Overview B
Environmental degradation and Regional Vulnerability: Lessons From Hurricane Mitch

Photo: Red Cross Honduras photo, International Red Cross

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Abstract

The factors and processes that shape disaster vulnerability are often the product of complex interactions between natural and social systems. The impact of Hurricane Mitch in October 1998 provided a dramatic reminder of this vulnerability in Central America, and demonstrated how decades of environmental degradation had weakened the natural resilience and buffering capacity of the affected ecosystems. An understanding of the linkages between environmental stewardship and disaster vulnerability requires an appraisal of the structure and function of the social systems that influence access to and uses of environmental resources. Thus, issues such as war, population growth, forced migration, marginalization, urbanization, and foreign debt all contribute to or compound the effects of deforestation, biodiversity loss, and land degradation, which can in turn intensify the effects of natural disasters. As such, disaster risk can be mitigated through modified land use practices, the enhancement of the role of wetlands and mountain ecosystems in mitigating flood and landslide risks, and through local participation of stakeholders in resource management decisions.

Introduction

"Every society is constructed as a complicated 'negotiation' between artifice and nature, a two-way flow of materials, control and mutual adjustments." (Hewitt, 1997: 71)

Risk is inherent to the Central American isthmus. Born from a violent land, recurrently destroyed by earthquakes and volcanoes, flogged by hurricanes and awash with floods, Mesoamerican societies seem to have replicated this violence in countless conflicts, wars and policies of denial. The relationship between environmental factors and security is a particularly complex one in Central America. Many rural communities have co-evolved with their environment in a process of mutual adjustment. As a result, the extraordinary biodiversity of Mesoamerica is matched by its rich cultural diversity. A long history of natural disasters, cultural clashes, and natural resource wealth and scarcity has made Central America a particularly compelling region in which to explore the relationship between natural and social systems in the context of disaster risk.

This paper explores the social and environmental context of endangerment for Central American societies. As such is provides a new look at the relationship between environment and security in an evolving context. It seeks to identify the factors and processes that shape risk, loss, and human response in the environmental context of Central America. It addresses the growing concern about the link between disasters and environmental stewardship, which is a function of the structure and operation of social systems. In particular, this case study will explore the origins and facets of the vulnerability of human settlements and ecosystems in Central America to natural hazards, thereby exploring the environmental and social configuration of disaster risk.

This paper begins with a brief conceptual introduction to the relationship between hazards, vulnerability and disaster risk. As a primer it centers on the idea that "natural" disasters are a misnomer, and that most disaster related loss of life and property can be attributed to the human allocation of endangerment. This is referred to in this chapter as the social construction of risk. This first section is followed by an appraisal of the root causes and macro-forces at work in Central America which have contributed over the past decades to the social construction of risk in the region. A review of the recurrence of natural disasters in Central America, and a brief appraisal of the processes of exclusion, denial and repression which have marked the social history of this tormented region of the world, reveal how vulnerable various Mesoamerican social institutions and practices are to hazards. This second section will provide us with a background for understanding the differential impacts of Hurricane Mitch in 1998. The third section of this chapter assesses the impact of Mitch, and suggests how this

impact was the result of cumulative and compounding effects of population growth, environmental degradation, urban sprawl and increases in the human allocation of endangerment and vulnerability in the Central American region over the last decades. A fourth and final section addresses possible actions that could potentially enhance resilience and security in Central America. This case suggests that conserving the integrity and diversity of nature, and ensuring the sustainable and equitable use of natural resources may be a significant factor in mitigating disaster risk.

I. A Conceptual Primer on Hazards, Vulnerability and the Social Construction of Risk

1.1 A Model for Mitigating Disaster Risk

The linkages between risk, security and resilience illustrate some of the major challenges facing societies throughout the world today. Blaikie *et al.* (1994) have provided us with the Disaster Pressure and Release Model (PAR), taking into account a combination of global factors, dynamic national pressures and local conditions which generate vulnerability to disasters (See Fig. 1). In the PAR model, root causes are often linked to global forces over which local communities have little or no influence, but which determine access to power, land and resources. Root causes emerge from the economic and political spheres, where policies and structures are enacted that promote social exclusion, concentration of wealth and targeted use of force against marginalized groups through military or police structures. Root causes also determine to a large degree the tenure over land and resources.

Dynamic pressures are seen as linkages between larger structural causes and local conditions, "translat[ing] the effects of root causes into the vulnerability of unsafe conditions" (Blaikie, P., 1994:24). Dynamic pressures are those which determine the basic health and nutritional status as well as the access to education and job opportunities of a population, its resource tenure security and the state of its surrounding environment. Macro-level dynamic pressures include population growth, rapid urbanization, deforestation and loss of biodiversity, decline in soil fertility and the relative scarcity of key resources such as water.

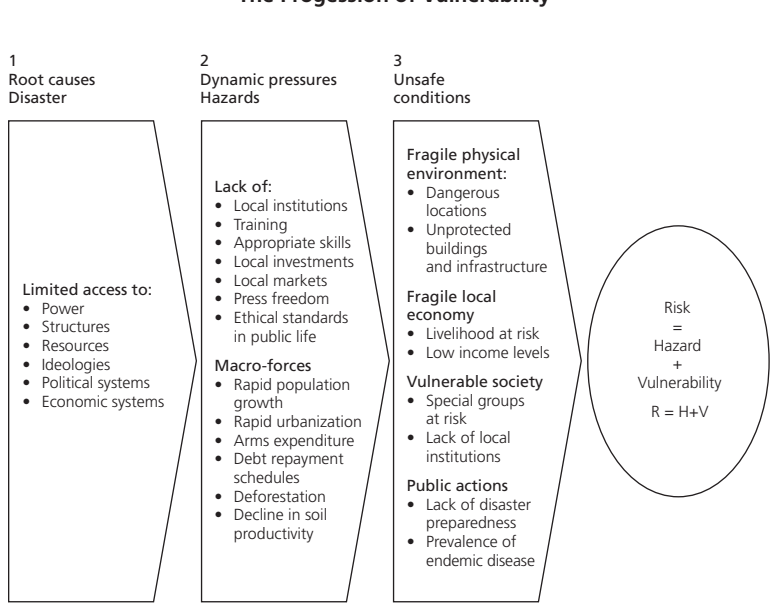
All these dynamic pressures contribute to create unsafe conditions, including a fragile physical environment, a fragile economy, vulnerable social groups and inadequate public action due to low income, limited access to resources and weak local institutions. As a result, natural hazards can result in major damage through such agents as floods, droughts or earthquakes.

The PAR model is an analytical tool that illustrates how disasters occur when these pressures, both global and dynamic, compounded by unsafe

conditions, are released by natural hazards. This model also serves to identify the policies and measures that must be taken to reduce the risk of disasters. An analysis of the social construction of risk (Lavell, A., 1996) reveals how well (or ill) adapted and resilient social institutions and practices are to hazards. Hewitt (1997:27) defines resilience as "capability to avoid, withstand or offset and recover from disaster." An important set of factors in resilience to disaster is the relative vulnerability of livelihoods, in terms of access to land, resources and wealth (Blaikie *et al.*, 1994). Achieving safe conditions at the local level therefore hinges on creating more resilient environments, sustainable livelihoods, healthy and capable people. That said, while communities throughout the world have developed coping mechanisms and local institutions which enable them to improve their co-existence amidst natural hazards, there are processes and root causes which can only be addressed on a broader scale.

In their effort to devise policy advice for disaster reduction, Blaikie *et al.* (1994) provide us with key guidelines for making mitigation measures more effective (see Box 8A). The model presented here argues for deepening our understanding of the contribution non-structural hazard mitigation measures—in particular, targeted environmental conservation initiatives—can have in lessening the impacts of extreme meteorological and hydrological events like Hurricane Mitch in Central America.

Figure F1. Blaikie, P. et al. 1994 Disaster Pressure and Release Model



Box 5A: Twelve Steps to Mitigate Risk

1. Manage mitigation
2. Integrate the elements of mitigation
3. Capitalize on a disaster to initiate or to develop mitigation
4. Monitor and modify to suit new conditions
5. Focus attention on protection of the most vulnerable
6. Focus on the protection of lives and livelihoods of the vulnerable
7. Focus on active rather than passive approaches
8. Focus on protecting priority sectors
9. Measures must be sustainable over time
10. Assimilate mitigation into normal practices
11. Incorporate mitigation into specific development projects
12. Maintain political commitment

Source: Blaikie, P. *et al.*, 1994

Vulnerability is closely linked to environmental degradation according to the PAR model. Figure F1 represents an integrated approach which enables cross-scale linkages, thereby allowing for an improved understanding of the inter-relationship between environmental factors (biodiversity, upper watersheds, aquifer recharge areas, slope stability, buffer role of wetlands) and macro forces affecting society (population growth, migration, urban sprawl, agricultural frontier expansion, external market demands on local resources, access to land and resources). Addressing these forces also demands the capacity to set forth changes in many of the factors which generate unsafe conditions, including non structural mitigation through sound environmental planning.

According to Blaikie *et al.*, adaptability is key to risk mitigation, but this often hinges on the capacity of local populations to understand and interpret their habitat and associated hazards and risks. For this to be achieved, it is necessary not only to understand the range and intensity of natural hazards and their probable occurrence, but also, more importantly, to develop policies which effectively attack those dynamic forces which produce vulnerability. As Hewitt (1997: 153) suggests: "Empowerment may be much more critical to reducing the vulnerability of such people than any particular tools, information or regulations to combat a hazard." It is

also a key factor in prompt recovery following a disaster, as coping strategies are often conditioned by access to resources, employment and safety.

Coping strategies are those practices adopted by individuals and groups in the face of trends and shocks that affect the viability of their livelihoods, as in the case of a major disaster. Such strategies include changing the mix of livelihoods upon which individuals and communities depend, creating new livelihoods, intensifying competition for existing resources, finding new resources bases (by force of arms or otherwise), or migrating elsewhere in search of greater livelihood security. In the wake of Hurricane Mitch, many responded to the emergency through outmigration, competition for foreign assistance, and innovative coping strategies, such as local solidarity movements, community organizations and political lobbying. Out-migration is often attributed to the collapse of livelihood systems, the impact of armed conflicts, and the loss of adaptive mechanisms which enable local populations and institutions to be more resilient to violent changes, such as those associated with wars and natural disasters. These problems in turn further degrade a country or region's productive capacity in negative feedback loops, particularly in the form of weakened public institutions.

This conceptual primer provides us with an adequate framework within which to analyze, in the next section, the factors contributing to the social construction of risk in Central America. Its seeks to reveal the linkages between processes of social exclusion, environmental degradation and heightened vulnerability to natural disasters, as was tragically illustrated by Hurricane Mitch.

2. Central America: A Territory at Risk

> "Desde esta América, encarnada y encendida, Mi América de rabia, la Central." – Ana Istarú.

The immediate reaction to a humanitarian tragedy the size of one left behind by Hurricane Mitch, late October 1998 in Central America, is one of disbelief. How could such a disaster produce over 10,000 deaths, directly impacting one tenth of all Central Americans, paralyzing entire countries like Honduras, and require one of the largest international humanitarian responses in Central American history? In order to begin answering this question, other contextual questions must first be addressed. Firstly, how vulnerable is Central America to severe weather systems such as depressions, storms and hurricanes? Furthermore, what is the relationship between environmental degradation and the compounded vulnerability of impoverished societies recovering from decades of war and civil strife? Finally, can any examples of sound environmental stewardship be identified which may provide insights into linking environmental management to the broader humanitarian and security concerns of the Central American Region?

The following section reviews the factors involved in Central America´s social and environmental history which have shaped conditions of vulnerability. It seeks to identify those ecosystems most crucial to mitigating disaster risk, and examines how alternative livelihood systems have responded to the impact of destructive agents. Finally, it reflects on environmental and institutional resilience in Central America at the dawn of the twenty-first century.

2.1 The History and Geography of Disasters in Central America

A single disaster like Mitch cannot be properly understood without taking into account the cumulative and interacting effects of many cyclical, natural and anthropogenic hazards. These include weather-related storms and flooding, drought, earthquakes and landslides, the climatic variations induced by the El Niño effect as well as the history of conflict and insecurity in the region.

The Central American isthmus, located at the crossroads of the Americas, has historically been shaped by calamity. It is one of the most geo-dynamic regions of the world, marked by recurrent seismic and volcanic activity, as well as hurricanes, forest fires and drought. Central American societies have co-existed in highly hazard-prone areas for centuries, even millennia. The agrarian societies settled on some of the most fertile soils of the region, particularly those derived from volcanic ash in the highlands and from alluvial deposits in the lower valleys and coastal plains. These settlement patterns have determined the urban and regional structure of most Central American countries.

This structure has undergone several episodes of dramatic change over time. All of the colonial capitals of Central America's five nations (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua) were destroyed and relocated at some point in time over the past centuries. For instance, recurrent earthquakes and mudflows destroyed the colonial capital of Guatemala, Antigua, several times during the colonial period (1541, 1575, 1607, 1651, 1689, 1717). A major earth tremor in 1773 damaged several of the city's buildings, leading to its relocation to its current site in 1775 (Musset, A., 1996). San Salvador, the capital of El Salvador, suffered similar earthquake episodes, but was never relocated from its original setting (Romano, L., 1996). Similarly, Cartago, the colonial capital of Costa Rica, was destroyed in 1911, and the new capital is now located in San José. In addition to natural disasters, the region underwent periods of dramatic human-generated biophysical change, or "ecocide," which were characterized by massive deforestation and the draining of wetlands and waterbodies.

The figures in Table 1 reflect the impact of hurricanes in Central America between 1961 and 2001. Adding to these official figures produced by the CEPREDENAC (regional Committee of National Civil Defense and

Table F1: Humanitarian and Economic Losses from Hurricanes in Central America 1961–2001

Month and year	Event	Extent/ region and countries affected	Dead	Wounded	Displaced	Economic losses (in US$)
October 1961	Hurricane Hattie	Belize and Northern Guatemala	275			150,000,000
September 1969	Hurricane Francelia	Guatemala, Belize, El Salvador E and SE Honduras	296	248	18,200	35,600,000
September 1971	Hurricane Edith	Nicaragua, Honduran Mosquitia	35		2800	2,968,000,000
September 1974	Hurricane Fifi	Honduras Belize	8000 (all in Hond-uras)		670,000	3,478,000,000
September 1978	Hurricane Greta	Honduran and Nicaraguan Mosquitia, Eastern Guatemala and Belize			2,000	
October 1988	Hurricane Joan	Nicaragua, indirect effects in Costa Rica and Panama	156	182	427,000	460,000,000
July 1996	Hurricane Cesar	Costa Rica and Nicaragua	49	50	681,367	53,000,000

Month and year	Event	Extent/ region and countries affected	Dead	Wounded	Displaced	Economic losses (in US$)
October 1998	Hurricane Mitch	All seven countries in the Central America Region, hardest hit Honduras and Nicaragua	9,977	13,440	1,981,912	6,009,000,000
October 2000	Hurricane Keith	Belize	8			250,000,000
October 2001	Hurricane Iris	Belize and Guatemala	20			220,000,000
Total	10		18,816	13,920	3,783,279	13,623,600,000

Source: CEPREDENAC Web site—www.cepredenac.org -, 2002; Government of Belize, National Emergency Management Organization, web site-www.nemo.org -, 2002

Emergency Commissions) all losses due to weather related and seismic and volcanic hazards since the 1960s, the total death toll attributed to disasters has been 56,669 persons, leaving 123,346 wounded and 10,247,330 displaced or evacuated. The economic burden of disasters in the region has also been high, estimated at a total of US$15,535 million over a 40-year span (CEPREDENAC, 2000).

Latin America has also undergone an urban explosion over the past 30 years, and today hosts at least two of the largest cities in the world—Sao Paulo and Mexico City. These cities are located in high risk areas, as the 1985 Earthquake in Mexico revealed. The Pan American Health Organization (PAHO) has estimated that in Latin America, some 100,000 people have died in earthquakes during the twentieth century (IDNDR, 1999).

A recent study published by Oxfam-U.K., provides an assessment of the degree to which the Mesoamerican population is exposed to natural hazards. According to this survey, the most frequent cause of disaster in Central America over the past century has been extreme weather systems such as hurricanes and tropical storms. At least one third of disasters affecting Nicaragua, Honduras and Belize, have been due to hurricanes and

tropical storms, affecting an estimated exposed population close to 8 million inhabitants (Ordóñez, A., 1999:18) The study also estimates that 5.4 million inhabitants of the region are exposed to potential flood risk, while the total population exposed to volcanic risk is half that amount, with 7.5 million inhabitants (Ordóñez, A., 1999:21).

The ENSO (El Niño Southern Oscillation) phenomenon (commonly known as El Niño) produced months of drought in parts of Central Honduras, Guatemala, El Salvador and Northern Nicaragua during 1997–1998. Massive forest fires destroyed over 1.5 million hectares of forests throughout the region (an area amounting to 3/4 the size of El Salvador) between May and December 1997 (Rodriguez, J., A. Salas and R. Pasos, 1998). Recurrent drought episodes are not always linked to the El Niño phenomenon. As recently as 2001, southern Guatemala, El Salvador, Honduras and Nicaragua experienced rainfall well below monthly averages, causing episodes of famine and outmigration in isolated drought stricken rural communities in Nicaragua and Guatemala.

The perennial nature of risk scenarios present in the region has also fostered a wide variety of natural and cultural responses. Adaptation by ecosystems to a hazard prone context has produced an extraordinary biological diversity in Central America (Myers, N., 1994). Similarly, societies in the region have, over time, developed a broad diversity of coping mechanisms and mitigation measures to reduce risk and minimize the impact of recurrent flooding and earthquakes. Many Caribbean settlements of Central America developed housing on stilts in order to better withstand flooding events. Likewise, Spanish colonial authorities often adopted structural mitigation measures to reduce the impact of flooding in cities located near lakes. This was the case of Mexico City, where Lake Texcoco was completely drained by the end of the nineteenth century, and San Salvador where Lake Ilopango was also drained and dried during the 1920s (Musset, A., 1996). These engineering feats also provided additional space for growing cities. However, while successful in mitigating flood risk, these flat lake beds contributed to intensifying seismic waves, as was made evident during the earthquakes of San Salvador (1965) and Mexico City (1985) (Hewitt, K., 1997).

As in most other regions of the world, the most recurrent type of damaging agents are linked to severe weather and its impact on land in the form of hurricanes, tropical storms and associated flooding and landslides. But by far the most destructive single events in terms of human lives are earthquakes, with the 1976 Guatemala earthquake at the top of the list with over 23,000 deaths, followed by the 1972 Managua earthquake which resulted in 10,000 deaths.

In order to fully understand the differentiated impact of extreme weather events in the Central American isthmus, one must analyze the interrelation

between population growth, changes in land use, settlement patterns and forest cover in Central America over the past three decades. The relationships between these factors and broader macroeconomic and social trends create and modify disaster vulnerability.

2.2 Root Causes of Disaster Vulnerability and Macro Forces at Work in Central America

Central America has in 50 years undergone rapid demographic growth, coupled with increasingly inequitable access to resources and land. In 1950, the region's total population was 11 million inhabitants. By the end of the century, Central America's population had more than tripled to 35 million. Prior to the war-torn decade of the 1980s, concentration of land in the hands of the few caused massive migrations and subsequent expansion of agricultural and settlement frontiers into areas of higher rainfall. According to Utting (1996:18), extensive cattle ranches constituted 10 per cent of the total number of farms in the early 1990s, but covered 46 per cent of total agricultural land. Conversely, small holder farmers represented 44 per cent of the total number of farms covering only 6 per cent of total farm land. This *latifundio*[305]-*minifundio*[306] binome has profoundly marked environmental history in Central America. It constitutes one of the most relevant factors in increased conditions of vulnerability in the region.

The overall process of environmental degradation, forest and biodiversity loss and soil erosion also tends to intensify the impact of extreme climatic and teluric events. For example, the continuous expansion of the agricultural frontier into more fragile ecosystems—eliminating stabilizing forest cover from steeper and unstable terrain—has caused a clear increase in flash floods, mudflows and landslides. This was most clearly demonstrated in Honduras during Hurricane Mitch in the *minifundio* centered in the highlands and steep terrain, and the *latifundio* in the valleys, where plantation agriculture and shrimp farms occupy the best agricultural lands. Flash floods were the leading cause of death and destruction during Hurricane Mitch. While landslides and mudflows hit hillside small farmer areas the hardest, floods were most prevalent in the lowlands and floodplains where most of the large scale farming takes place.

The settlement of agricultural frontiers is particularly demonstrative of the linkages between policies of exclusion, environmental degradation, social conflict and disaster vulnerability. As in many other countries of Latin America, the process of national integration in Central America was tardy and subject to the fluctuations of world commodity prices. In several countries, vast regions, particularly the Caribbean lowlands of the Mosquito Coast, still remain isolated from their respective national economies because of lack of access. The famous dichotomy between the

Pacific Heartland and Caribbean Rimland formulated three decades ago by West and Augelli (1966,1989) still applies, although with important exceptions. The dominant national cultures are generally based in Pacific and Intermontane regions, while much of the Caribbean rim is still considered peripheral, both culturally and economically. This gap between the Caribbean rim and the Pacific heartland has recently been recognized as a major structural reality in Central America´s current situation in terms of Sustainable Human Development (UNDP/Proyecto Estado de la Región, 1999).

The contrast between densely populated highlands and sparsely inhabited Caribbean lowlands is evolving fast, and the process of agricultural colonization which began in the 1960s is reaching some of the most remote reaches of national territories. While the agricultural frontier in El Salvador is estimated to have reached the political boundaries of the country in the 1930s, in Costa Rica the agricultural frontier only drew to a close during the 1990s (Pasos, R., 1994; Augelli, J., 1989). In Panama, Honduras, and Nicaragua, the agricultural frontier is alive and well, and constitutes a key safety valve for preventing agrarian conflicts over access to land. This is the case for many other South American nations.

The frontier lands undergoing agricultural colonization are, in many cases, located along peripheral border regions. These regions, long neglected due to difficult access, inhospitable climate and rough terrain, have functioned for centuries as refuges for displaced populations fleeing war, political persecution, economic indigence and land dispossession. Their function as refuges has fostered a unique combination of cultural and biological diversity. The co-existence between indigenous people and tropical forests in Central America often coincides with forested areas, as illustrated by Mac Chapin's map for National Geographic's Research and Exploration Division (1992). Indigenous peoples are thus also custodians of some of the most biologically diverse natural ecosystems, either montane (Cuchumatanes, Guatemala), lowland tropical forest (Emberá-Darién Panama) or coastal ecosystem (Miskito, Garifuna, Nicaragua, Honduras, Belize). These remote regions constitute the setting for border parks and indigenous territories, under increasing encroachment by ladino settlers.

In this sense, the promised "open lands" for settlers often coincides with the ancestral territories of indigenous peoples. Often referred to as "the poor among the poor," Central America's indigenous population is estimated at 6 million, of which 85 per cent are found in Guatemala (Proyecto Estado de la Región, 1999). However, many of the border regions of Central America coincide with the last remnants of indigenous lands, including the Toledo Maya in southern Belize, the Xicaque, Lenca, Garifuna and Miskito of Honduras, the Miskito and Sumos of Nicaragua, the Bri-bri, Cabécar and Guaymis of southern Costa Rica, and finally the

Ngobe-Bugle, Kuna and Emberá-Woonan in Panamá. These transboundary ethnic groups have learned to adapt, as border societies do, to the realities of bi-national life. They have also suffered the brunt of wars and policies of exclusion and denial. As a result of their longstanding condition of structural disadvantage, they show the greatest vulnerability to natural disasters.

This structural vulnerability stems from the combination of settlement on marginal lands (steep slopes, difficult climate), subsistence dependence, lack of alternatives, degree of isolation, lack of transport infrastructure, and lack of government or other support to enhance the resilience of buildings, infrastructure and livelihoods. For instance, in the Kekchi communities of Alta Verapaz, Eastern Guatemala, the impact from Hurricane Mitch in terms of flood damages and loss of crops was compounded by the lack of access to alternative sources of income and subsistence. Many Kekchi had to rely on food aid or else migrate to other regions as seasonal labourers.

Many traditional societies have developed conflict and disaster coping mechanisms. These may include the development of united and tight-knit cultures with political recognition, reciprocal social arrangements, smaller settlements, elevated constructions, light materials, distribution of risk in land use and sustainable livelihoods, most of which have been profoundly modified over the past decades. While some communities still nurture systems of reciprocal labour exchanges between households and joint labour for community works such as building roads, schools and irrigation systems, many others are losing these mechanisms of solidarity in favour of more individualistic social paradigms.

On the other hand, there are increasing signs that a resurgence of cultural identity and political mobilization is occurring among indigenous groups throughout the region. Conflicts between indigenous territorial claims, ladino settlers, mining and timber concessions are very likely in the next decade. Both the extension of the territories involved, and especially the resources they contain, will be the object of future contention. There has been a sharp increase in large infrastructure, mining and tourism-related investment in remote regions, such as in the Petén region and in Southern Belize. This may explain why many indigenous people in the region are striving to secure firm legal recognition over their land, and a degree of territorial autonomy to defend their lands against outside encroachment. Although these factors may at times stimulate conflict, they are also crucial in empowering local communities to mitigate their own disaster risk. By building upon existing social networks, disaster preparedness, evacuation and even mitigation measures can be introduced/integrated into community structures. There are encouraging examples of post-disaster assistance which have incorporated risk management into community-based organization as a form of local empowerment to reduce vulnerability (British Red Cross, 1999).

3. Risk Perpetuated by War, Internally Displaced and Resettled Populations

All Central American nations were marked by war in the 1980s, even those which did not engage directly in armed conflict. The cost of attending to the thousands of displaced populations and refugees placed a particular burden on neighbouring countries such as Belize, Honduras and Costa Rica. While the war-torn regions of Guatemala, El Salvador and Nicaragua have finally found peace, there are still enduring conflicts linked to the spontaneous and planned repatriation, resettlement and assimilation of refugees into their country of origin. With over 150,000 persons forced to emigrate during the 1980s throughout Central America, and an additional 400,000 internally displaced people, the humanitarian toll of the past wars is daunting. The resettlement of these displaced populations has compounded disaster risk, as many of these returning migrants have settled in hazard-prone areas. The sociological intricacies of many of these recently established settlements are thus important to take into account when understanding the sources of vulnerability to disaster.

Disaster vulnerability may have been increased by the results of forced migration and resettlement on marginal lands, partly as a result of exclusionary politics in which particular social groups have been excluded from decision-making and public services. This situation is illustrated in the case of the Lower Lempa Valley in El Salvador and Suchitepéque and Retalhuleu in Guatemala. The peace process in both El Salvador and Guatemala has led to the resettlement of displaced, repatriated and other highly vulnerable populations in several rural areas, many of them in high-risk flood-prone areas. Many of the resettled groups are comprised of former armed opponents to existing governments and in some cases they have been systematically excluded from government programs. Many of these resettled groups are composed of mixed ethnic and geographic origin, a factor which affects community building, trust and solidarity, essential ingredients of successful coping strategies.

The regions settled by the returning populations were among the most devastated by the armed conflict of the early 1980s. Some of the areas chosen for resettlement were allegedly marked by landmines, and constitute a continuous threat for the rural populations settled there. The most critical problems however are linked to agrarian conflicts over land tenure and titling. Indeed, the return of refugees to their lands left in the midst of war 10 years prior has created increasing tensions in many of these rural areas.

Many major projects, funded by the United Nations system, such as the PRODERE project in Nicaragua, El Salvador and Guatemala, sought to provide pre-emptive aid to defuse the most critical agrarian conflicts in resettlement zones. While some experiences were successful, others pro-

vided the returnees with alternative land grants, most of them in newly settled areas in the lowlands (such as the Petén and Suchitepeque in Guatemala, Bajo Lempa in El Salvador,Siuna in Nicaragua) generally located on poorer soils, steep slopes or flood-prone plains.

In a clear reference to the environmental impact of the post-war era in Central America, Jaime Incer, then Minister of the Environment of Nicaragua (Director of IRENA), was quoted as saying in 1991 "It is a strange fact that the war has been benevolent with our forest while peace is destroying it" (Utting, P., 1996:47). Paradoxically, war contributed to forest conservation, while peace is reactivating the agricultural frontier and hence deforestation (Nietschmann, B., 1991). Thousands of campesino families are returning to their original settlements, left during the past decade of war, as either returning refugees (or *retornados*) or as demobilized regular and irregular forces. Many of these resettled populations were not previously employed in agriculture, since they spent most of their early adult life in arms; as such, they are dismally prepared for eking out a living on marginal lands. This fact contributes greatly to predatory uses of natural resources, primarily through deforestation, wildlife trade and unsustainable extractive activities like gold mining, illicit contraband and drug trafficking, much of which can be currently found in border regions and coastal areas. (Nietschmann, B., 1995).

4. Macro-forces and the Social Construction of Risk: Urban Sprawl and Economic Slump

By the end of the 1980s, civil war had profoundly changed the nature and spatial distribution of populations in Central America. Armed conflict between government and revolutionary forces occurred in many remote regions of Central America, where indigenous populations—such as the Miskito in Honduras and Nicaragua and the Quiché and Mam in Guatemala—suffered the brunt of these wars. These conflicts produced large contingents of internally displaced people, out-migration and the swelling of urban shantytowns. Today, over 64 per cent of Nicaragua's population lives in cities, whereas a generation ago it was a predominantly rural society. In fact, half of Central America's population now lives in cities, one fifth in cities larger than 100,000 inhabitants (CCAD, 1998, Proyecto Estado de la Nación, 1999). Future projections forecast the growth of the total urban population of the region from 16 million inhabitants today to 22 million by 2007, and it is expected to reach some 35 million in 2025 (World Resources Institute, 1999).

These processes have produced a corollary increase in risk. Most national governments emerged from the 80s with far greater external debts to service, and all adopted stringent structural adjustment policies during the

1990s, as the next section will illustrate. Already limited public expenditures on social programs were further curtailed to satisfy the conditions and mandates of international lending institutions. As a result, high levels of ill health, exclusion and indigence among both the rural and urban poor have compounded levels of vulnerability. Uncontrolled urban sprawl and speculative land markets have pushed many marginal settlements into high-risk areas, such as river canyons and flood-prone coastal areas. Without a doubt, the environmental dimension has become, and will continue to be a major issue in disaster prevention and mitigation in Central America. As population pressure increases, compounded by skewed land distribution and urban sprawl, key natural resources are dwindling. As will be illustrated in the following section, the impact of resource capture and relative scarcity of key resources such as water and fuelwood create not only conditions of heightened vulnerability, but also exacerbates tensions between communities and countries vying over scarce resources. This rapid depletion of resources occurred in a context of negative economic growth and increasing poverty, both urban and rural.

All of the region's countries experienced negative growth rates during the 1980s, most dramatically those which were immersed in civil war. In Nicaragua, the GNP in 1985 was $2,136 million but only $1,792 million in 1993, a contraction of 16 per cent or 2 per cent per year. At the same time, the Central American population has continued to grow at an average rate of 2.7 per cent annually, from 22 million in 1980 to 28.3 Million in 1990, and an estimated 32 Million in 1995. As a result, Per Capita GNP has tended to drop from $1039 in 1980 to $919 in 1985, to $883 in 1990.

By the end of the 1980s, over 80 per cent of the rural population of Central America were in conditions of poverty, and 50 per cent in extreme poverty, particularly in Guatemala, El Salvador, Honduras and Nicaragua (Lucke and Cussianovitch, 1996). Life expectancy in Guatemala is 64.2 years, and 68.2 for Nicaragua whereas it is 74 for Panama and 76.5 for Costa Rica. Infant mortality rates also reflect the sad fact that one out of four Central Americans are malnourished, and hunger kills 12 of every thousand Costa Ricans, and 46 of every thousand Guatemalans. But in spite of these dismal figures, Central America, for the first time since the 1960s, reached the end of a decade in better macro-economic shape than when it began (Proyecto Estado de la Región, 1999).

A major aspect increasing vulnerability in the 1990s was the economic aftereffects of the wars of the 1980s. In Table F2, the evolution of the GDP of the regions' countries since 1920 is shown. The combination of habitat and livelihood destruction due to armed conflict and extensive infrastructure damage, economic recession and more recently structural adjustment policies, have left a Central America that is poorer and unsustainable by any standards.

Table F2: Average Annual Gross Domestic Product Growth per capita in Central America 1950-1996

Decade	Annual GDP growth per capita for the region	Annual GDP growth per capita for countries with no war*	Annual GDP growth per capita for countries at war**
1950–1960	1.7	2.1	1.7
1960–1970	2.9	2.6	3.1
1970–1980	1.7	2.1	0.5
1980–1990	-2.0	-1.1	-3.2
1990–1996	1.7	1.1	2.0

(*) Including Panama, Costa Rica, Honduras
(**) Including Nicaragua, El Salvador, Guatemala

Source: Proyecto Estado de la Nación, 1999, Cuadro 1.3

In terms of land use, the entire region witnessed a dramatic increase in conversion of "unused" land to pastures, which grew from 6.9 million hectares in 1970 to 10.5 million hectares in 1983. At the same time, the crisis of livestock and beef export industry has led to the abandonment of unprofitable pastures, meaning that the area dedicated to annual crops and food production has actually stagnated. Annual deforestation rates in Central America have been estimated at between 324,000 Ha and 431,000 Ha for the 1980s (Kaimowitz, D., 1996). In the 1990s, deforestation rates continued unabated with an average annual loss of over 388,000 ha for 1997 (CCAD, 1998) A more subtle change has been the progressive growth in "other uses" of land during the 1990s, which according to FAO are areas not under permanent or annual crops or pastures or forests. This refers to abandoned lands, secondary regrowth and fallow, which grew from 9.1 million hectares to 12.1 million hectares between 1976 and 1991, excluding El Salvador (Lucke and Cussianovitch, 1996:17). This confirms estimates that there could be up to 13 million hectares of secondary forests in the region. In sum, these figures suggest that almost a quarter of the lands in Central America are under-utilized, abandoned or in fallow.

These figures must also be put into the context of trade liberalization and structural adjustment which most countries in the region have attempted during the 1990s, with serious implications for food security in the region. The results have been a sharp increase in food imports and a correspondingly steady decrease in the areas cultivated for food production for national markets as well as a continuous reduction in the size of the rural popu-

lation involved in basic grains production (maize and beans) (Proyecto Estado de la Nación, 1999). This raises concerns about the future food security of the majority Central American populations, for whom competition in a global market is a daunting perspective. The 1990's was marked by the opening up of Central American economies to world trade, each with extremely differentiated social, political and economic conditions. While many governments passed legislation reducing tariff barriers and import taxes, few had the resources to improve the infrastructure, education and information upon which national and regional businesses could expand. This brought about a parallel increase in economic vulnerability of the national economies in the region. Trade liberalization without the corollary public and private investments in infrastructure only contributed to expose national industries and producers to outside competition, eroding their share of internal markets.

Increasing attention has been put on the function of trade corridors and their importance the regional economies of Central American. INCAE, with the Harvard University, have proposed the concept of the Central American Logistical Corridor which consists in the major trade routes, airports and port facilities in the region. Geared to a faster insertion of Central American economies into a globalized setting, their recommendations are the basis for improved transport infrastructure, modernized ports and customs reform. During Hurricane Mitch, this logistical corridor was literally split in half since all the bridges in southern Honduras was destroyed, thus stopping traffic between Costa Rica and Nicaragua and their northern neighbours. Thus even the key regional infrastructure—and hence international trade as a source of foreign capital—is vulnerable to environmental degradation and mismanaged urban sprawl

5. Environmental Scarcity and Resource Capture in Central America

A strong relationship exists between the demand for increasingly scarce natural resources and increased conditions of disaster risk. The causal factors underlying environmental scarcity are very much present in Central America.[307] We find structural scarcity in the skewed distribution of land use; demand-induced scarcity in the expanding cycles of primary resource extraction linked to exports of raw materials and agricultural foodstuffs; and supply-induced scarcity stemming from the degradation of the physical resource base in the most densely populated regions of isthmus.

Other concepts developed by Homer Dixon (1999) can also be distinguished in Central America. A long history of "resource capture"[308] by the landed elite has had a particular impact on the availability of land. This has been the motor behind much of the expansion of the agricultural frontier since the 1960s, in which "ecological marginalization"[309] has forced the

poor to settle onto more fragile and hazard-prone land. Most migrants, both in rural and in urban areas, have tended to settle on steeper land, poorer soils and areas of higher rainfall. Changes in land use have had a direct impact on the distribution of forest cover in upper watersheds, on urban sprawl and on the distribution of wetlands and coastal forests, increasing vulnerability to natural hazards such as hurricanes. Among the most threatened forest ecosystems in the region are coastal mangroves, which have been cut to make way for urban settlement, shrimp farms and tourist resorts.

These increasing pressures on natural resources and protected areas are a direct result of skewed land and income distribution. Natural ecosystems, particularly wetlands, can play an important role in non-structural mitigation of disasters. In order to maintain wetlands and coastal forests, enduring and stable institutional arrangements for conservation are vital. Such arrangements can only be made enduring by involving local communities and stakeholders in natural resource management schemes.

Box 5B: Water Scarcity in Central America

Depletion of reliable freshwater resources in Central America has been a growing concern. As in other water-scarce regions of the world, "hydropolitics" is an important part of political discourse, as conflicts emerge between nation-states over the use and access to water resources for hydropower, irrigation or canal projects (Girot, P. and Nietschmann, B., 1992; Girot. P., 1994). As illustrated in the figure below, the disparities between freshwater resources availability among Central American countries are severe and are reaching critical thresholds. The accelerated depletion of this lifeline will no doubt exacerbate hostility between neighbouring states in the next century.

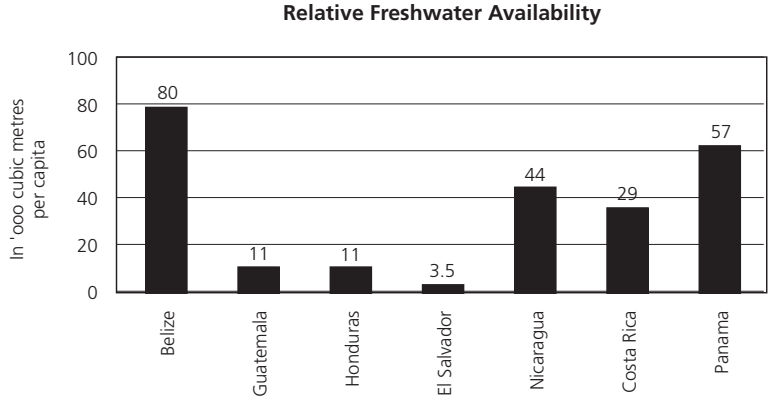
There are several examples of emerging hydropolitical conflicts. The Río Lempa is the single most important source of freshwater and hydroelectric power for El Salvador, and its drainage basin spans the Guatemalan and Honduran border. Due in major part to deforestation in its upper tributaries, the volume of available surface water in the Lempa dropped from 11,260 m^3 to 4482 m^3 between 1985 and 1993 (Ordóñez, A. *et al.*, 1999). El Salvador has an average of 3,500 m^3 of freshwater available per capita, in contrast with the 11,900 m^3 and 11,600 m^3 per capita available annually in Guatemala and Honduras respectively.

Another case of potential conflict over water resources, albeit less critical than in El Salvador, is that of the San Juan river between Costa Rica and Nicaragua. There is a clear gap in freshwater availability between the north (excluding Belize) and south of the Central American isthmus, with significantly higher per capita averages in Nicaragua, Costa Rica and Panamá.

Historically, the Lake Nicaragua-Río San Juan route for a planned "interoceanic canal" was the source of relentless litigations and arbitrations during the second half of the nineteenth century (Girot, P., 1994). In recent years, the focus of dispute is no longer over rights to a hypothetical canal route, but rather over access to the river by tour operators, and over the impacts of water pollution from banana plantations. The 1980s were marked by several litigations concerning the contamination of tributaries flowing from Costa Rica into Nicaragua. The Nicaraguan State sued Costa Rica for allegedly contributing to the pollution with pesticide residue of the Sarapiquí river, a major tributary of the San Juan. The case has remained unresolved, but rights of access and uses of the Río San Juan still constitutes a major item in the binational agenda clearly marked by the immigration/deportation issue. This has been referred to as the "Sanjuanización" of bilateral relations between Costa Rica and Nicaragua (Solís, 2000).[310]

Access to water itself is unlikely to constitute the source of conflict in the foreseeable future. Instead, the use and pollution of waterways are likely to cause conflict.

Figure F2. Per Capita Water Availability in Central America



Source: CCAD, 1997

Box 5C: Illegal Transboundary Harvesting of Forest Products

Another key natural resource under ever-increasing pressure are forests, both as sources of timber, fuelwood and non-timber forest products.

Recent studies of the forest sector, as illustrated in the figure, below, reveal that 92 per cent of all timber and forest products consumed yearly in Central America are destined for fuelwood consumption. This strong dependence on natural resources for basic energy needs exerts exceedingly strong pressure on dwindling forest resources.

Per capita fuelwood consumption of Honduras is well over twice that of El Salvador. Honduras' annual fuelwood consumption totaled 7.5 million cubic meters in 1997, twice that of Nicaragua, four times that of Costa Rica and 100 times that of Belize. In all countries except Belize, Panama and Costa Rica, over 90 per cent of the forest products literally end up in smoke as fuelwood (CCAD, 1998).

Similar contrasts exist between Costa Rica and Nicaragua, not as much for fuelwood use but for access to lucrative hardwood stands. With the rapid depletion of timber availability in El Salvador and Costa Rica, the market for legal and illegal sources of timber is growing. There will be probably ever growing conflicts over illegal transboundary resource extraction activities, as the high market prices for timber products in Costa Rica and El Salvador justify taking the risks. These are clearly conditions which foment future conflicts over scarce resources.

Table F3. Total Firewood Use, Per Capita Use, as Percentage of Total Wood and Timber Use in Central America, 1997

Country	Use of firewood, in millions of cubic meter/ year	Per capita firewood use in cubic meters/ year	Per cent of firewood out of total wood and timber usage (%)
Belize	0.07	0.34	54
Guatemala	7.11	0.85	96
El Salvador	5.3	0.68	94
Honduras	7.5	1.58	91
Nicaragua	3.7	0.95	93
Costa Rica	1.69	0.55	78
Panama	0.93	0.4	95
Total (mean)	26.3	0.76 (mean)	92 (mean)

Source: Diagnósticos Forestales de Belice, Guatemala, Honduras, EL Salvador, Nicaragua, Costa Rica y Panamá, CCAD/CCAB-CCAP,1997

3. Hurricane Mitch: Onset, Path and Impact

In this final section, we take a closer look at the impact of Hurricane Mitch, in October 1998, on the Central American region. By its magnitude and the regional scale of its impact, Mitch has been considered the twentieth century's worst disaster in Central America. Many of the factors and macro forces described in the previous section contributed to make Hurricane Mitch a devastating disaster, not only in terms of the massive loss of human lives and livelihoods, but also in terms of its enduring impact on the relationship between Central American societies and their surrounding environment. Things aren't quite the same as they used to be in Central America since October 1998.

3.1 Mitch´s Path of Destruction

Hurricane Mitch started as a tropical depression 560 kms east-northeast of Limon, Costa Rica, on the evening of 21 October 1998. High temperatures in the Caribbean contributed to intensify this weather system. At the Gulf of Mexico, a high pressure cold front from the United States made Mitch stray from the north-northwest path Caribbean hurricanes normally take. The storm brewed for four days just off the coast of Honduras roiling up to Category Five with winds over 285 kilometres an hour, one of four hurricanes of such force during the twentieth century. (See Fig. 6), Meanwhile, Mitch's low pressure system attracted cloud systems from the Pacific to make what would become a deadly weather combination over western Honduras and northern Nicaragua. By this time, most civil defense institutions in the region had been put on alert.

On October 28th, Mitch made an unusual southwestward swing toward central Honduras, heading south in an erratic manner. As it neared the continent, Mitch downgraded to Category Three and by the time it touched land near Trujillo on the north coast of Honduras, it had slowed to a tropical storm (see Fig.3). As the wind slowed, the hurricane's center passed over Tegucigalpa, the Honduran capital, and travelled south into El Salvador. As Mitch inched south—a rare move for Caribbean hurricanes, which commonly head north—heavy rainfalls pummelled the dryer Pacific Coast (See Fig.4). Whereas low-lying areas along Central America's Caribbean coast and the north and northeastern parts of Honduras were accustomed to and prepared for hurricanes, other regions were not as well prepared. Belize was able to evacuate 75,000 people from low-lying coastal areas (a staggering 32 per cent of the country's population), including 40,000 from Belize City alone. Southwestern Honduras was not nearly as prepared nor as fortunate. Mitch was stationed over this country for five days. Heavy rains and record river discharge flooded the Sula Valley cities of El Progreso, Tela and San Pedro Sula in the northern plain. The storm moved south and flooded the Choluteca Valley and hit the

cities of Comayagua, Tegucigalpa and Choluteca in the Gulf of Fonseca. (See Fig.7). Chinandega in Northwestern Nicaragua received close to 1,600 mm falling in ten days (more than the average yearly precipitation). The result was mass wasting, landslides, mudflows and flash floods, particularly in the Choluteca valley, as the debris-choked river flooded Tegucigalpa and tore through the town of Choluteca, near the Gulf of Fonseca.

Across the Gulf of Fonseca in Nicaragua, Mitch hit hardest in the north, causing floods and mudflows in the Departments of Chinandega, Estelí, Madriz, Nueva Segovia, and Matagalpa. Large sections of the Coco River and Caribbean Coast were flooded and Lake Managua rose rapidly, flooding parts of the capital. But by far the deadliest of all events occurred in Chinandega, where the entire side of the Casitas Volcano near Posoltega collapsed. This collapse turned into a mudslide a mile wide and three meters high, reaching speeds of up to 130 miles per hour, covering three entire villages and killing an estimated 2,000 people. Mitch hit the Gulf of Fonseca Region and the Lempa valley area hardest, as well as parts of La Union and San Miguel, particularly in the Chilanguera River where most of the deaths in El Salvador occurred.

Hurricane Mitch had downgraded to a tropical storm category by the time it reached Guatemala. Fortunately, it spared the populous (over 10 million) and in many ways the most vulnerable country in Central America. The storm subsequently crossed the Yucatan Peninsula and traveled to Florida, where it was absorbed by a cold front on November 5th and became an extra-tropical storm. While large amounts of rain severely damaged infrastructure, evacuations saved many lives. This was not the case however, for poor neighbourhoods settled on steep slopes in marginal areas around the capital, Guatemala City. Heavy rainfall over these deforested and eroded hillsides generated deadly floods and mudslides, destroying and burying anything in their path. This was particularly the case in the Berrinche neighbourhood in Tegucigalpa, Honduras, in which marginal urban settlements on steep slopes were destroyed by a large landslide. Similarly, the entire village of Morolica and a large portion of Choluteca, Honduras, were destroyed by floodwaters of the Choluteca River.

3.2 The primary impact of Hurricane Mitch

Mitch's first impacts were the direct results of severe geomorphic activity such as sheet erosion, flash floods, landform collapses, landslides and mudslides. Satellite imagery analysis by the U.S. Geological Service (USGS) indicated that Mitch caused over one million landslides in the disaster's first days in Honduras—a country 112,000 square kilometres in size. Mud and debris-choked rivers raged down the streets and throughout neighbouring towns and cities. Floods destroyed thousands of homes, damaged or obliterated hundreds of bridges, highways and piped water systems, in addition to wiping out

Table F4. Humanitarian Impact of Hurricane Mitch, October 1998[311]

Country	Deaths	Missing	Wounded	Displaced	Evacuated	Destroyed and damaged housing	Destroyed and damaged bridges	Damaged water mains
Honduras	5,657	8,058	12,272	1,482,659	2,100,721	*	215	1,683
Nicaragua	2,863	970	388	368,261	_	41,430	63	79
Guatemala	268	121	280	105,055	106,604	21,000	121	60
El Salvador	240	29	_	28,452	49,000	10,372	10	155
Costa Rica	5	4	_	3,007	5,500	965	69	12
Panama	2	_	_	8,408	602	1,933	1	_
Belize	_	_	_	_	75,000	_	_	_
Total	9,035	9,182	12,930	1,995,842	2,335,427	*75,490	479	1,989

power and telecommunications systems. (see Table F4). It is estimated that the hurricane directly affected one in ten Central Americans, or at least 3.5 million people(Caballeros, R. 1999; HIID-INCAE, 1999)

The majority of affected people were from the very poorest groups. Inequitable land policies and skewed incomes led to the urban and rural maginalization of these groups, where they were left with little choice but to build their houses on precarious, disaster-prone areas such as steep hillsides, river canyons and floodplains (Maskrey, A. 1994; Wisner, 2001). In rural areas, protective forest covers were cleared for subsistence crops, while simultaneously exposing the land to increased erosion and run-off. As a result, the likelihood and impact of destructive landslides and floods was increased, effectively exposing the most socially and economically vulnerable groups to disaster risk. In fact, Mitch's impact was worst in coastal flood plains and near river courses—lands naturally predisposed to flooding.

High winds, floods and landslides killed over 18,000 people (taking into account the missing as well as the dead) and seriously injured 12,930 others. As storm-induced flooding and landslides wiped out over 2,000 potable water systems within Honduras and Nicaragua, a large portion of the population in these countries were left without dependable drinking water. In addition, Mitch destroyed or seriously damaged almost 80,000 homes, leaving up to 300,000 people homeless. Two million others had to abandon their homes and belongings, and many were left stranded without access to shelter or relief in waterlogged areas of northern Honduras. In the days and weeks following Mitch, thousands needed rescuing and immediate medical care, and millions needed humanitarian relief aid, in the form of water, food, shelter, clothing and tools.

Mitch also destroyed or severely damaged 25 sewage and drainage systems and 130,000 latrines, as floods and landslides left lakes of standing water in many low-lying areas. For example, in the Honduran capital of Tegucigalpa, damages to sewer systems by the Cerro del Berrinche landslide created a septic lake two kilometres long, 72 metres wide and 2 metres deep in the centre of the city, with fecal coliform counts of 1,080,000 (OPS/OMS, 1999). Large numbers of refugees had to co-exist in crowded shelters. These unsanitary conditions and a lack of clean water and food contributed to the spread of diseases in the weeks following the storm. Serious damages to 30 per cent of Central America's hospitals, health units and other social service units made responding to these secondary impacts even more difficult.

3.3 Secondary and Tertiary Impacts

Mitch hit subsistence crop production hard, inflicting US$155 million in damages to this vital sector in Honduras alone (maize and bean stocks were

already low in the region due to El Niño's effects). Mitch also inflicted substantial damages on small and medium-scale livestock production and destroyed countless kitchen gardens and orchards. Farmers saw their crops devastated, livestock lost or drowned, and their land stripped of soil or covered by sterile sediments. In this sense, Hurricane Mitch destroyed the livelihoods of thousands, for in a matter of hours or days, the widespread destruction of crops, roads and cities brought severe long-term economic consequences. These conditions compounded the immediate impacts felt by the survivors, who were already faced with inadequate services, dwindling food supplies and limited seed availability for replanting.

The storm inflicted an estimated US$4 billion in direct damages on Central America's productive sector (agriculture, forestry, fisheries, industry and commerce) (Caballeros, R., 1999; SICA-SG, 1999) Damages to the productive capacity of these already debt-ridden, impoverished nations caused secondary catastrophes for public health, unemployment, labour migrations, reduction of available social services and general poverty. Mitch's damages to some of the primary components of Central America's productive capacity included: the destruction of two-thirds of Honduras and Nicaragua's precarious infrastructure; US$1.2 billion in damages to Central America's overall physical infrastructure; over US$800 million in damages to housing, health and education; and US$3 billion in losses in raw materials and plantation production (especially in Guatemala) (Caballeros, R., 1999) Assistance was—and continues to be—needed to rebuild or repair housing, make micro-loans to small businesses, replace tools, and rehabilitate hospitals, clinics, and other areas of the social and productive sectors. Aggravating factors such as foreign debt also needed—and still need—to be addressed.

4. Lessons Drawn: Resilience-Building Mitigation in Central America in the Twenty-First Century

4.1 Central American Disaster Vulnerability—Recommendations for Action

Central America's near and distant past has been marked by recurrent disasters. This very recurrence has constituted a constant reminder of the geography of risk in the region. This continuity is such that most Central American societies have co-evolved with areas exposed to seismic and volcanic risk. The perennial nature of these hazards in many localities has allowed for the emergence of a culture of risk prevention and mitigation. Many of the forest fallow systems, elevated housing and wise use of wetlands were historical ways in which Mesoamerican societies mitigated risk through cultural adaptation. It is clear that the region's extraordinary biological and cultural diversity have constituted some of its most effective

mechanisms for distributing and mitigating risk. However, most of these traditional natural resource management systems have faced increasing pressure from macro-forces such as growing populations, speculative markets and the degradation of natural resources and services.

Among some of the most pressing challenges Central American societies face at the onset of the twenty-first century is to reduce the levels of vulnerability to disasters. To achieve this implies several steps which we can itemize as follows:

Empower Local Communities to Mitigate Their Own Disaster Vulnerability. There are key lessons to be learned from the past in terms of mitigating risk. One is to empower local communities to manage their own risk by increasing the resilience of traditional institutions and local ecosystems. This can be achieved through a variety of ways, but by far the most effective is to build on local governance systems to ensure equitable access to resources, manage conflicts and strengthen inter-communal cooperation, particularly between up-stream and down-stream communities through local early warning systems. There have been interesting examples of community-based flood warning systems which have contributed to save lives in Guatemala and Honduras (Lavell, A., 1999).

Traditional social institutions, which have survived for generations through the tumultuous political history of Central America, are often geared to regulating and supervising the wise use of natural resources. Often linked to indigenous and communal land tenure systems, these stable, diverse and versatile livelihood systems were key to maintaining a steady flow of goods and services from natural ecosystems, while adapting to sudden changes over many hundreds of years.

This is the case for many indigenous communities, such as those in Totonicapan in Highland Guatemala, or the forest Ejidos of Quintana Roo, Mexico. In the Kekchi communities of the Polochic Valley in Eastern Guatemala, most of the highlands and hill country is settled by indigenous villagers, most of whom work in the coffee plantations or cattle ranches in the valley. Hurricane Mitch hit hardest in the valley, but many highland villages were isolated by mudslides. For the most part, it was community organizations and existing communication networks which brought emergency aid to these communities, through church and civil society groups with the support of international humanitarian organizations such as Oxfam U.K. and Action Aid (British Red Cross, 1999; DEC, 2000). Traditional community support and reciprocity were cited as key factors in the effectiveness of post disaster recovery (Quarentelly and Dynes, 1976; Blaikie, P. *et al.*, 1994)

Adaptation here is the key to determining how resilient a society is in the face of natural hazards. Enduring livelihood systems require community-

based institutions capable of adapting to changes in market orientation, land and resource availability. Resilience, when related to disaster preparedness, is linked to the capacity to predict, prepare for and recover from damaging agents. But it also means the capacity to identify the thresholds which constitute the limit of a system's capacity to absorb sudden climatic, geological or biological shifts. Traditional societies have shown a greater adaptation to cycles of environmental change, by enforcing flexible resource use regimes (Berkes, F., 1997). More research should be conducted on these traditional knowledge systems, in order to apply them to sound environmental management elsewhere.

Identify and Protect "Mitigating" Ecosystems. There are particular ecosystems and life zones which contribute directly to risk mitigation by protecting/enhancing their buffering functions linked to the hydrological cycle (such as precipitation capture and aquifer recharge, maintenance of river baseflow and flood storage by wetlands). These ecosystems include the cloud forests and montane forest ecosystems of the upper Chagres in the Panama Canal basin, the cloudforests of Rio Macho/Tapantí as well as the Cordillera Volcánica Central in Costa Rica. Much of the water which supplies Managua in Nicaragua comes from volcanic lakes and montane forests such as the Laguna de Apoyo. La Tigra National Park in Honduras protects one of the tributaries of the Río Choluteca, which caused much damage in Tegucigalpa and Choluteca during Hurricane Mitch. Similarly, Honduras' second largest city and its economic capital, San Pedro Sula, obtains much of its domestic water from the Sierra de Omoa, but is also prone to flooding from larger watersheds such as the Chamelecón and the Ulúa Rivers.

Preservation and restoration of mangrove forests also emerge as part of a sound risk mitigation strategy. A recent report on the hidden costs of coastal hazards confirms the crucial role played by barrier reefs, barrier islands and mangrove in the mitigation of hurricane risk (John Heinz III Center, 2000). For example, the coastal ecosystems of the Estero Negro, Gulf of Fonseca and some of the only remaining forests in El Salvador are mangroves. Although these mangroves have contributed to absorbing the inordinately high discharge and sediment loads from the runoff from Hurricane Mitch, these mangroves are under increasing pressure from shrimp farms as well as being used for firewood and as a source of basic subsistence for thousands. While the impact of hurricane on coastal ecosystem has yet to be assessed in detail, there is evidence that the mangroves have helped to buffer the high influx of sediments and debris by increasing land area (USGS, 1999). In Belize, a country endowed with the second largest barrier reef in the world, it has been established that the combination of coral reefs and mangrove provide key coastal protection during storms and tidal surges (UNDP, 1999).

Agricultural practices and soil conservation measures also have the potential to reduce disaster risk. Much of the impact of Mitch was blamed on the large-scale clearing of forest cover for extensive cattle ranches and subsistence farming (Rocha and Christoplos, 2001). Such unsustainable use of land and forest resources removed protective environmental services and increased the destructive capacity of landslides and floods. Furthermore, recent El Niño droughts and forest fires had exacerbated the precarious ecological resilience in the region. In the wake of Mitch, agro-ecological practices have been promoted as disaster mitigation measures. A recent study involving some 2,000 farmers in Guatemala, Honduras, and Nicaragua, and field tests in a number of sites found that farmers who practiced soil conservation reported less damage as a result of Hurricane Mitch (World Neighbours, 2000). Institutions long involved in promoting agro-ecological techniques are now orienting their work towards disaster mitigation, although further research is needed to assess the effectiveness of these techniques in the face of extreme conditions such as those associated with Mitch.

Other authors have questioned the linkage between farm level soil conservation and forest management practices and changes in the watershed discharge and flooding in Central America. (Kaimowitz, D., 2000). Scaling-up becomes a crucial element to produce palpable results in watershed management and hazard abatement.

Support Innovative Partnerships. Indigenous communities can work in partnership with urban communities in mutually beneficial risk mitigation activities. Indigenous community forestry in Totonicapan, in the Highlands of Guatemala, have for decades guaranteed a steady supply of wood and water to surrounding settlements (UICN, 2000). Other such partnerships that contribute to the preservation of a city's watershed forest cover and upstream wetlands deserve careful consideration.

Over the years, the distinct episodes of Central American integration have emerged from the recurrent concern for seeking common solutions to common problems. The relative small scale of these countries provides key incentives to seek a larger regional institutionality. A key component of early integration efforts was the completion of the Panamerican Highway System which links Canada, the United States and Mexico to Central America through a regional trade corridor. This trade corridor, called the logistical corridor by Harvard University/INCAE specialists, is of key importance for intra-regional trade. (SICA/SG, 1999; Bender, S., 1997) However, the growing vulnerability of this trade corridor was clearly demonstrated during Hurricane Mitch, when hundreds of damaged bridges and thousands of miles of roads were destroyed, interrupting traffic between and within countries for weeks. This in turn directly affected the region's economies, increasing costs and spurring inflation.

The linkage between the resilience of the regional trade corridor and the conservation and active management of the biological corridor remains one of the major challenges in the Central American region in the coming decades. Many of the upper tributaries of the rivers which tore through Choluteca, Tegucigalpa or San Pedro Sula, are located in or near protected areas. These biological corridors, if adequately conceived and managed, could provide local communities with very real mitigation opportunities. Providing far more than biodiversity protection, they also are sources of firewood, water and protection against flash floods.

Flood protection will no doubt become an environmental service of increasing value to communities downstream. There are encouraging examples throughout the region of local early warning system for floods which involve communities in Belize, in Guatemala, Honduras and Costa Rica (Relsat/CEPREDENAC). One of the key examples of the impact of sound land management in upper tributaries comes from southern Belize. Of all the Central America countries, Belize suffered the least impact from Hurricane Mitch. It also happens to be the only country with over 75 per cent forest cover and a country capable of mobilizing and evacuating a third of its total population from coastal settlements. However, Figure F2 reminds us that Belize has a long history of hurricane-related destruction, and its institutional preparedness may reflect a greater conscience about the need for early warning systems and civil defense.

How can we link these local initiatives to the growing number of projects involving community forestry, collaborative management of protected areas and ecotourism, and make risk abatement an integral part of sound environmental stewardship? This is not impossible to conceive in Central America, in spite of the extreme odds we have described in the first section of this study.

During the 1990s, *in situ* conservation efforts have enabled the creation of the Central American Protected Areas System, which covers practically a fifth of the regional territory. Other *in situ* efforts include several World Heritage sites, such as Tikal and the Mayan Biosphere Reserve, Bosawas, Río Platano, Talamanca and Darien, and over 400 protected areas throughout the area. The current launching of the GEF-funded Mesoamerican Biological Corridor reflects the concern in linking and integrating protected areas throughout the Central American isthmus. While the Biological Corridor provides for continuity through ecosystem connectivity, it may also go a long way to protect transport and production infrastructure from untimely damage, reducing the vulnerability of this crucial regional trade corridor.

One of the leading foci for regional cooperation is the Central American Commission on Environment and Development (CCAD). Recently

restructured as part of the reforms to the SICA (Central American Integration System), the CCAD has probably been the most dynamic expression of the new integration effort of the 1990s. In an effort to harmonize public policy, share experiences and pool resources, CCAD has created several technical bodies such as the Consejo Centroamericano de Bosques y Areas Protegidas (CCAB/AP), which groups the region's Directors of Forests and National Parks Systems Directors, along with a broad spectrum of representatives from civil society (peasant and indigenous groups, environmental organizations, technical staff from international organizations and regional projects, etc.). Among the most notable achievement of this integration effort has been the completion of up-to-date studies of the forestry and national parks systems in the region. And it is likely here that much of the regional effort towards disaster risk mitigation through investment in conservation could be stimulated.

Box 5D: The Role of Protected Areas in Central America in Environmental Security

The spectacular growth in the number of parks and protected areas in Central America has been an outstanding feature of the 1990s. Indeed, the number of protected areas in Central America has grown exponentially during the 1990s, from 25 in 1969 to 391 in 1996, of which 184 were declared between 1990 and 1996. Today there are over 400 declared protected areas in Central America.These protected areas cover a wide-ranging array of ecosystems, and harbour some of the region`s most extraordinary natural heritage sites, totalling over 9.5 million hectares (approximately 18 per cent of the region's land area).[308] Many of the larger parks and biosphere reserves are located in border regions, such as the Maya Biosphere Reserve in Petén, Rio Plátano Biosphere Reserve in Honduras, Bosawas Biosphere Reserve in northern Nicaragua, La Amistad International Park between Costa Rica and Panamá, and the Darien National Park on the border with Colombia.

The creation of most of these border parks coincided with the pacification process initiated in Central America after 1987 (Arias, O. and J. Nations, 1992). In spite of efforts throughout the region to created truly co-administered border parks, the only protected area along a border which has become Law on both sides of the border, and is run binationally is the International La Amistad Park, also a World Heritage Site, between Panama and Costa Rica.

However, the creation of parks in Latin America has been a major source of social/environmental conflicts, as documented in Borel, R. (1999). Over three quarters of the region's protected areas do not have any permanent institutional presence (UICN, 1997). The creation of

protected areas, often dubbed "paper parks," without the staff to patrol and control access has favoured increased poaching, land grabs and timber contraband. Transboundary pressures however may present scenarios for future conflicts, as in the case of the Darien Gap between Colombia and Panama which is subject to increasing encroachment by Colombian settlers, traffickers and irregular troops. These incursions have less to do with contrasts in resource availability than with the spillover of the Colombia civil war, which is raging in the Atrato and Chocó regions of northern Colombia.

In Central America, over half of the region's 400 declared protected areas were created since 1990 with little or no regards to the active participation of local populations. This has produced frequent conflicts between local landowners and peasant organizations over the way parks are created. The diminishment of state capacities and manpower in the wake of structural adjustment policies has opened the door to an increase in collaborative management of protected areas. An IUCN survey, conducted in 1997, revealed over 80 collaborative management initiative in the region's protected areas, including the Sierra de Las Minas in Guatemala, and Isla Cañas in Panama (Girot, P. *et al.*, 1998).

There have also been encouraging experiences in environmental management in Central America, and a conspicuous increase in the role of non-consumptive uses of natural resources, such as eco-tourism. This has also coincided with a boom in community based natural resource management, and more particularly community forestry. This is the case of Totonicapan, in highland Guatemala, where over 63 indigenous communities have sustainably managed and defended a 21,000 ha pine forest, to supply over 32,000 people with freshwater and wood (UICN, 2000). Similar experiences were recently documented by IUCN in Central America. There are a growing number of local forest management initiatives geared to providing environmental goods and services to local stakeholders. In some cases, they have contributed significantly to reducing the levels of vulnerability of local populations, while increasing ecosystem resilience.

4.2 Conclusion: Confronting The Growing Vulnerability of Central American Societies

Since 1960 in Central America, at least 200,000 people have perished as a result of civil war, over 50,000 died in disasters and an increasing number are dying from citizen insecurity and crime. There also has been a major shift in the geographic distribution of the population. As changes increase in speed, and populations tend to concentrate, conditions of risk

augment commensurably. A major challenge to disaster prevention and mitigation in Central America has been the dramatic increase in the rate of change on all fronts. Population has more than tripled in 50 years and urban population is fast becoming the majority in these rural societies. Marked by a violent past, most Central American societies have undergone years of civil strife and military rule. The skewed distribution of land and wealth has continued to produce conditions of extreme vulnerability. Today 3 out of 5 Central Americans are poor. And these figures of poverty are on the rise.

As most of the disaster and ecosystem literature indicates, it is precisely during these period of rapid change and transformation that disasters strike. Changes in land use, forest cover, wetlands distribution and watershed degradation have combined with social vulnerabilities to create larger and more complex scenarios of risk. But what are the thresholds, beyond which changes in population distribution, wealth concentration, ecosystem modification, lead to irreversible changes in the provision of key resources? Homer-Dixon (1999) has demonstrated convincingly the linkages between environmental scarcity and social violence. While the link is strong one in Central America, the ancient tradition of armed conflict and political struggle pre-dates most of the current degradation of resources. However, there are clear indications that in certain key regions, the rapid growth in urban population, the accelerated deterioration of soil, forest and water resources have created circumstances which can be considered as resource scarcity, and that this scarcity not only can lead to violence but also to increased disaster risk.

A safer Central America in the twenty-first century will depend on a careful review of the development model adopted so far in the region. There is an urgent need to redirect resources, both public and private, in order to increase the environmental services and institutional capacities that prevent and mitigate natural hazard risk. During the last Presidential Summit of Central America in October 1999 in Guatemala, the topic of disaster prevention was the first item on the agenda. For the first time, Central American governments took on the challenge of reducing risk. They signed a commitment for a 5 Year-Plan (Quinquienio) for Disaster Reduction. However, much of the discussion on disaster prevention and mitigation remains a marginal part of the reconstruction agendas. In Honduras and Nicaragua, for example, infrastructure development, road repair and other megaprojects get the lion's share of some of the US$ 11 Billion in international aid and debt rescheduling which was granted at the Stockholm summit in May 1999.

While, millions of dollars are currently being spent on building dikes and levies to protect human settlements, little is being channeled to attack the

root causes of vulnerability, or to contribute to the non-structural mitigation of disasters through sound environmental management. The 1998 winter following Mitch brought about more floods and landslides, and in many cases bridges and housing rebuilt in the wake of Mitch were again destroyed.

In a recent article about the links between forests, soil conservation and water in Central America, David Kaimowitz (2000:25) reaches the following conclusion: "The slow, steady, and diffuse degradation of Central America's hillsides has no easy solution…. Sporadic short-term efforts to promote soil conservation and reforestation in individual plots selected on the basis of farmer interest are unlikely to have any discernible effect at the watershed level. In many cases they will not even increase farmers' yields or improve their incomes. They do provide much needed investments and services to the rural areas, but at a high cost, with limited effectiveness, and little prospect of sustainability."

For these issues to be addressed, there is a need to integrate risk management into environmental policy and the converse. How do healthy ecosystems contribute to abating risk? What has been the environmental impact of land concentration, misuse of wetlands and massive deforestation? What are the growing urban risks linked to accelerated urban sprawl into the periphery of the city lands markets?

A sustainable vision for a safer twenty-first century needs to involve a new assessment of collective security arrangements, vulnerability and sovereignty in the face of regional disasters. There has been a growth in environmental concerns in the region and the 1990s marked a high tide for the environmental movement in the region. More than most integration efforts in place since the Esquipulas Peace Treaty of 1987, the efforts led by the CCAD in harmonizing legislation, brokering regional projects and defining joint policies for the seven member states have been the most enduring. Recent efforts also include the growth of regional agendas on disaster prevention (CEPREDENAC) water resources and climate change (CRRH), and Forests and Protected Areas (CCAB/CCAP). There still remains an urgent need for systematic research on the linkages between environmental stewardship, watershed management and risk reduction in Central America, as part of a regional environmental agenda.

This paper began with a history of the interaction between civilizations and their environment in Central America, and concludes by looking towards the future. Whether it is to be punctuated by conflict or by cooperation, by increasing prosperity or growing poverty, disasters will continue to shape the destiny of Mesoamericans.

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Climate Change and Security in the Pacific Islands

While the Pacific Islands have contributed discernably little to the onset of climate change, the anticipated impacts of a 1.5–6 ºC rise in global temperatures will be felt most readily by these small, oftentimes remote landmasses scattered throughout the world's largest ocean.[312] Fragile ecosystems, limited natural resource bases, high demographic pressures, and relatively weak and restricted economies already render these islands biophysically and socially vulnerable to environmental changes and the vagaries of globalization. Because security is in many respects, "an accentuated discourse on vulnerability," climate change effects such as sea-level rise, increased sea-surface temperatures, and greater climatic variability and frequency of extreme weather events has made climate change a leading security concern in the Pacific Islands.[313]

The estimated 50 cm rise in sea level by 2100 will lead to the loss of productive and inhabitable lands through direct submergence, inundation, accelerated coastal erosion and salinization of aquifers and soils. The socio-economic implications of this loss for the Pacific Islands are profound. For these predominantly agrarian societies, decreased agricultural output will translate into lost incomes and employment, and overall economic decline, undermining efforts to achieve economic self-reliance and attract overseas investors. Under these circumstances, governments may seek revenues through environmentally unsound activities such as forest clearing and nuclear waste storage, further compromising the livelihoods of Islanders. The evacuation/forced relocation of coastal communities may prompt higher rates of urban to rural migration, compounding those problems already associated with urban growth (i.e., pollution, unemployment, the growth of squatter settlements, crime, and increased health risks). In some cases, such as in Tuvalu, entire nations of people may have to abandon their homelands and relocate to foreign countries.[314] Loss of land area may also force changes in land-tenure systems—an already politically and culturally sensitive issues in the Pacific Islands—so as to allow more people access to smaller areas of land.[315]

In addition to agriculture, the majority of Pacific Islanders are also dependent on fishing for food, income and cultural preservation. This is particularly relevant to concerns surrounding the impacts of climate change, as increased sea-surface temperatures will result in frequent episodes of coral bleaching and subsequent coral mortality. Tourism—

an important economic sector and source of foreign exchange for many island nations—will be jeopardized, as natural attractions are lost. The damage to fisheries and reduced catches will similarly undermine economic security, as well as possibly affect the health of many Islanders, as their protein intake is lowered.[316] The loss of coastal protection provided by barrier reefs will increase vulnerability of coastal lands to erosion and the impacts of increased storm activity. In fact, changing weather patterns will compound many of the socio-economic impacts of climate change, as higher frequency and intensity of extreme weather events will be coupled with heightened vulnerability to their impacts.

With climate change threatening livelihood security, and even national sovereignty, throughout the Pacific Islands, the potential for political instability and ethnic unrest may also be rising. As Islanders face losses in incomes, employment, food sources, land, and cultural identity, and the prospect of being forced to leave their homes and countries, tensions will mount and frustrations may spark conflict between nations, between government and civil society, and amid different tribal and/or ethnic groups. While such conflict may be indicative of more fundamental problems and inequities (i.e., poverty, indebtedness, institutional resilience, and state legitimacy), the impacts of climate change will simply exacerbate these factors and bring them to the fore of Pacific Island Societies.

Recognizing all of this, migration and resettlement planning, foreshore stabilization, economic decentralization and increased infrastructure resiliency will all be key components of an overall adaptation strategy. To advance the cause of these nations, the conservation community—in addition to ensuring the implementation of greenhouse gas emissions commitments—should aid in the development of adaptation plans that include environmental priorities, monitor the effects of climate change and provide early warning of dangers, and promote international cooperation between islands on issues of coastal management, and livelihood security.

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Environmental Sources of Vulnerability to Disaster

The protective value of natural systems—acting as "shock absorbers" in the face of extreme climatic events such as hurricanes—may be consistently undervalued in development decision-making. Worldwatch Institute's Janet Abramovitz (2001) argues that the destruction of coastal wetlands, dunes, and mangroves may eliminate vital natural "shock absorbers" for storms, while deforestation, urbanization and river "straightening" can increase the likelihood of flooding.

Some hypothesized links include:

- *Deforestation and Landslides:* The loss of vegetative cover on steep hillsides contributes to runoff and slope failure due to the loss of stabilizing root structures.[317] Trees in a mixed forest also catch snow and hold it, preventing avalanches.[318]
- *Draining of wetlands and Floods:* The draining of swamps and clearing of mangrove wetlands may disrupt natural runoff patterns and magnify flood hazards.[319]
- *Loss of vegetation and Droughts:* Local clearing of cover vegetation can prolong dry periods, changing the reflectivity of the land surface and accelerating soil loss.[320]
- *Urbanization and Floods:* Paving of surfaces decreases infiltration and increases runoff, exacerbating the impacts of high rainfall events on river flow regimes.[321]
- *Structural Mitigation and Risk:* River levees that are built to provide flood protection can destroy riparian habitat and heighten downstream floods.[322] Forest fire suppression may increase the magnitude of fires, when they escape control.[323]

Switzerland learned the importance of conserving its high mountain forests over 100 years ago. Widespread flooding, avalanches and landslides in the late nineteenth century demonstrated the link between deforestation and these catastrophic events and led to the passage in 1876 of an historic law aimed at conserving forested areas. The protective value of these forests in safeguarding villages, towns, infrastructure and tourism, and thus the economy as a whole, was estimated in the mid-1980s at US$2–3.5 billion per year.[324] The Swiss government provides US$25–35 million per year in subsidies for conservation of "protective" forests.[325]

Likewise, in Bangladesh it is recognized that the Sundarbans, one of the world's largest mangrove forests, protect several communities from otherwise-devastating tropical cyclones. An estimate by the Bangladeshi government suggests that the storm protection provided by the mangrove area has saved the public purse nearly half a billion dollars in avoided costs of structural mitigation and relocation.[326]

In Central America, the seven disaster-prone countries of the region are collaborating to protect a Mesoamerican Biological Corridor along the Atlantic coast of the isthmus, from Mexico to Panama. The corridor aims to preserve watersheds and forests, while attracting over US$100 million per year in international greenhouse gas offset funds.[327]

In the wake of the Yangtze River basin floods of 1998, which reportedly affected an area of nearly 26 million square kilometres and forced the relocation of nearly 14 million people, China is putting measures into place to tackle the environmental sources of vulnerability.[328] China is today seeking to restore natural forests, wetlands and grasslands along the river.

Experts have long called for the integration of enhanced natural resource management to reduce disaster vulnerability. In 1994, international experts assembled for the UN Decade for Natural Disaster Reduction (IDNDR) concluded, "Environmental protection… is imperative to the prevention and mitigation of natural disasters."[329] If so, conservation of natural systems may have a vital role to play in protecting societies from disaster, particularly in the face of our changing climate. The conservation community needs to better understand the links between the sustainable and equitable management of natural resources, and the security of societies in the face of disaster.

Endnotes

305. Small landholding, usually dependent on subsistence-level agriculture.

306. Large Land holdings, usually involving plantation agriculture or livestock ranching.

307. T.F. Homer-Dixon (1999:15) defines three primary sources of environmental scarcity. These are structural scarcity, which is the imbalance in distribution of a resource due to underlying inequities of wealth and power. Demand-induced scarcity is the growth in need for a resource stemming from population or consumption pattern growth. Supply induced scarcity is the decrease in the actual size of the quantity or quality of resource available due to depletion or degradation.

308. Homer-Dixon (1999:15) defines resource capture as the action by dominant groups in a society to shift in their favor the laws and institutions governing distribution of a scarce resource.

309. According to Homer-Dixon (1999:16) ecological marginalization occurs when a structural imbalance in resource distribution joins with rapid population growth to drive resource-poor people onto ecologically marginal areas.

310. L.G. Solis, personal communication with author.

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