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NATURAL DISASTER PREVENTION AND MITIGATION

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WASHINGTON, D.C., MAY 2005

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WASHINGTON, D.C., MAY 2005

Certification that I have reviewed this work of investigation I have found that it fits the norms and methodologies of the IADC.

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EXPLANATORY NOTE

The opinions expressed in this work are the exclusive responsibility of the author and do not necessarily represent the position of the IADC.

AUTHORIZATION

I authorize the Inter-American Defense College to publish this work as an article for selected reading or in the college magazine with the condition that it includes in said publication all bibliographical notes considered in this work of investigation.

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Definition of the Topic

A natural disaster is “a hazardous event [avalanche, earthquake, flood, forest fire, hurricane, lightning, tornado, tsunami, volcanic eruption, et al.] that causes unacceptably large numbers of fatalities and/or overwhelming property damage.”¹ While natural events like those listed above are unavoidable for developed and developing countries alike, natural disasters can be prevented and/or mitigated. Developed countries may have the financial resources to develop elaborate systems (e.g., early warning, comprehensive drainage systems, “hurricane-proof” structures); however, it’s virtually impossible to prevent all loss of life and property damage from the range of natural events found on earth. The trends in the more developed countries indicate that loss of life is likely to be relatively low; however, damage to manmade structures can easily run into the hundreds of millions or billions of dollars. Natural events in lesser developed countries can lead to incredible loss of life as well as significant property damage. A case in point is the earthquake and tsunami that occurred December 26, 2004 in Indonesia and several other countries bordering the Indian Ocean.

While this monograph will focus mainly on sustainable development practices in this hemisphere and how they can affect the damage sustained by communities when natural events strike, there are some very well-known natural disasters that have occurred in other parts of the world that will be used for illustrative purposes. Sustainable development is development balancing near-term interests with the protection of the interests of future generations.²

An example of the relationship between sustainable development and natural disasters is the building of residences in an area prone to flooding. All concerned (i.e., national and local government, homebuilders, people living in area, etc.) may be aware that this area is likely to flood; however, the home is built anyway and a family moves in. Sooner or later a flood occurs that wreaks havoc on the area (killing people and/or destroying property), which causes people to ask why this situation occurred and what can be done to prevent recurrence. If government (town, county, state, federal), private businesses (e.g., builders, insurers) and private citizens had considered the misery that was likely to result if construction were allowed in this particular area, the decision may have been made to build elsewhere. Appropriate government institutions could have passed laws, if appropriate, to forbid building in this area based on the likelihood of flooding, wetland protection /

¹ Disasters, Planning and Development: Managing Natural Hazards to Reduce Loss, OAS, Dec 1990, p. 7.

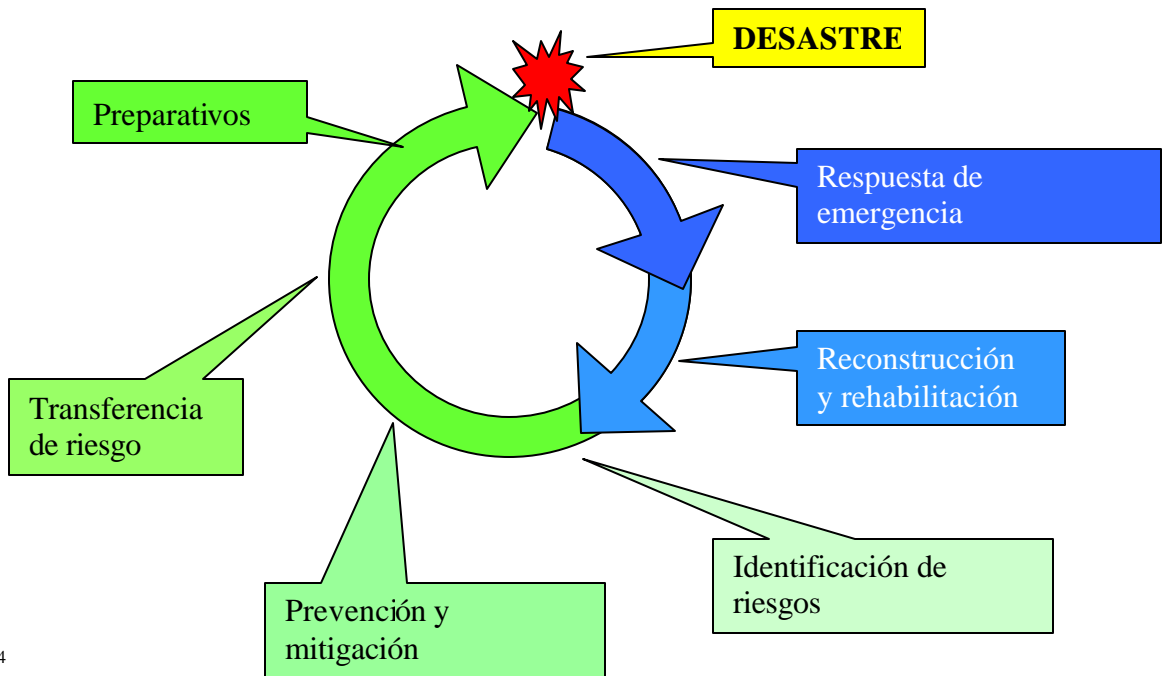
² Webster's New Millennium™ Dictionary of English, Preview Edition (v 0.9.5) 2004, www.dictionary.com.

habitat preservation, zoning or a combination of these and others. If government regulations were inappropriate, private companies could play a major role – mortgage lenders could refuse to provide a mortgage, insurers could refuse to provide insurance. Private citizens could refuse to buy homes in this area because they don't want to put their families and possessions in danger unnecessarily. Bottom line – it's not sustainable development to build in areas that are likely to be devastated by a natural disaster. Of course, the factors that governments, businesses and individuals need to consider in these situations are many and complex – I suggest there are many instances where a better job could be done.

Since I've lived in the United States most of my life, I'll draw on those experiences as well as those I've read about in other countries.

I believe this topic is relevant to hemispheric security because it affects all countries and nearly all regions of each country. The small states of the Caribbean and Central America are particularly at risk due to their size and location with respect to annual hurricanes, volcanoes, etc. While hurricane season comes as a surprise to no one, the damage wrought by one of these monster storms can be especially devastating to an island country that sustains major damage in multiple areas. In some cases island nations are in the process of recovering from a hurricane that visited the previous year only to be hit again. Developing countries often require the assistance of other governments and NGOs to reduce suffering, survey the damage, and start the recovery process. Military forces are often called to assist when natural disasters occur – these forces may serve within their home country or they could deploy to another country. For these and other reasons I'll discuss, sustainable development and its relation to natural disasters is absolutely pertinent to a course on defense and hemispheric security. This monograph also aligns very closely with a number of the presentations given by several guest speakers during the 5-7 April seminar, entitled “Natural Disasters and Emergencies.”

Since this topic is broad, I'll concentrate on the areas of prevention and mitigation that are identified in the below diagrams. The first diagram was in a slide show presented by Dr. Ugarte of the Pan American Health Organization (PAHO) and the second diagram was presented by Mr. Keipi of the Inter-American Development Bank (IDB); both were presented on April 6, 2005. I chose to include both to show the similarity between two very different international organizations – PAHO is part of the UN and IDB is a regional entity.



³ "Health Considerations in Disasters" presentation, Dr. Ciro Ugarte, Emergency Preparedness and Disaster Relief, PAHO (WHO), 6 Apr 05.

⁴ "Protección financiera para sobrevivir desastres" presentation, Kari Keipi, Inter-American Development Bank, 6 Apr 05.

Chapter 1

Introduction

Defense and Hemispheric Security

Threats to defense and security in this hemisphere are many and are intractable. Some are directly applicable to the armed forces (e.g., narcoterrorism, defense of the nation from hostile groups that seek to overthrow a government in violation of its constitution) and some involve the military peripherally at best (e.g., poverty, hunger, disease). Natural disasters and their aftermath often require the use of a nation's armed forces due to the magnitude of the destruction and the response that's required to address it. If a military force is not actively engaged in a military conflict or operation, it can be diverted from whatever peacetime mission it was performing or training it was involved in to assist the civilian population to recover from a disaster. Most militaries also have equipment and training that is invaluable before, during and after a disaster (e.g., medical personnel, aircraft, boats, security personnel).

Countries in this hemisphere face a long list of serious threats to their security: poverty, hunger, disease, arms trafficking, drug trafficking, human trafficking, money laundering, corruption, ad infinitum. Many of these are caused by people seeking wealth, notoriety, and/or power without regard to their fellow human beings. As if these problems weren't serious enough, Mother Nature sometimes throws societies a curve ball. Nearly every kind of natural event can be found in this hemisphere due to its size and diversity. In fact, virtually every kind of natural event occurs somewhere in the U.S. due to its size and diverse geographic / climatic regions. Most would acknowledge that the challenges we face are difficult enough and that we don't need to do anything to worsen the situation. However, lack of sustainable development throughout the hemisphere leads to much misery when powerful natural events strike.

I will explore this situation using some of the numerous natural disasters that have occurred in recent decades. Examples will be provided and discussed; possible solutions will be offered that might have prevented the problem from occurring and may prevent a similar incident from occurring in the future.

Chapter 2

Floods

Haiti. When I think about natural disasters causing many more problems due to a lack of sustainable development, Haiti always comes to mind. Haiti is a textbook example of how people will pay the price (i.e., fatalities, other casualties, destruction of property, etc.) when the environment is badly abused.

In September 2004 Tropical Storm Jeanne skirted the northern departments of Haiti and unleashed a deluge of water down its mountain passes. Downstream, the city of Gonaives, which felt only a drizzle of precipitation during the storm, received wild torrents of water that, fed from the mountain rivers, leveled nearly everything in its wake. On the other side of the island, urban Port de Paix was similarly devastated.

In total, over 3,000 Haitians died, including 2,326 in Gonaives. An estimated 35,000 homes in Gonaives were affected with nearly 5,000 destroyed or damaged. Almost all the city's 397 elementary and 54 secondary schools were damaged and closed.

Gonaives' hospital was damaged and closed down indefinitely, and health care made available primarily through small health centers. With the entire watershed already denuded because of deforestation, an estimated 70% of the region's agricultural areas were damaged.

Adding to nature's wrath, Haiti's political unrest added to the turmoil, as the country's gangs fought each other over the relief supplies distributed in the immediate aftermath of the disaster, heightening an already tense security environment.

USAID provided \$8 million in immediate relief to the victims (e.g., food, shelter, medicine and emergency health care) and \$38 million to begin the reconstruction of roads, public buildings, drainage canals, homes and small infrastructure.⁵

While this kind of assistance and aid is absolutely necessary to alleviate human misery after an event like Tropical Storm Jeanne, the expression "an ounce of prevention is worth a pound of

⁵ Haiti's Clean-up Progresses in the Caribbean As Asia's Tsunami Burden Continues to Rise, www.usaid.gov/locations/latin_america_caribbean/country/haiti/haiti_hurricanes.html.

cure” is definitely applicable. The effects of this storm could’ve been prevented or mitigated through programs to restore the natural ground cover that existed before Haitians removed it. International donors could’ve provided funds to replace trees and other ground cover, develop and construct systems to better handle storm runoff, and assemble buildings that could withstand a certain amount of flooding (e.g., build on stilts as is done on Hatteras Island, NC). Not only would these efforts have greatly decreased the numbers of casualties if they had been started several years ago but they would’ve provided employment in an area that suffers from very high unemployment and underemployment. It must be painfully obvious to the residents of Gonaives what can result when the environment has been severely degraded; however, economic conditions and a lack of options have left them little choice but to cut down forests for firewood. With the trees gone, rains would eventually wash away the soil that had built up over centuries, leaving bare earth without topsoil. The soil that is carried away by the rain will damage streams and rivers and end up in the ocean. Fragile reef systems will be deleteriously affected in a number of ways, exacerbating a bad situation since Gonaives is on the coast. Fishermen and others who depend on a healthy reef ecosystem will be negatively impacted.

Haiti has had myriad problems since it gained independence from France in 1804. There are many countries and organizations that have tried to help Haiti become a stable democracy but all have failed. While the serious problems facing Haiti are complex and difficult to resolve, it can’t possible become a stable society without healthy ecosystems. Along with organizations (e.g., NGOs) that will help Haiti to restore healthy ecosystems, organizations and the Haiti government / society must educate current and future generations to respect the environment on which all life depends. It’s vitally important for the citizenry to fully understand why certain actions should or must be avoided and why sustainable development matters to the community.

Last year many in the world discovered how important the simple act of planting trees can be. The Nobel Peace Prize in 2004 was awarded to Wangari Maathai of Kenya "for her contribution to sustainable development, democracy and peace."⁶ She introduced the idea of planting trees with the Kenyan people in 1976 and continued to develop it into broad-based, grassroots organization whose main focus is the planting of trees with women groups in order to conserve the environment and

⁶ <http://nobelprize.org/peace/laureates/2004/index.html> .

improve their quality of life. However, through the Green Belt Movement she has assisted women in planting more than 20 million trees on their farms and on schools and church compounds.⁷

Haiti needs people with the vision and perseverance of Wangari Maathai. She was able to export her ideas to several other African countries and there is no reason her model couldn't be followed in Haiti. Of course, it will take decades, a lot of money and much sweat equity on the part of the Haitians. While this won't solve all or even many of Haiti's myriad problems, it's a risk-free step that must be taken to provide current and future generations of Haiti a viable environment in which to live, farm, recreate, etc. There's no question there will be hurricanes and other large storms in the future; the international donor and NGO communities need to start meaningful efforts today if they hope to minimize misery during future deluges.

Dominican Republic. Less than a year prior to this disaster in Haiti, the Dominican Republic experienced severe flooding in November 2003. The Economic Commission for Latin America and the Caribbean (ECLAC) carried out an assessment of the socioeconomic and environmental impact of this flood and the data that follows was extracted from this report.⁸ ECLAC's task was to propose a number of actions to surmount these emergencies and to improve risk management through prevention and mitigation.

Flooding was aggravated by both an earthquake on the northern coast and Hurricane Odette, which hit the southern area. Flooding extended throughout towns and villages of the northeastern coast and resulted in losses in human lives, cattle, crops, infrastructure, and housing. As a consequence of the strong rainfall and flooding, damage was reported in houses, educational centers, government offices, roads, and bridges. More than 9,400 families (mostly from Haiti) were affected by the floods. Many communities were isolated, and lost their crops and livestock.

The combined effects of rain and floods also affected the infrastructure of this country. Hispaniola's topography makes it vulnerable. From a hydrological perspective, floods in the basins of the Yaque del Norte and Yuna Rivers resulted from an extreme event (intense rainfalls on already saturated soils, which caused most of the water runoff) with situations of vulnerability (infrastructure for agricultural activities and housing located in flood-prone areas). An aggravating factor is the loss of plant cover (particularly forests) in river basins. Forests play a pivotal role in regulating water --

⁷ <http://nobelprize.org/peace/laureates/2004/maathai-bio.html>

they favor water permeation into the soil, which reduces water runoff. Recent studies carried out in the Dominican Republic show that the basins of these two rivers have experienced a process of forest substitution (i.e., destruction) for other uses. The existence of various dams contributed to reducing the volume of water, which avoided greater damage.

Losses in property will have minor consequences on the country's capacity to create capital, but this flooding occurred at a time of crisis in the national economy -- international cooperation was required to overcome this emergency.

The greatest effect was felt within productive activities (73%), particularly agricultural, followed by the transportation sector (17%) and health (4%). According to the Dominican Republic State Agriculture Department, affected crop surfaces were not too large but economic losses were substantial, since many of these crops were for export. This has consequences on the trade balance, due to the reduction of export products (banana, plantain and rice) as well as to the increase in imports to make up for products to be consumed internally. It was determined that the total direct and indirect losses amounted to \$42.5 million (77% represent direct damage and 23% indirect damage). In addition to being an event of great economic impact, floods reiterated the high level of vulnerability of this country, associated with a non-integrated river basin management.

Damage to social sectors was particularly significant affecting housing, health, sanitation, and water services. In terms of housing, floods affected more than 1,000 families, as well as the quality of life of a large segment of the population in the northern region of the country, a sector already disadvantaged and with higher levels of vulnerability and exposure to climate and health risks.

As a response to the assessment of these floods, projects in the amount of \$152 million are being proposed, mainly in the fields of prevention (28%) and improved and integrated river basin management (60%). These projects would bring about three different benefits:

- Improved water supply for human use and irrigation purposes
- Improved hydroelectric capacity to reduce the dependency of imported means of energy
- Reduced levels of vulnerability to floods

⁸ ECLAC, Assessment of the Socioeconomic and Environmental Impact of Floods in the Dominican Republic, www.eird.org/ing/revista/No9_2004/art4.htm

We can see some of the same factors at play in the Dominican Republic that affected Haiti – loss of ground cover (particularly forest) in critical areas (i.e., river basins) and financially vulnerable populations at risk.

The UN has established the International Strategy for Disaster Reduction (ISDR) as a global framework for action with a view to enabling all societies to become resilient to the effects of natural hazards and related technological and environmental disasters, in order to reduce human, economic and social losses. It is based on a conceptual shift from the sheer protection against hazards to the management of risk through the integration of disaster reduction into sustainable development. The implementation of the strategy is premised on the establishment of partnerships between governments, non-governmental organizations, UN agencies, the scientific community, the media, as well as other relevant stakeholders in the disaster reduction community.⁹

I think this is the right focus and it's unfortunate the people and agencies involved didn't come to this realization a long time ago. The significant sum (\$152 million) that is proposed to be spent on mitigation and prevention in the Dominican Republic should help to avoid or, at least, minimize the effects of a similar event in this region. As a society, we need to ensure development funds are spent on these types of projects in the first place so catastrophes don't occur or aren't catastrophic when Mother Nature overwhelms our good planning. As long as the community supports what's done and maintains the environmental and man-made systems in perpetuity, this region should remain reasonably storm-proof -- indefinitely.

Now that I've taken a look at a flooding scenario in a developing country I'd like to compare it to one in a developed country and the prevention strategy that was devised. The following section was extracted from the U.S. Army Corps of Engineers "The Great Flood of 1993 Post-flood Report"¹⁰ and modified.

The flood of 1993 was a very significant event that devastated the midwestern U.S. The flooding of the Mississippi and Missouri rivers resulted in the deaths of 47 people and caused \$15-20 billion in damage. The 1993 flood was distinctive from all other record U.S. floods in terms of its magnitude, severity, the resulting damage, and the season in which it occurred. Excessive precipitation April - July 1993 produced severe or record flooding in nine states in the upper Mississippi River basin. Excessive precipitation also affected the Missouri River basin, adding to the

⁹ www.eird.org/ing/eird/eird.htm

¹⁰ www.mvr.usace.army.mil/PublicAffairsOffice/HistoricArchives/Floodof1993/fl-8.htm

flood's extent in three states. The rain storms that caused the flood of 1993 were unique both in the size of the flooded area and in the fact that the storms resulted in the Mississippi and Missouri rivers cresting within the same week. Floods typically occur in the spring; however, this flood occurred throughout the summer along the Mississippi and Missouri rivers. U.S. Army Corps of Engineers (Corps) reservoirs along the upper Missouri River were able to store much of the excess runoff in Montana and North and South Dakota. However, on the Missouri River, downstream of Omaha, Nebraska, the reservoirs could not accommodate the record runoff. Portions of the Missouri River were above flood stage for several months.

On the Mississippi River, there were only three reservoirs with significant storage capacity above St. Louis, Missouri. Due to the prolonged runoff periods, the maximum crest reductions amounted to 11 inches at Quincy, Illinois and Hannibal, Missouri. Even with these three flood-reduction reservoirs, the flood of 1993 was in excess of a 100-year flood and, in some areas, perhaps a 500-year flood. As local, state and federal agencies prepared for providing cleanup and other assistance, additional rains in August and September continued, prolonging the soggy conditions and causing further delays. After most flood waters had receded, heavy rainfall in mid-November resulted in a third disaster declaration on December 1, 1993, for southeastern Missouri. The urgency concerned the need to try to provide closures to breached levees and rehabilitate pumping facilities to protect against eventual spring 1994 floods. Portions of some towns were relocated; e.g., Valmeyer, Illinois and Chelsea, Iowa.

A number of Interagency Hazard Mitigation Team reports were prepared due to the federal disaster declarations resulting from the flood of 1993, as required by the Federal Emergency Management Agency (FEMA). These reports provide actions that will reduce the potential for future flood loss. Hazard-mitigation measures are actions that individuals, organizations and governments can take to reduce the effects of future disasters.

The flood of 1993 was the worst flood ever experienced by the Midwest. It was the costliest ever in the U.S. due to its extent and long duration. Effective mitigation measures need to be implemented in order to reduce future loss of life and property. Flooding from this event caused major highways, bridges, and rail lines to be closed for long periods of time. Officials responsible for this infrastructure now will be redesigning their facilities to protect against future floods of this magnitude. Navigation was shut down on the Mississippi River, closing a main transportation artery to the Midwest. In the aftermath, major efforts were carried out to restore the lock operations on the

Mississippi River. Many wastewater and water supply facilities were disrupted or even totally shut down. Officials of these facilities are redesigning them to provide greater flood protection. Cost-effective measures for hazard mitigation are expected to be incorporated into the repair cost of damaged public facilities. Since damage to communities was extensive, many are reassessing their situation and seeking relocation opportunities. Major public power utilities sustained damage to electrical transmission and distribution systems -- many of these damaged utilities will need to be relocated. Finally, the damage to farmland and pastures was severe -- some acreage may not be restored for agricultural purposes. The federal floodplain management policy is being reassessed. Possibilities for returning some of the flood plain to their natural state -- particularly to wetlands -- will be studied as part of the Corps "Floodplain Management Assessment of the Upper Mississippi and Lower Missouri Rivers and Their Tributaries" report. The impacts of the flood of 1993 are expected to provide a planned approach to drastically reduce the flood damage of future large flood events.

The impact of this flood is consistent with many other natural disasters in the developed world – there was relatively little loss of life but there were significant monetary losses. The Corps, other government organizations and individuals had mitigation and prevention systems in place; however, the flooding was so severe that it overwhelmed the capacity of these systems to cope with the volumes of water produced by the storms.

This report mentions that portions of two towns were relocated. I'll now discuss the relocation of a third town as a result of this flood. Details were extracted from an article in YES! magazine.¹¹

Pattonsburg, Missouri (population 316) has been flooded at least 30 times since it was founded in 1845. Residents relocated to higher ground in July 1993 due to rising waters. They returned home after flood waters receded and proceeded to get their lives back to normal. Then a second, more devastating flood came to town.

A private citizen who lived in another state understood the federal government was prepared to spend \$6 billion for flood relief in the Midwest had an idea. She thought a portion of this money could be spent to relocate the small town of Pattonsburg so federal dollars would not have to be spent in this town the next time there's a flood. Through persistence she located people within the federal bureaucracy who were willing to put this idea into effect.

¹¹ YES!, "Skipping Town," Winter 1998, Steve Lerner, www.yesmagazine.org/article.asp?ID=927.

Professional town planners, including those knowledgeable of the latest environmental / energy-efficient technologies, came together to work with the citizens of Pattonsburg on a sustainable future for their town. Residents were made aware of similar projects that had been accomplished in other flood-stricken Midwest towns. The federal government provided \$12 million to move the town to a higher elevation several miles away. Government officials agreed to finance the largest post-flood relocation in the nation's history due in part to a study directed by the Corps that found that federal flood control efforts would be less expensive and more effective if people were moved out of flood plains. This seems obvious but some bureaucrats need one or more rigorous studies / cost-benefit analyses before they're convinced a project is a good idea. Common sense is not always a common virtue.

The relocation of Pattonsburg will ensure it does not suffer from flooding in the future. While some agricultural, marsh and parkland may be inundated periodically, this is much less damaging than having residences, businesses and other man-made structures under several inches or more of mud and water every several years.

One of the considerations that must be addressed when a town is relocated is how are people going to earn a living. Part of Pattonsburg was moved next to an interstate highway and businesses were created to take advantage of the private and commercial vehicles that used to pass by the town without stopping. The original farmers could still earn a living as they had done before but now didn't need to worry about periodic inundations of their homes.

This type of response was possible because a wealthy country had the political will to provide sufficient funds to make the relocation possible. The cost-benefit analysis showed enough of a positive return that millions of dollars were made available. While a developing country may not have the resources to undertake a project like this, it could combine resources from public and private sources within the country, NGO donations, aid from international organizations (e.g., UN, IDB) and other countries, and loans (if feasible). It may seem to a government that it can't afford to undertake a particular prevention or mitigation project but when hundreds or thousands of lives may be lost and thousands of buildings may be partially or completely destroyed, a government cannot afford not to initiate substantive projects. Along with following through with appropriate projects to reduce vulnerability, governments need to ensure people don't move back to areas that are vacated. Land can be bought by governments for parkland, marshland, agricultural purposes, etc. However, it's imperative that whatever purpose flood-prone land is converted into, major problems won't occur to

those who use the land. For example, if hundreds of families will lose their livelihoods because their farms and livestock are in a flood plain, parkland or marshland would probably be more appropriate.

There may be instances where it's appropriate for a government to exercise eminent domain. Eminent domain is defined as the right of the government to take property from a private owner for public use by virtue of the superior dominion of its sovereignty over all lands within its jurisdiction.¹² The Fifth Amendment to the U.S. Constitution requires the government to compensate the owner of property taken by eminent domain, stating "... nor shall private property be taken for public use, without just compensation." Landowners in other countries also have rights – governments should consider other options before invoking eminent domain. While there will be times when it's necessary for a government to expropriate the property of a private citizen or business for the common good (i.e., the good of a community), this should only be done when it's absolutely required and the party whose land is condemned should be fairly compensated. Transparency is very important in situations like this so all who have an interest can see what the government is doing and can intercede to protect the rights of the non-governmental party if it doesn't want to sell or the government is pursuing an inappropriate agenda.

An option that's available to keep land from being developed that's not nearly as controversial as expropriation is the use of conservation easements. A conservation easement is a voluntary, legally binding agreement that limits certain types of uses or prevents development from taking place on a piece of property now and in the future, while protecting the property's ecological or open-space values.¹³

Conservation easements:

- Benefit the public and the environment -- conserve watersheds, buffer national parks, preserve agricultural lands, and protect open space.
- Keep land in private hands, preserve traditional land uses and protect land for future generations – they allow landowners to retain many private property rights and to live on and use their land as they have traditionally.
- Protect landscapes efficiently and effectively -- for more than four decades, The Nature Conservancy (TNC) has been using conservation easements to protect more of a landscape from development than could be accomplished through outright purchase.

¹² Merriam-Webster's Dictionary of Law, © 1996, www.dictionary.com.

A private landowner is essentially selling certain development rights to his land. While TNC uses conservation easements for some purposes that have little or nothing to do with the prevention or mitigation of natural disasters, it's clear that some of their goals are consistent with those who want to decrease or eliminate the negative effects of storms. Government or private organizations could buy the development rights to critical areas of flood plains and other sensitive lands to provide a place for flood waters to go without taking land away from private landowners. Of course, private and government agencies could outright buy land that's needed for mitigation purposes if the owners are willing to sell it; however, this is a more expensive proposition.

While the Corps and others have reservoirs, levees and other man-made structures to prevent or minimize flooding, Mother Nature periodically throws a hardball that partially or totally defeats our best attempts to manage natural events. Some scientists say that el niño/la niña, global warming and other worldwide phenomena are increasing the severity of storms. This only increases the urgency of putting in place comprehensive prevention/mitigation systems that have the ability to withstand storms larger than those usually encountered. Put another way, what used to be a 100-year storm may now occur every 40 years and what used to be a 500-year storm may now occur every 100 years. Experts will need to determine if the ability to handle a 100-year storm is adequate or if a higher level of protection is more appropriate.

¹³ The Nature Conservancy,
<http://nature.org/aboutus/howwework/conservationmethods/privatelands/conservationeasements/>.

Chapter 3

Fires

Lightening and volcanoes have been starting fires since the beginning of time. Many plant and animal communities have evolved in an environment that's marked by periodic fires. Of course, nowadays many fires are started inadvertently or purposely by humans. Since I'm looking at natural disasters, I won't investigate man-made fires.

Fires have the ability to destroy tens of thousands of acres of forest along with nearly every man-made structure in their paths. While some ecosystems evolved with fires, some did not. Heat from a fire is needed for the cones of some lodgepole pines to open for seed dispersal. Many plant and animal communities thrive shortly after a fire has passed through an area. Plants for grazing animals sprout anew and saplings flourish in the sunlight that's able to reach the forest floor after a fire. However, families and businesses that had property destroyed won't be consoled knowing many plants and animals will recover.

It's understandable why many people want to live in or near a forest. Although, thousands have learned in recent years there's an inherent risk living surrounded by forest. During much of the twentieth century, park managers in the U.S. viewed fire solely as a destructive force that needed to be controlled as much as possible. By the 1940s ecologists recognized that fire was an essential component of some natural systems and significant problems resulted if it were suppressed too successfully. When an area that needs fire is prevented from experiencing fire for decades, forest litter accumulates on the forest floor. However, eventually there will be a fire. Fires that occur after decades of successful fire suppression have the ability to quickly rage out of control because there's much more fuel than would be the case without human involvement. Not only are fire suppression efforts much more dangerous and less effective, man-made structures in the affected area have little chance of surviving. Of course, drought, high winds, rugged landscape and many other factors have the ability to hamper fire fighting efforts. In addition to the damage to homes and other buildings, the ecosystem is likely to be set back for much longer than would otherwise be the case. Because the fire burns hotter and longer than it would in the absence of a lot of fuel, trees that would normally only be charred are killed and plants that grow close to the ground die because the earth gets so hot the roots are killed.

The details of the Yellowstone fire of 1988 were taken from a National Park Service web site.¹⁴ This area of Wyoming had evolved in an environment that included periodic fires. After following a policy of suppressing fires for decades, U.S. national parks and forests began to experiment with controlled burns in the 1950s and 1960s. By the 1970s Yellowstone and other parks had instituted a natural fire management plan to allow the process of lightning-caused fire to continue influencing wildland succession (the series of changes that create a full-fledged plant and animal community). The summer of 1988 turned out to be the driest in the park's recorded history; however, by July 15 only 8500 acres had burned in the entire greater Yellowstone area. On July 21, due to continued dry conditions, the decision was made to suppress all fires. Within a week, fires within the park encompassed nearly 99,000 acres. By the end of July dry fuels and high winds made the larger fires nearly uncontrollable. Military personnel were called upon to assist professional firefighters. Residents of towns outside the park feared for their property and their lives.

By September 1988 the first snows dampened the fires after the nation's largest firefighting effort could not. A total of 248 fires started in greater Yellowstone in 1988 (50 in Yellowstone National Park). Firefighting efforts cost nearly \$120 million. Fortunately there were only two fatalities, both firefighters. About 1.2 million acres were scorched (about the size of Trinidad and Tobago) and 67 structures were destroyed (\$3 million).

Few military personnel are trained to be firefighters. Units have to be identified as soon as practical and training needs to be conducted as quickly as possible. Since firefighting can be deadly, it's imperative that training be thorough even when it's expedited. Military personnel will be taken away from their primary duties or training, which can have a negative impact on mission readiness. It would be particularly difficult for the U.S. military to support an ancillary mission like this while supporting war efforts in Afghanistan and Iraq. Prevention and mitigation of forest fires is definitely the preferred course of action.

Moving to Central America, TNC and the Programme for Belize (PFB), a Belizean NGO that manages the Rio Bravo Conservation and Management Area, work together to mitigate damage from fires. The following was adapted from "The Good Burn: Fire as a Tool for Conservation in Central America."¹⁵ Belize's diverse and highly specialized fire-dependent ecosystems (low lying coastal

¹⁴ "Wildland fire," www.nps.gov/yell/nature/fire/.

¹⁵ www.tncfire.org/intl/Fire%20Poster_WCC_v7.pdf.

plains and higher elevation pine ridge forests) have proven to be excellent demonstration sites for fire management to train protected-area managers from Central America. The team needed to determine an appropriate fire regime that balanced competing groups (hunters, cattlemen, nearby communities, conservationists). Threats needed to be mitigated through:

- Fire suppression -- Pre-fire season planning which includes the establishment of a firefighting organization, detection procedures, and fire equipment inventory and maintenance. Some roads will be upgraded to provide additional firebreaks to minimize the rate of spread.
- Prescribed burning -- Objectives will be based on parameters such as fuel load and type (i.e., dead plant matter) and the presence of pine stands. Hands-on fire training such as prescribed burns gives site staff a practical understanding of fire regimes, allowing them to implement fire management into their daily management activities. Land managers from other countries can observe and participate in these burns so they're better able to develop programs for their regions of responsibility.
- Community outreach workshops -- Carried out to sensitize the community on the effects of wildfires and to promote the use of prescribed fires. Database development is important to properly store information and documentation as the fire aspects of pine savanna ecosystem management become integrated with other programs. Geographic information system-based programs and a central database will store fire and forest management information and data collected in all of PFB's programs.

The Latin American and Caribbean Fire Learning Network is organized and coordinated by staff from TNC's Fire Initiative, in cooperation with TNC country and state programs. Staff from these programs organizes and runs network workshops and oversees network-related communications. Specialists from the TNC Fire Initiative, Mexico Program and Florida Chapter also provide extensive assistance to field practitioners participating in the network through site-based consultations and other mentoring activities. In addition to those countries already mentioned, Latin America partners include: the Dominican Republic, Costa Rica, Panama, Honduras, et al.

Network workshops focus on fire use, fire behavior, and comprehensive fire management planning and community-based fire management. Experts in fire management provide the conceptual scientific framework for each workshop. Meetings are held at demonstration sites, which are used as case studies for workshop exercises, such as development of fire management plans. Workshop experts provide feedback and scientific information to teams representing the demonstration sites.

Representatives from other conservation areas participating in the network also have opportunities to discuss fire management planning and implementation needs. Workshops also devote time to understanding and discussing specific fire-related needs, such as public education or fire prevention, in different regions or countries.

Here is an example of government bodies (e.g., U.S. Forest Service) and NGOs in multiple countries cooperating to manage a potentially very destructive force (fire). While a major component of the effort is for conservation purposes, there is also a threat reduction element. Can fire always be used to mitigate the threat of a runaway forest fire? Unfortunately, no. If there's a community that's surrounded by forest or homes that are interspersed in a forested region, it may be too dangerous to use a controlled burn. While controlled burns are meticulously planned (e.g., certain wind conditions, humidity range, adequate crew), it's certainly possible for a controlled fire to turn into an uncontrolled fire. An option for populated areas is the manual removal of forest fuel. This could be a lengthy process as well as an expensive proposition; however, it's a better alternative than simply waiting for the inevitable fire that can quickly become a conflagration due to decades of fuel buildup on the forest floor. People choose where they want to live for many different reasons. It only makes sense for there to be a public and/or private partnership to keep the area as safe as reasonable.

Chapter 4

Earthquakes

Earthquakes can directly destroy most manmade structures by shaking the earth so violently that buildings, bridges, etc. topple or are condemned afterwards because the structure is rendered unsafe by the temblor. They can also lead to tsunamis, landslides, fires, volcanic eruptions, etc. While we're not able to prevent earthquakes, we can set up a network of sensors so scientists can advise us when one is likely. People can minimize their susceptibility to earthquake damage by living a safe distance from fault zones. However, we know the real estate above some fault zones is in very desirable locations (e.g., certain areas of California). Since people elect to live in earthquake-prone areas, mitigation techniques need to be used to minimize casualties and property damage when one occurs.

Building codes exist for a variety of reasons. These codes can mandate that new buildings must be able to withstand a certain magnitude earthquake. They can also stipulate that existing buildings must meet certain structural standards if they were built before existing building codes were in place. Building regulations also must apply to infrastructure like bridges, water and power systems, etc.

In September 1985 a magnitude 8.1 earthquake struck Mexico City -- 10,000 people were killed, 20,000 were injured, 100,000 people were left homeless, and \$5 billion in property damage was sustained. More than 400 buildings collapsed in Mexico City alone -- hotels, a children's hospital and office buildings were turned into rubble. Ultimately, approximately 6,000 buildings were destroyed or demolished. Landslides caused damage and rockslides were reported along highways in the Ixtapa area. A tsunami was generated which caused some damage (estimated wave heights were three meters at Zihuatenejo, near Ixtapa).¹⁶

Vibration caused failure of the subsoils (the layer of soil between the topsoil and bedrock) and subsidence which resulted in the collapse of streets. This type of damage was particularly prevalent in Mexico City since much of the city is located on unconsolidated (i.e., loose) lake-bed sediments (soft sedimentary clay deposits) which amplified the seismic waves and resulted in ground failure.

¹⁶ U.S. Geological Survey, http://neic.usgs.gov/neis/eq_depot/world/1985_09_19.html

In August 1999 CNN provided an update on the situation in Mexico City.¹⁷ In the nearly 15 years since the quake, much has been learned about preparation, survival and reconstruction.

Within days after the earthquake, city authorities revised building codes. Structures that were determined to be safe for occupancy were rebuilt to newer, safer standards. "Many of them have been upgraded to new regulations (and) that makes at least Mexico City less vulnerable now than it was 15 years ago," Roberto Meli of Mexico's National Center for Disaster Prevention said.

A public park now stands on the site of a former downtown hotel. It honors the memory of those who died and reminds the living of the need for constant preparedness.

When a quake hits now, occupants of public buildings, organized into security squads beforehand, supervise quick evacuations. Earthquake drills are conducted periodically.

The National Center for Disaster Prevention has installed an alarm system that detects movement under the Pacific Ocean which is often an indicator of a potential quake. "The use of the network is to alert critical systems," said Meli. This earthquake early warning system allows authorities to stop the city's subway system a few tenths of a second in advance, possibly saving countless lives.

Despite all the preparedness, enforcement and stricter construction codes, CNN reported few in Mexico feel ready for the next major earthquake. No matter how vivid the memories of recent past destruction or how extensive official contingency plans are, few can predict the effects of a force of nature. I think the latter part of the previous statement from CNN is interesting. While it may be true that we're unable to predict the exact effects, we can certainly predict what's likely to happen based on the countless disasters that have occurred around the world. Experts can advise us where we should and should not build, how we should build along with other actionable information. Many will suffer the consequences if they believe the effects of a natural event cannot be reasonably predicted. This may not be an exact science; however, much is known and can be acted upon by those in developing and developed countries.

It's certainly a positive development that Mexico City instituted constructive changes after the devastating earthquake of 1985; however, these measures won't help those affected 20 years ago. We won't know for sure if the steps taken were effective or how effective they were until the next earthquake occurs. Too often we find that building codes and other government regulations were

¹⁷ CNN, "Mexico City learns from the past quakes," 17 Aug 99, Harris Whitbeck, <http://edition.cnn.com/WORLD/americas/9908/17/mexico.quake/>.

ignored or improperly implemented after an event occurs. Corruption and poverty are often to blame. The cycle repeats until all those who are involved do what needs to be done – properly.

In 1906, San Francisco, California experienced a major earthquake (estimated at 7.7 on the Richter scale), which led to a fire in which thousands died. The total death toll was over 3,000; more than 200,000 people were injured and the economic damage exceeded \$400 million in 1906 dollars. In 1989, San Francisco experienced another major quake (6.7 on the Richter scale), which killed 62 people and caused substantial economic losses, but San Francisco recovered quickly. As San Francisco developed economically and put in place more robust buildings, roads and other infrastructure, the impact of earthquakes on the city has been reduced.¹⁸ This is another example of an event in a developed country that caused relatively few deaths but a lot of economic damage.

The volcanic eruption of Mount Usu in Japan in March 2000 is an ideal showcase for sound disaster reduction for three reasons:

- The early warning system (which monitored the rapid increase in earthquake tremors) allowed for the timely warning of the communities residing close to the volcano.
- The coordination between the national government, the local authorities and the private sector allowed for a very efficient information flow and smooth logistical evacuation procedures.
- A pilot project instigated by the Asian Disaster Reduction Center and the National Space Development Agency of Japan allowed for the live observation of the disaster via satellite. The voice and motion picture data was made accessible on the internet. A disaster expert was thus able to give instructions for the efficient management of the event. Fewer disaster specialists needed to go onsite and live satellite coverage allowed for a better overall observation of the situation.

Again we have the situation where a developed country used its substantial financial, technical and other resources to protect its citizens, infrastructure and economy from a likely disaster. Those developing countries that are unable to put adequate prevention and mitigation systems in place must be helped by the wealthier developed countries. Otherwise, the developed countries, along with international institutions and NGOs supported by them, will be faced with major

¹⁸ Sustainable Development Network, "Disasters and Development," 17 January 2005, p. 2, <http://sdnetwork.net/>.

emergency efforts after a disaster occurs. The adage “a stitch in time saves nine” definitely applies in the field of disaster prevention.

Chapter 5

Summary

I could easily include chapters on each type of natural disaster that occurs in the world along with examples from developed and developing countries in this hemisphere and elsewhere; however, the trends are clear. Prevention and mitigation are the only reasonable courses if we want to minimize death and destruction when the inevitable occurs.

I selected this topic because it was of interest to me and it fits under the umbrella of “defense and hemispheric security.” I am heartened to learn from my research that there are numerous supranational and regional organizations, national and state governments, NGOs and others who are devoting a lot of effort to ensure development dollars are funneled into projects to prevent or mitigate disasters when cataclysmic natural events occur.

For example:

- **UN:** The UN established the International Strategy for Disaster Reduction whose mission was discussed previously. Its four goals are:
 - To increase public awareness about disaster reduction
 - To obtain commitment from public authorities
 - To stimulate inter-disciplinary and inter-sectoral partnerships
 - The improvement of the scientific knowledge of the causes of natural disasters and the consequences of natural hazards.

The UN World Conference on Disaster Reduction (WCDR) was held in January 2005. Some 4,000 participants attended the WCDR, including representatives from 168 governments including more than 40 ministers, 78 UN specialized agencies and observer organizations, 161 NGOs, and 562 journalists from 154 media outlets. The WCDR aimed to:

- Increase the international profile of disaster risk reduction
- Promote its integration into development planning and practice
- Strengthen local and national capacities to address the causes of disasters that hamper development in many countries

Discussions at the WCDR resulted in two negotiated documents: a program outcome document entitled “Building the resilience of nations and communities to disasters: Hyogo Framework for

Action 2005-2015,” and the Hyogo Declaration. Participants succeeded in addressing the urgent needs of the December 2004 tsunami’s aftermath while maintaining a focus on the long-term goal of reducing disaster risk and vulnerability.¹⁹

- International Institute for Sustainable Development (**IISD**): acts like an NGO but is supported in part by the Canadian government (it’s based in Canada with offices in New York and Geneva). Its vision: Better living for all – sustainably. Its mission: To champion innovation, enabling societies to live sustainably.

For development to be sustainable it must integrate environmental stewardship, economic development and the well-being of all people -- not just for today but for countless generations to come. This is the challenge facing governments, NGOs, private enterprises, communities, and individuals.

IISD contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change, measurement and indicators, and natural resources management.

This organization is one that views mitigation efforts before a natural disaster occurs as an integral part of sustainable development. IISD is but one example of an NGO working in this area.

- **OAS**: Published “Disasters, Planning and Development: Managing Natural Hazards to Reduce Loss” in 1990 with support from the U.S. Office of Disaster Assistance and USAID. The executive summary of this insightful work states, “...the most effective approach to reducing the long-term impact of natural hazards is to incorporate natural hazard assessment and mitigation activities into the process of integrated development planning and investment project formulation and implementation.” This report is chock full of impactful facts and figures to convince government and non-government policy makers that threat reduction is good business and must dictate which development projects will and will not be supported in Latin America.

- Regional organizations in the Western Hemisphere:

-- **CAPRADE** – Comité Andino para la Prevención y Atención de Desastres

-- **CDERA** – Caribbean Disaster Emergency Response Agency

-- **CEPREDENAC** – Centro de Coordinación para la Prevención de Desastres Naturales en América Central

¹⁹ Earth Negotiations Bulletin, 24 Jan 05, "Summary of the World Conference on Disaster Reduction: 18-22 January 2005," www.iisd.ca/download/pdf/enb2609e.pdf.

-- et al.

Again I could identify many different organizations that have similar and overlapping missions in this field. It's clear to me there is much agreement among governmental and non-governmental actors regarding the way ahead. Unfortunately, change of this type take will take decades even if there is broad consensus. The financial resources that would be required to retrofit or replace all buildings and infrastructure that aren't built to an acceptable standard is staggering. It's imperative that there be appropriate laws (an indication of political / public will) in vulnerable areas to replace buildings that are most vulnerable.

An example of this political will is the significant decision made in Belize after a 1961 hurricane. Hurricanes have played key and devastating roles in Belizean history. In 1931 an unnamed hurricane destroyed over two-thirds of the buildings in Belize City and killed more than 1,000 people. In 1961 Hurricane Hattie struck the central coastal area of the country, with winds in excess of 300 kilometers per hour and four-meter storm tides. The devastation of Belize City for the second time in 30 years prompted the relocation of the capital some eighty kilometers inland to the planned city of Belmopan.²⁰ While this was a historic decision for a country to make, the population of Belize City is still higher than the population of Belmopan 35 years after the government relocated. People live where they choose unless there are major economic and/or legal incentives to stay away from an area. Societal change can be incredibly slow, especially in the absence of meaningful encouragement.

Relocation of its capital away from the coast may have been practical for Belize in 1970 but is certainly not an option for the world's megacities (population of more than 10 million). Of the 19 megacities in the world in 2000, six are in this hemisphere: Mexico City, São Paulo, New York, Los Angeles, Buenos Aires, Rio de Janeiro.²¹ The disasters that have been discussed are likely to be magnified many times when they affect a megacity. Megacities in developed countries, as with other cities in these countries, will be better prepared to bear the brunt of natural events and will be able to quickly muster the resources necessary to recover. However, developing countries are more likely to face devastating damage and casualties. Ever increasing urban populations, particularly in the developing world, raise the ante with respect to the potential of mind-boggling disasters as a result of a natural event (earthquake, hurricane, etc.). The sooner regions start prevention and mitigation

²⁰ Library of Congress Federal Research Division, A Country Study: Belize, www.loc.gov.

²¹ UN, World Urbanization Prospects, "A World of Cities / An Urbanized World", www.unchs.org/Istanbul+5/10-11.pdf.

initiatives, the sooner they'll be completed. The saying "Don't put off until tomorrow that which you can do today" is definitely applicable. While it's obvious some hazard avoidance projects won't be completed for a number of decades, each vulnerable area should be able to note some significant improvement every year. If a few years go by and meaningful improvements are hard to identify, the region in question must reaffirm what it wants to achieve with respect to natural disaster avoidance and work with all stakeholders to obtain results. A country will likely never be able to say it's achieved all possible prevention and mitigation goals; however, steady progress must be evident.

Governments rarely seem to have enough resources for the many needs their societies have. Politicians daily face urgent problems that demand their attention and their country's resources (disease, hunger, illegal trafficking, gang violence, ad infinitum). The next major natural event may not be until next year, or during the next administration, or a decade from now. Regardless, elected officials and others with a stake in this important outcome must ensure an adequate amount of scarce resources are devoted to making improvements (to infrastructure, warning systems, training of emergency responders, etc.). Those who have studied costs versus benefits have determined repeatedly that money spent on prevention and mitigation will be repaid severalfold once an event occurs. These costs must be considered investments that will pay big dividends sooner or later, perhaps multiple times.

Now that many different governmental and nongovernmental organizations are focusing on this issue, it's worthwhile to ensure there isn't excessive overlap. Society as a whole doesn't benefit much if there are too many bureaucracies trying to do the same thing. A reasonable amount of overlap can be beneficial but the bottom line is ensuring available funds are spent on improving the society's ability to "weather the [next] storm."

As is true with many of the transnational and other substantial issues facing developing nations today, it's absolutely imperative that developed countries provide financial resources (directly, through supranational organizations, through NGOs) to assist in this undertaking. Hurricane Mitch struck Honduras and other countries hard more than six years ago. Some believe it'll take up to ten years from now for Honduras to fully recover from this devastating storm. There are too many other priorities that demand our attention to allow ourselves or our neighbors to endure this kind of pain for an extended period of time. Of course, another great storm could sweep through the area before reconstruction is complete.

Let's get started – time is of the essence!

I would like to end with an extract from the Hyogo Declaration²² from the UN World Conference on Disaster Reduction, 18-22 January 2005, in Kobe, Japan because it captures the essence of this monograph in one short paragraph.

“We now call for action from all stakeholders, seeking the contributions of those with relevant specific competences and experiences, aware that the realization of the outcomes of the World Conference depends on our unceasing and tireless collective efforts, and a strong political will, as well as a shared responsibility and investment, to make the world safer from the risk of disasters within the next decade for the benefit of the present and future generations.”

²² UN World Conference on Disaster Reduction, 18-22 January 2005, Kobe, Hyogo, Japan, www.unisdr.org/wcdr/intergover/official-doc/L-docs/Hyogo-declaration-english.pdf.

Bibliography

CNN, "Mexico City learns from the past quakes," 17 Aug 99, Harris Whitbeck, <http://edition.cnn.com/WORLD/americas/9908/17/mexico.quake/>.

Earth Negotiations Bulletin, "Summary of the World Conference on Disaster Reduction: 18-22 January 2005," 24 Jan 05, www.iisd.ca/download/pdf/enb2609e.pdf.

ECLAC, "Assessment of the Socioeconomic and Environmental Impact of Floods in the Dominican Republic," www.eird.org/ing/revista/No9_2004/art4.htm.

Inter-American Development Bank, "Protección financiera para sobrevivir desastres" presentation, Kari Keipi, 6 April 05.

Library of Congress Federal Research Division, A Country Study: Belize, www.loc.gov.

Merriam-Webster's Dictionary of Law, © 1996, www.dictionary.com.

OAS, Disasters, Planning and Development: Managing Natural Hazards to Reduce Loss, Dec 1990.

PAHO (WHO), "Health Considerations in Disasters" presentation, Dr. Ciro Ugarte, Emergency Preparedness and Disaster Relief, 6 Apr 05.

Sustainable Development Network, "Disasters and Development," 17 January 2005, <http://sdnetwork.net/>.

The Nature Conservancy, "The Good Burn: Fire as a Tool for Conservation in Central America," www.tncfire.org/intl/Fire%20Poster_WCC_v7.pdf.

The Nature Conservancy, Conservation Easements, <http://nature.org/aboutus/howwework/conservationmethods/privatelands/conservationeasements/>.

The Nature Conservancy, The Latin American and Caribbean Fire Learning Network, www.tncfire.org/intl/intro.html ; www.tncfire.org/intl/overview.html.

The Nobel Foundation, The Nobel Peace Prize 2004, <http://nobelprize.org/peace/laureates/2004/index.html>.

U.S. Army Corps of Engineers, "The Great Flood of 1993 Post-flood Report," www.mvr.usace.army.mil/PublicAffairsOffice/HistoricArchives/Floodof1993/fl-8.htm.

U.S. Geological Survey, Large Historical Earthquakes, http://neic.usgs.gov/neis/eq_depot/world/1985_09_19.html.

U.S. National Park Service, "Wildland fire," www.nps.gov/yell/nature/fire/.

UN International Strategy for Disaster Reduction (Latin America and the Caribbean), www.eird.org/ing/eird/eird.htm

UN World Conference on Disaster Reduction; 18-22 January 2005; Kobe, Hyogo, Japan; www.unisdr.org/wcdr/intergover/official-doc/L-docs/Hyogo-declaration-english.pdf.

UN, World Urbanization Prospects, "A World of Cities / An Urbanized World," www.unchs.org/Istanbul+5/10-11.pdf.

USAID, "Haiti's Clean-up Progresses in the Caribbean As Asia's Tsunami Burden Continues to Rise," www.usaid.gov/locations/latin_america_caribbean/country/haiti/haiti_hurricanes.html.

Webster's New Millennium™ Dictionary of English, Preview Edition (v 0.9.5) 2004, www.dictionary.com.

YES!, "Skipping Town," Winter 1998, Steve Lerner, www.yesmagazine.org/article.asp?ID=927.