainability[10] aims to engage the research and development communities in joint problem solving ventures. Participation in such dialogues could greatly enhance the planner's ability to develop effective programs.

Despite the challenges of quantifying prevention there seems to be little argument that, in qualitative terms, prevention pays. Warmington (1998) offers that simple evidence that, "where prevention and mitigation have not been practiced, human and economic losses are significantly higher than they need to be.

[10] *For more information on the Initiative on Science and Technology for Sustainability see http://sustsci.harvard.edu/ists/updates.htm*

Acronyms

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
BWDB	Bangladesh Water Development Board
CBA	Cost-Benefit Analysis
CIDA	Canadian International Development Agency
DEM	Digital Elevation Model
DST	Decision Support Tools
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	Food and Agricultural Organization: United Nations
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICZM	Integrated Coastal Zone Management
IDNDR	International Decade of Natural Disaster Reduction
IFRC	International Federation of Red Cross and Red Crescent Societies
IHDM	UK Institute of Hydrology Integrated Model
IISD	International Institute for Sustainable Development
IPCC	International Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
IUCN	The World Conservation Union
IWRM	Integrated Water Resources Management
MRC	Mekong River Commission
NGO	Nongovernmental Organization
SENSA	Swedish Environmental Secretariat
Sida	Swedish International Development Cooperation Agency
SHE	Système Hydrologique Européen
SIDS	Small Island Developing States
UN OCHA	United Nations Office for Coordination of Humanitarian Affairs
WSSD	World Summit on Sustainable Development

Appendix A: Disaster Losses in Asia 1992-2002

	Reported disasters	Reported persons affected	Reported fatalities	Reported Damages (in millions of dollars -2001 prices)
Avalanches/Landslides	101	1,671	6,106	439
Droughts and famine	77	301,362	271,051	12,688
Earthquakes	112	28,799	52,540	170,119
Extreme Temperatures	35	839	5,469	4,497
Floods	362	1,227,387	50,034	119,167
Forest/scrub fires	18	3,105	181	20,941
Volcanic Eruptions	16	360	180	1
Wind Storms	322	210,894	34,895	41,508
Other Natural Disasters	14	47	511	0
Subtotal hydro-meteorlogical disasters	*929*	*1,745,305*	*368,247*	*199,241*
Subtotal Geophysical Disasters	*128*	*29,159*	*52,620*	*170,121*
Total Natural Disaters	**1,057**	**1,774,463**	**420,867**	**369,362**
Industrial Accidents	225	218	6,654	629
Miscellaneous Accidents	178	144	7,674	731
Transport Accidents	668	15	28,486	1,173
Total Technological Disasters	**1,071**	**377**	**42,814**	**2,533**
TOTAL	**2,128**	**1,774,841**	**463,681**	**371,895**

Adapted from IFRC 2002

Appendix B: Related Definitions

Excerpted from "Living with Risk" (ISDR2002)

Coping capabilities/Capacity: The manner in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal, and adverse conditions of a disaster event or process.

The strengthening of coping capacities usually builds resilience to withstand the effects of natural and other hazards.

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/society to cope using its own resources.

Disaster risk reduction: (disaster reduction) The systematic development and application of policies, strategies and practices to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) adverse impact of hazards, within the broad context of sustainable development.

Hazard: A potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hazards can include latent conditions that may represent future threats and can have different origins natural (geological, hydrometeorological and biological) and/or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterized by its location, intensity and probability.

Mitigation: Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Preparedness: Activities and measures taken in advance to ensure effective response to the impact of disasters, including the issuance of timely and effective early warnings and the temporary removal of people and property from a threatened location.

Prevention: Activities to provide outright avoidance of the adverse impact of hazards and related environmental, technological and biological disasters.

Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disaster. In the context of public awareness raising and education, prevention refers to attitude and behaviour leading towards a "culture of prevention".

Resilience/resilient: The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure. This is determined by the degree to which the social system is capable of organizing itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster.

Risk: The probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable/capable conditions. Conventionally risk is expressed by the equation : Risk = Hazards x Vulnerability / Capacity

Beyond expressing a probability of physical harm, it is crucial to appreciate that risks are always created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Risk assessment/analysis: A process to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability/ capacity that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

The process of conducting a risk assessment is based on a review of both technical features of hazards such as their location, intensity and probability, and also the analysis of the physical, social and economic dimensions of vulnerability, while taking particular account of the coping capabilities pertinent to the risk scenarios.

Risk management: The systematic management of administrative decisions, organisation, operational skills and responsibilities to apply policies, strategies and practices for *disaster risk reduction.*

Vulnerability: A set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of a community to the impact of hazards.

Positive factors, that increase the ability of people and the society they live in, to cope effectively with hazards, that increase their resilience, or that otherwise reduce their susceptibility, are considered as capacities.

Appendix C: Select Asian Environmental Initiatives

Excerpted from "Living with Risk" (ISDR 2002)

In Asia, although there have been few examples of effective, systematic and long-term integration efforts between disaster reduction and poverty alleviation programmes, a dialogue between the two interest groups is beginning to take place. In February 2001, the *Asian Development Bank (ADB)* organized the Asia Pacific Forum on Poverty. One of the key focus areas was social protection to diminish vulnerability to risks, generate employment and improve productivity and working conditions in Asia and the Pacific. It was one of the few times that a discourse on poverty alleviation in the region recognized disaster reduction as one of the key interventions for social protection.

The region, however, has a long way to go in terms of integrating poverty alleviation and disaster reduction programmes in practice. More research is required on understanding the nature of linkages between poverty and vulnerability in different social, political, economic and hazard-specific contexts. Only then can specific frameworks, tools and methodologies be developed and applied to integrate poverty alleviation and disaster reduction programmes. A notable example of an integrated program is the recent initiative of the *Mekong River Commission (MRC)*. Following the extensive floods in Viet Nam and Cambodia in 2000, it developed a holistic strategy for flood management and mitigation that emphasizes land-use planning, structural measures, flood preparedness and emergency response.

The Phnom Penh Regional Platform on Sustainable Development for Asia and the Pacific adopted in the participatory phase leading up to WSSD, notes that the financial crisis of 1997, the isolation and vulnerability of *Small Island Developing States (SIDS)* and recurrent natural disasters had posed major constraints to the achievement of sustainable development. Coping with natural disasters is perceived as an essential issue to be addressed in the region. Measures are called for to ensure that populations suffering the consequences of natural disasters, severe environmental degradation and other relevant humanitarian emergencies are given every assistance and protection so that they can resume normal life as soon as possible.

Until recently, the relationship between environmental degradation and mismanagement, hazard incidence and vulnerability was a non-issue in most regions and countries except for lip-service. Neither the subject nor the designated authorities for disaster management were thought to be relevant for ecologists and environmentalists. There was little discussion, and even less organizational contact, linking the perceived interests of environmental management and the dynamics associated with risk reduction. In fact, the primary actors frequently considered one another to be antagonists, struggling to represent forces either empowering the interests of the people or expanding the uncompromising power and authority of the State, often played out over competing uses of land and natural resources. It should also be recalled that the existence of environmental divisions in bilateral and multilateral agencies as well as of environmental ministries was not the norm during the 1980s.

This changed dramatically in the closing years of the 1990s in Latin America and the Caribbean. El Niño and Hurricanes Georges and Mitch focused attention on the importance of the full range of the hydrological cycle to both development and disaster concerns. The magnitude of the resulting fires, drought, flooding and landslides associated with these disasters inevitably stimulated discussion about the relationships that exist between environmental mismanagement and the occurrence of hazards. One of the most important initiatives was the CCAD publication, *Strategy for the Reduction of Environmental Vulnerability in Central America when Faced with Natural Disasters: Environmental Management and the Evaluation of Vulnerability*, (May 1999). Produced with the collaboration of the Economic Commission for Latin America and the Caribbean (ECLAC), UNDP, UNEP and the World Bank, this document provided an overview of the disaster and vulnerability problems in the region and proposed many wide-ranging projects for financing as part of the international process to rehabilitate the Central American region. The content of the proposals went quite beyond environmental problems, touching on almost every foreseeable topic of interest to risk analysts and managers.

The World Conservation Union (*IUCN)* and the *International Institute for Sustainable Development* (IISD) have joined forces to promote the use of environmental management and policy tools to reduce vulnerability of communities, especially the poor and marginalized, to the growing threat of climate change and climate-related disasters. The project seeks to:

- identify environmental actions that reduce the vulnerability of social and economic systems;
- enhance the role of these activities by offering a tool kit of options with detailed examples of their application to relevant actors in research, advocacy, policy-making and industry;
- build the capacity of local institutions in regions and countries vulnerable to climate-related disasters to assess and respond to the environmental sources of vulnerability;
- create a platform for integrating environmental management measures that reduce community vulnerability into existing policy frameworks and international strategies on disasters mitigation, climate change adaptation, biodiversity conservation and poverty alleviation.

The initiative is guided by a task force on climate change, vulnerable communities and adaptation composed of a multidisciplinary group of experts from the fields of climate change, disaster reduction, sustainable livelihoods and environmental management and policy. Working from different points of departure, members will explore how natural resource mismanagement contributes to the vulnerability of human systems, and how enhanced management can provide tools for vulnerability reduction. It will produce the following:

- case studies that improve the understanding of environmental factors which shape vulnerability to climate-related disasters, and the options for adaptation within policy frameworks;
- guidelines for reducing vulnerability to climate change and climate-related disasters using environmental management tools;
- a network of institutions at the regional and national level with the capacity to assess and address vulnerability to climate-related disasters.

Klang River (Malaysia) Flood Mitigation and Environmental Management Project
Funded by the Asian Development Bank and undertaken under CBD, the project objectives are to improve environmental conditions, including those that worsen flooding, through an integrated river basin approach that addresses environmental and economic development needs, and reduce the adverse socio-economic and environmental impacts of flooding in the Klang river basin. Some of the considerations affecting environmental management and flood mitigation are integrated river basin management, solid waste management, sediment trapping, tributary corridor improvement and flood forecasting and warning systems.

The China National Wetlands Conservation Action Plan finalized in 2000 is an example of a specific environmental legislation supporting disaster reduction. The purpose of wetland protection legislation is usually to minimize the degradation of wetlands and to preserve the beneficial values of wetlands. This means that for development activities, alternatives to wetland sites or limiting wetland damage must be considered. Such provisions usually apply to acquisition, management, and disposition of land and facilities, construction and improvement projects, activities and programs affecting land use, including water and related land resources planning, regulation, and licensing activities. Valuable information produced includes detailed wetland maps, studies and reports on wetland characteristics, documentation of compliance and consistency with floodplain management programs.

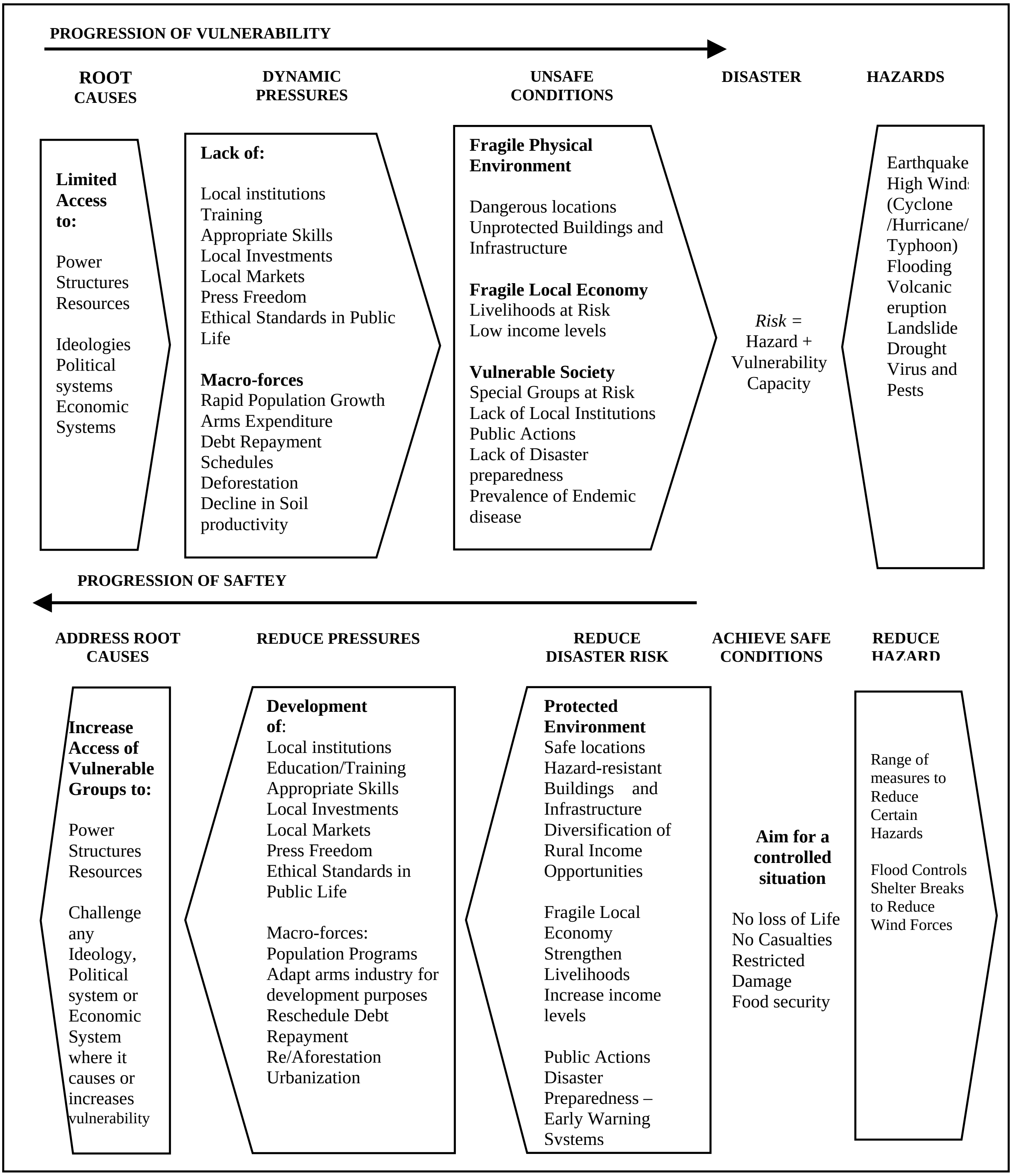
World Bank has been integrating environmental management and hazard reduction through The Dominican Republic - National Environmental Policy Reform, while not explicitly addressing natural hazard vulnerability perfectly, the initiative matches hazard mitigation concerns as its objectives include curbing deforestation and degradation of watersheds and coastal zones. Its development objective is to establish the basis for improved environmental management by defining environmental policy reforms and elaborating a national environmental management programme. The St. Lucia - Integrated Watershed Management Project was initiated in 1994 in response to damages resulting from floods and landslides related to tropical storm Debbie. Apart from structural rehabilitation, it also supported the formulation of a Watershed Management Plan, which would serve as the basis for more integrated and sustainable development of key watersheds and strengthen the Government's capacity in environmental management and flood preparedness.

Bangladesh Coastal Greenbelt Project (Bangladesh State of the Environment Report, 2001) is a project serving environment and disaster reduction undertaken by the Department of Forest, under the Ministry of Environment and Forest, the project's main objectives are to:

- Prevent loss of life and damage to property by cyclone, storms and associated tidal surges
- Protect and improve the coastal environment through increased vegetation
- Help alleviate poverty by generating income through increased tree cover and derived products
- Increase forest resources
- Increase coastal embankment stability
- Establish industries based on forest plantation
- Increase multiple use for land
- Create popular awareness on sustainable forest management.

"Open space, greenways, and riverside parks serve as habitat for wildlife protect streams from pollutants, help maintain water temperatures, and keep people and development from the highest-risk floodplains. Trees can drastically reduce storm water management costs. American Forests studied Garland, Texas, and calculated that the city's canopy reduced storm water runoff by 19 million cubic feet during a major storm. Annually, the trees save Garland $2.8 million in infrastructure costs and $2.5 in air quality costs and residential energy bills." (Natural Hazards Research and Applications Information Center, 2001)
.
Around the village of Guarita in *Honduras*, local people practiced traditional Quezungal farming methods consisting of planting crops under trees, maintaining ground vegetation and terracing, in order to root the soil and reduce erosion. During hurricane Mitch, only 10 per cent of the crop was lost, leaving reserves that could be shared with more severely affected neighbouring areas.

Appendix D: The Progression of Vulnerability



Adapted from ADPC 1999

Appendix E: Declaration on Disaster Reduction and Global Environmental Change

GERMAN NATIONAL
COMMITTEE ON
GLOBAL CHANGE
RESEARCH

Federal Foreign Office, June 20 - 21, 2002, Berlin, Germany

Declaration on Disaster Reduction and Global Environmental Change Towards a Policy of Disaster Prevention

Seventy-five experts from seventeen countries in Africa, North and South America, Asia and Europe and representatives of four United Nations organizations (ISDR, UNEP, UNFCCC, UNCCD) as well as major international scientific research programmes (International Geosphere-Biosphere Programme IGBP, World Climate Research Programme WCRP, International Human Dimension Programme IHDP and the International Programme of Biodiversity Science DIVERSITAS), implementing agencies (GTZ, ADPC), the IGAD Drought Monitoring Center (DMC), the Global Fire Monitoring Center (GFMC) and the Inter-American Development Bank, met on 20 and 21 June 2002 in Berlin under the auspices of the German Committee for Disaster Reduction (DKKV), Germany's National Committee on Global Change Research (NKGCF) and the Federal Foreign Office. The Symposium brought together experts from the global change research and disaster reduction communities to discuss trends in global change and their implications for disaster reduction activities.

In the course of their deliberations, participants identified a number of points they considered of key importance for the future:

* Despite the good progress made by some countries in reducing the impacts of and deaths caused by natural disasters, environmental degradation continues to exacerbate not only the hazard potential but also the vulnerability of societies. Human suffering and material losses from natural disasters are on the rise worldwide: since the 1960s the global economic cost of disasters has increased by more than 800 %. Given the growing long-term vulnerability of people living in high-risk regions, rising prosperity and the cumulative effects of global environmental change, this trend is expected to continue.

* There is increasing evidence that global environmental change and natural disasters are linked. Future trends with regard to natural disasters are expected to be non-linear, featuring critical thresholds caused by abrupt changes in earth system dynamics. Extreme weather events having particularly severe impacts on certain regions of the world are likely to increase. At the same time economic marginalization and population shifts towards more hazardous regions will increase people's vulnerability to extreme events such as hurricanes, coastline flooding, droughts, wildland fires, river floods and famine. Poor people tend to live in high-risk areas and urban settlements are often not adequately prepared to deal with such extreme events. Increasing attention therefore needs to be given to the vulnerability of urban settlements and their infrastructure.

As the first forum bringing together experts from both the disaster reduction and the global environmental change communities, the Berlin Symposium has been instrumental in launching a new and important dialogue, from which both communities stand to gain. To maintain this dialogue, however, further ongoing efforts are needed.

In the light of the data on current trends presented at the Symposium, participants call for:

- A recognition on the part of policy-makers and decision-makers that losses from natural disasters – in terms of both human suffering and infrastructure - will continue to increase unless a concept is adopted that makes disaster reduction an integral part of sustainable development and links efforts to reduce community vulnerability and promote resilience with efforts to develop the local economy and sustainable management of natural resources.
- A new approach to global cooperation designed to raise awareness among decisionmakers that communities may suffer a higher incidence of natural hazards also as a result of environmental emissions possibly originating in distant regions of the world.
- Endorsement of the Amsterdam Declaration of the four international programmes (WCRP – IGBP – IHDP – DIVERSITAS) and the development of “an ethical framework for global stewardship and strategies for earth system management” as well as “a new system for global environmental science".

The Symposium adopted the following specific recommendations:
Action should be taken to:

1. Establish a “Type 2” partnership linking disaster reduction and global environmental change under the auspices of the WSSD process. A partnership along these lines under the umbrella of the ISDR and ICSU should envisage concrete project-oriented action to be implemented by global environmental change programmes as well as specific ISDR programmes.

2. Improve the capacity of the social and economic sciences to undertake global monitoring of the human aspects of disaster reduction. Integrating a monitoring system of this kind with the well-established observation systems of the natural sciences will generate a new dimension of predictive data giving decision-makers further insights into how to effectively reduce vulnerability.

3. Establish a global early-warning mechanism under the auspices of the United Nations that would also include an International Early Warning Platform. Such a Platform should facilitate inter alia concrete action to implement the recommendations of the global environmental change and disaster reduction communities along the lines approved by the Experts Meeting on Early Warning and Sustainable Development held in March 2002 in Bonn.

4. Promote the development of global observation systems, including inter alia satellite technology applications and ground-based observation, with special emphasis on incorporating such data more effectively into global mapping and geographic information systems. This could be achieved by encouraging greater political awareness and networking on the part of ongoing international initiatives (e.g. Data Exchange Platform for the Horn of Africa, Global Monitoring for Environment and Security, Integrated Global Observing Strategy and others). Here the proposed International Early Warning Platform could give an important lead. The main focus should be on environmental impacts, land-use changes and natural disasters. Unrestricted and affordable access to such data for all actors is the key to their effective utilization, improved transfer of information to end-users and increased awareness on the part of all concerned.

5. Strengthen local, regional and national strategies encompassing medium and longterm action to mitigate the impacts of climate change and related hydro-meteorological events. This should be achieved through capacity-building, education and training, building networks of community stakeholders as well as developing and improving consistent government policies and programmes for sustainable disaster risk management.

6. Put in place supporting economic mechanisms to provide vulnerable countries with funding and technical assistance to help mitigate the impact of global environmental change, establish early warning systems and rehabilitate communities affected by disasters.

7. Develop with the full involvement of all parties indicators designed to enhance the effectiveness of disaster reduction and vulnerability reduction activities. Linking research data on global environmental change and disaster reduction yields a wealth of information on socio-economic issues, ecosystems and food security that gives significant added value to the available data base.

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2002. Living with Risk: A global review of disaster reduction initiatives. Geneva: Prepared as an inter-agency effort coordinated by the International Strategy for Disaster Reduction (ISDR) Secretariat with special support from the Government of Japan, the World Meteorological Organization and the Asian Disaster Reduction Center.

Living with risk: a global review of disaster reduction is the first comprehensive effort by the United Nations system to take stock of disaster reduction initiatives throughout the world. Coordinated by the secretariat of the International Strategy for Disaster Reduction (ISDR), the report discusses current disaster trends, assesses policies aimed at mitigating the impact of disasters, and offers examples of successful initiatives. It also recommends that risk reduction be integrated into sustainable development at all levels - global, national and local.
Most of all, Living with risk shows that we are far from helpless in the face of natural hazards... – Kofi A. Annan, United Nations Secretary-General

The full report is available online at http://www.unisdr.org/Globalreport.htm

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1991. Disaster Mitigation in Asia and the Pacific. Asian Development Bank. Manila, Philippines

This study primarily addresses officials in the developing member countries of the Asian Development Bank who are engaged in disaster management or are responsible for designing and implementing national economic development strategies. In addition, the study is addressed to the international donor community. The study is organized a technical background paper, which provides an overview off disaster mitigation practices in general, and four country studies (Bangladesh, Nepal, the Philippines and the South Pacific).

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This Handbook is a companion volume to the ADB study mentioned above. This volume is intended to serve as a ready reference guide for those actively involved in the management of natural disasters before, during and after the disaster situation. The authors argue persuasively that to be effective, disaster management should be implemented as a comprehensive and continuous activity, not as a periodic reaction to individual disaster circumstances. The book covers the broad field of disaster management and offers guidelines on the major segments that constitute the field.

IFRC

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The International Federation Red Cross and Red Crescent Society publishes an annual report which includes statistics on the frequency and impacts of natural and man-made hazards worldwide. In addition, each report contains substantial and substitutive articles on a different theme or issue in disaster management. In 2000, the focus was on Public Health; in 2001, the focus was on Recovery and in 2002 the focus was on Risk Reduction.

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This two-volume set covers a broad range of peer-review articles related to the flood risk and flood management. Topics include hydrological aspects, early warning systems, structural and non-structural mitigation (to name a few). Two articles by J.A.A. Jones were relied on heavily for this study, “Human modification of flood producing processes: The evidence from catchment studies” and “The physical causes and characteristics of floods”. Other sets in the series include Droughts, Earthquakes and Windstorms.

Coburn, A.W., R.J.S. Spence and A. Pomonis
1994. Vulnerability and Risk Assessment *2nd Edition.* United Nations Development Programme in collaboration with the Office of the United Nations Disaster Relief Coordinator for the Disaster Management Training Programme (DMTP) in association with the University of Wisconsin Disaster Management Center. Available online at:

This training module, *Vulnerability and Risk Assessment*, is designed to introduce this aspect of disaster management to an audience of UN organization professionals who form disaster management teams, as well as to government counterpart agencies, NGOs and donors. This training is designed to increase the audience’s awareness of the nature and management of disasters, leading to better performance in disaster preparedness and response. This module examines the scope for measuring the risk of future losses and for using this knowledge to assist in the selection of an appropriate disaster mitigation strategy. It considers the nature of risk, and the difference between actual and perceived risk; it discusses the techniques by which natural hazards and the accompanying risk of future losses can be estimated; and it discusses the ways in which future risk estimates can be used to assist the choice of the optimum disaster mitigation strategy.

Dedeurwaerdere, Ann
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The objective of the study is to examine cost/benefit evaluation models of natural disaster preparedness, mitigation and prevention measures in relation to the costs of the relief and the rehabilitation operations. The report aims at providing a simple methodology for practical decisions on the prevention and reduction of natural disasters by international, national, regional and local authorities. The most appropriate models should define whether an investment is justified. In the first part, the study undertakes a short critical overview on the current thinking of cost/benefit evaluations for natural disaster preparedness, mitigation and prevention measures Three approaches have been examined here, in terms of their ease of application and appropriateness for policy decisions. One of these is retained for further development and application. In the second part, the selected model is expanded and applied to a case-study in the Philippines to assess the practical applicability of the model in the field and with real data constraints. In the final part, the results, data and methodology are evaluated and recommendations are made for future applications of the model prepared.

This study is available online at: http://www.cred.be/centre/publi/143e/begin.htm - Contents

Selected Training Courses at the Asian Disaster Preparedness Center

Community Based Disaster Risk Management Training

The CBDRM 11 will provide an opportunity to learners to acquire tools and obtain knowledge on "how to" design and implement programs on reducing vulnerability, mitigating hazards and building community capacity so as to promote a ‘culture of safety’. Through exercises and simulations they will practice risk assessment and risk management planning.

The learners would have a chance to know about globally acknowledged programs and projects on community based disaster risk management from leaders of these initiatives. In particular the cases would include examples particularly from South and South East Asia and Pacific regions.

CBDRM course would tackle the issues in disaster risk management from a developmental perspective. There will also be discussions on issues and problems concerning sustainability, replication/adaptation of CBDRM projects, ethics of CBDRM practice and integration of risk management plans with government and non-government development plans.

The bulk of discussions would be in Asian context. However, learners from other regions are welcome to attend the course.

Flood Risk Mitigation Course

The Flood Risk Mitigation Course is an integrated approach to development of flood risk reduction strategies that involves engineering, settlement development, public administration, community-based strategies and land use planning (with environmental considerations). This multi-disciplinary treatment of the flood problem and of the requirements of flood risk management is expected to enable a holistic view of the situation and the needed preparedness measures. Cases of responses at the national and local levels are presented to give the mitigation measures concrete applications.

The Course starts with an overall understanding of the flood issue and moves toward a discovery of the various options and best combinations available to mitigate hazards becoming disasters. The Course concludes with determination of measures desirable and applicable at the national level

Disaster Management Course

The purpose of the course is to provide comprehensive disaster management knowledge and skills to enhance the capabilities of executive managers who have key disaster management responsibilities. It is designed to enable professionals working in disaster management, development and donor agencies to effectively integrate disaster management into their development programs and policies. Participants will be encouraged to develop key skills and adopt proactive attitudes through participation in interactive lectures and reflection on a range of key issues raised during discussions and practical activities.

By completing the DMC participants will learn how to:

- Develop effective strategies and systems for disaster prevention, mitigation, response and recovery
- Apply risk management processes in order to identify, assess and deal with disaster risks
- Utilize an emergency operations center to manage disaster event.
- Assess key implementation issues and requirements in disaster management

Websites

http://www.adpc.net/

The Asian Disaster Preparedness Center website provides an overview of disaster management activities throughout the region, an online newsletter and links to other disaster management related web resources.

http://www.proventionconsortium.org/

The World Bank's Provention Consortium aims to help developing countries build sustainable and successful economies and to reduce the human suffering that too often results from natural and technological catastrophes. The website hosts a valuable risk management library with on-line articles and manuals.

http://www.colorado.edu/hazards/o/o.html

The *Natural Hazards Observer* is the bimonthly periodical of the Natural Hazards Center. It covers current disaster issues; new international, national, and local disaster management, mitigation, and education programs; hazards research; political and policy developments; new information sources; upcoming conferences; and recent publications.

http://www.unisdr.org/

The International Strategy for Disaster Reduction (ISDR) strives to enable all societies to become resilient to the effects of natural hazards and related technological and environmental disasters, in order to reduce human, economic and social losses. This vision will find its realization by focusing on increasing public awareness, obtaining commitment from public authorities, stimulating interdisciplinary and inter-sectoral partnership and expanding risk reduction networking at all levels and, improving further the scientific knowledge of the causes of natural disasters and the effects of natural hazards and related technological and environmental disasters on societies. In addition, the General Assembly separately mandated the ISDR to continue international cooperation to reduce the impacts of El Niño and other climatic variables and to strengthen disaster reduction capacities through Early Warning.

http://www.ifrc.org/

The International Federation of Red Cross and Red Crescent Societies (IFRC)
The International Federation of Red Cross and Red Crescent Societies is the world's largest humanitarian organization, with 178 member National Societies. Its programs aim to assist the world's most vulnerable people. Activities focus on health, disaster response and disaster preparedness.