concern, disaster mitigation is seriously constrained by the city's underdevelopment: La Paz lacks basic infrastructure for a large proportion of its population; the local administration and institutions are unable to design or enforce land-use plans; and the general public is largely unaware of disaster prevention techniques. Given these seemingly intractable problems, Ms. Plessis-Fraissard said that when the project team began to work on the loan, containing La Paz's natural hazards appeared insurmountable. As the project evolved, however, important lessons were uncovered and controlling risk seemed more feasible. The project team developed innovative techniques for identifying hazards and assessing their potential severity and imminence. Once the hazards were identified, mapped, and prioritized according to their gravity, risk reduction measures could then be systematically targeted for the most serious hazards.

Perhaps most important, Ms. Plessis-Fraissard said, disaster reduction was cost effective and affordable to the city. In contrast to the annual loss the city incurred from hazards, amounting to $8.00 per capita, the cost to contain the risk totalled about $2.50 per capita. With these auspicious figures, the project's disaster reduction component was designed to include flood, landslide, and erosion control works, and systems for solid waste collection and equipment maintenance. Loan conditionality for municipal and financial management was set and included mechanisms for collecting taxes and investing in municipal development. Agencies responsible for different aspects of disaster management and emergency readiness were organized into a coherent framework within the municipal government, and an early warning system was formulated. Finally, a pilot program to educate and involve the citizenry of the city in disaster reduction efforts was established.

Ms. Plessis-Fraissard ended her presentation by noting that although the La Paz project would not meet Californian risk reduction standards, the disaster reduction component would significantly reduce the number of lives lost and the amount of property damaged.

Thakoor Persaud of the World Bank, the panel's moderator, concluded the session by highlighting the financial and political difficulties that developing countries encounter when attempting to institute disaster reduction programs.

Mr. Persaud said that to formulate effective disaster reduction programs, development planners must be aware of the potential complications they might encounter. For example, politicians may have a shorter-term perspective on issues affecting a disaster-prone area than a development planner, and they may need to contend with priorities of greater immediacy than disaster reduction. Or, developing countries may be reluctant to embark upon a disaster reduction program requiring capital investments when they know that external assistance would be available in the event of a disaster. Mr. Persaud said that when conventional avenues of development are pursued for disaster reconstruction or reduction projects, the informal sector may often be excluded.

In addition, Mr. Persaud argued that within the cycle of a catastrophe, the window of opportunity for disaster reduction is short. In the immediate aftermath of a calamity, when a country and its population may be very receptive to lowering vulnerability, all available resources must be diverted to relief. As the disaster fades with time, competing demands regain their urgency.

To design successful disaster reduction programs, projects must operate within the bounds of these limitations. Project goals should be divided into discrete, short-term steps in accordance with the government's time horizon. Hiring staff with hands-on experience in the disaster-prone country could help to overcome bureaucratic hurdles, and enlisting locally-based institutions that have the confidence of the people, such as NGOs or the church, could provide access to the informal sector. Mr. Persaud also said that the great strides in the areas of construction technology and early warning systems are encouraging. He urged that as technology continues to advance, it must also be appropriate, accessible, and cost-effective. And finally, he advised that for disaster reduction programs to be effective, they must be built upon the mutual interest of all entities involved in hazard reduction.

Recovery and Mitigation Efforts In Bangladesh and Nepal

Patrick E. McCarthy
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Bangladesh

Bangladesh is prone to natural disasters: floods, cyclones, and droughts. Of the three types of disasters, the first (floods) has perhaps captured the most attention. Following the floods of 1987 and 1988, the international donor community, at the request of and with the cooperation from the government of Bangladesh, has carried out some intensive studies toward developing policies and strategies for managing the floods.

"According to all available evidence gathered over the last 100 years, since records have been kept, the severity and extent of flooding in Bangladesh has not increased. International awareness of recent floods has in all probability grown because of enhanced capabilities to communicate such disasters to the world, and because increased development activity in areas at risk has caused economic losses to rise."

Three of the great rivers of South Asia, the Brahmaputra, the Ganges, and the Meghna, which are also amongst the largest rivers of the world, have their confluence in Bangladesh before flowing into the Bay of Bengal. Only 8% of the watershed of these rivers lies in Bangladesh while 62% of the watershed lies in India. The rest is distributed among Nepal, Bhutan, and China (Tibet). The watershed is home to half a billion people, of which 350 million are from India and 110 million from Bangladesh. About 250 million of these people are classified as below the poverty line. The area's population is growing at about 2.2% per annum.

Within Bangladesh, 11.6 people inhabit 1 hectare of arable land, compared to 1.3 people in the United States. This ratio for Bangladesh is projected to rise to 38.5 people per hectare of arable land in

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about 100 years before stabilizing. The comparable ratio for the U.S. would be 1.5. Recent studies have, therefore, not only focussed on the physical management of flood prevention, but on the human and social dimensions as well.

Flooding of these rivers is an annual event to a greater or lesser degree. It is a necessary part of the ecosystem, providing fertility for the soil, water for monsoon crops, groundwater recharge, and fish production. According to all available evidence gathered over the last 100 years, since records have been kept, the severity and extent of flooding in Bangladesh has not increased. Inter-national awareness of recent floods has in all probability grown because of enhanced capabilities to communicate such disasters to the world, and because increased development activity in areas at risk has caused economic losses to rise.

While much could be done to prepare for and mitigate the effects of flooding within Bangladesh, long-term solutions for water management in the Brahmaputra and Ganges basins would require an integrated regional approach which would have to demonstrate benefits to all affected countries.

Snowmelt starts in the Himalayas. Nepal, however, can only divert and use a little of such waters; the rest flows into India. The construction of dams in the Himalayas would be subject to breaking by earthquakes and contribute to seismic destabilization. Estimates of the amount of funds and time required to construct dams which would make an impact on flood control are prohibitive: $60 billion and 60 years. At the end of that time, the dams would be silted, requiring the construction of new dams. Deforestation in Nepal, whilst a problem, does not appear to be a significant factor in the incidence of flooding in Bangladesh. China is also upstream of India, but it has little chance of diverting water from the Brahmaputra before it enters India because of the mountainous nature of its terrain and the low population densities in the area.

"All of the Bank's previous projects in Bangladesh have focussed on the agriculture/ irrigation sector. Donors, including the World Bank, are now taking a broader approach to flood rehabilitation, to include the human and social dimensions as well as the protection of urban infrastructure and other property and life."

India is upstream of all major rivers that flow into Bangladesh; however, it has a major problem in transferring the waters of the Brahmaputra in the northeastern state of Assam to the central part of India. In the low flows season, India diverts large quantities of water from the Ganges. But in the flood season, India appears to have no choice but to open all gates, thus exacerbating the problem in Bangladesh. The diversion of large amounts of water by India in the dry season causes shortages in Bangladesh.

Mitigation of flooding by embankments on both sides of the main rivers likewise involves tradeoffs between the benefits and negative consequences, which often are difficult to predict. Embankments could deny many of the benefits noted earlier and they cost billions of dollars to construct and millions a year to maintain.

What, then, are the solutions, if any?

A number of international and Bangladesh studies have been undertaken since the 1988 flood. Their findings are currently being assessed. However, it seems that a multipronged approach will be required through implementation of Bangladesh's National Data Plan and a permanent institutional focus on emergency preparedness activities. The former will enable Bangladesh to prioritize flood control, drainage, and irrigation projects, and the latter will assist the people of Bangladesh to better cope with future floods. Here are a few of the recommendations that have come out of the recent studies.

(i) Implement a phased and comprehensive flood plan incorporating the protection of public utility centers, communication networks, and urban, rural, commercial, and industrial infrastructure; and control flooding wherever possible and appropriate to meet intersectoral needs (e.g., agriculture, fisheries, water supply, and transport).

(ii) Support actions through a central office of emergency preparedness that will help people live with the floods. These actions could include establishing and improving refuge areas, providing better emergency food and medical services, increasing and improving surface drainage, and providing livestock protection.

(iii) Promote better disaster preparation, including international cooperation for flood forecasting, warning, and analysis. Many of the preparations for flood disasters lend themselves to cyclone and drought disasters as well.

(iv) Encourage programs for the development and more efficient use of tubewells during the eight months of the dry season. This would have to include the development of the hydroelectric potential of the region and gas-powered electricity generation as viable power sources to drive the tubewells.

(v) Strengthen development, in the long term, of a water development program based on a broad and integrated approach, recognizing that the most important immediate measures to be taken are in-country.

(vi) Obtain endorsement by the international donor community of Bangladesh's National Water Plan, developed as a way of dealing with floods within an overall water development strategy. The plan proposes an investment of $6 billion over 20 years on flood control, drainage, and tubewell irrigation projects, prioritized to meet food production needs until 2005.

The World Bank has been associated with disaster recovery projects in Bangladesh since 1970, when a cyclone struck coastal districts killing as many as 500,000 people and causing enormous damage. Due to the war of liberation, the reconstruction program made little progress, but after independence, the Bank reappraised and relaunched the project as the Coastal Areas Rehabilitation and Cyclone Protection Project in October 1982. Further Bank-financed disaster flood rehabilitation projects were approved in 1985 and 1988 in response to severe flooding during the 1984 and 1987 monsoons, respectively. All of the Bank's previous projects in Bangladesh have focussed on the agriculture/irrigation sector. Donors, including the World Bank, are now taking a broader approach to flood rehabilitation, to include the human and social dimensions as well as the protection of urban infrastructure and other property and life. These lessons have been incorporated into the Bank's most recent credit, the 1989 Third Flood Rehabilitation (Emergency) Project, which is designed to assist in reconstruction following the devastation of the 1988 floods and to prevent and mitigate future floods.

Nepal

Nepal, with its great Himalayan mountain range, is seismically active. Its excessive runoff from snowmelt combined with the monsoon rains, which are not necessarily an annual occurrence, can cause flooding.

In this century, Nepal has suffered three earthquakes. The first one, and the worst recorded to date, occurred in January 1934 and registered 8.2 on the Richter Scale. The second quake occurred in July 1980 with an intensity of 6.5, and the latest one struck in the early hours of August 21, 1988 with an intensity of 6.7. In July and August 1987, exceptionally heavy rains combined with snowmelt to cause the worst flooding in twenty years.

Let us concentrate on the two most recent events. The August 1988 earthquake rocked the entire Eastern and part of the Central Development Regions. Its epicenter was at Udaypur, about 160 km southeast of Kathmandu. The quake was felt in the Kathmandu Valley where some damage occurred in Bhaktapur. It lasted about 40 seconds, leaving 721 people dead, over 6,000 injured, and much infrastructure damaged beyond habitation or use in 28 districts. Specifically, 65,453 homes affecting about 460,000 persons, 2,351 education buildings, 83 health posts/hospitals, and 1,159 public buildings were destroyed or damaged. Additionally, roads, bridges, power infrastructure, irrigation, and water supply were also damaged. By far the greatest damage in dollar value was to housing ($78.5 million), followed by roads and bridges ($62.4 million) and schools ($32 million). The total direct estimate of damage was $172 million.

"Collapses occurred mainly in the mud-brick houses and in those with no framing. Damage resulted mainly from failure to bond corner walls, secure gable walls, provide lintels over openings, and secure roof structures. Houses of framed construction or reinforced concrete suffered no damage at all."

The government quickly mounted a relief effort which it originally anticipated completing within a month of the disaster, but which ultimately extended up to October 1, 1988. This relief included 2,000 Nepalese rupees (NRs) to the families of the dead, NRs 1,000 to those whose houses had collapsed or were rendered unfit for habitation, 40 kg of rice per affected family, and provision of plastic sheets for shelter. While this relief was underway, the government turned its attention to implementing a reconstruction program, making a number of key decisions:

(i) a Central Coordinating Committee, under the chairmanship of the Minister of Housing and Physical Planning, and a special implementation unit to coordinate the program was constituted;

(ii) three percent (about $14 million) of the 1989 fiscal year's development budget was allocated for reconstruction and rehabilitation;

(iii) 28 engineers and 272 overseers

would be recruited to work on the housing reconstruction program;

(iv) 1,200 rural workers would be trained to introduce an added benefit of promoting the use of low-cost toilets and smokeless stoves. A grant of NRs 600 would be paid to households that incorporated such improvement when reconstructing their homes;

(v) minimum earthquake-resistant requirements in reconstructed buildings would be developed (their incorporation into district headquarters and urban areas would be mandatory);

(vi) demonstration houses would be constructed to show sound building techniques and simple low-cost earthquake-resistant features; and

(vii) a housing reconstruction loan program would be initiated through banks which had branches in the affected areas.

On September 9, 1988, the World Bank received a request from the government for emergency assistance in reconstructing housing. Within a couple of weeks a mission from the World Bank went to Nepal to identify and appraise, if possible, an earthquake emergency housing reconstruction project. This was accomplished. The mission travelled to the affected areas and saw the extensive damage done by the earthquake. Although the quake was considered relatively mild, approximately 65,500 houses were destroyed (primarily due to weak construction techniques): 63,000 were classified as rural, 2,340 were classified as urban, and 410 were located in the district headquarters areas. Damage was most visible in the urban areas, particularly in the towns of Dharan (population 65,000), Dhankuta (population 8,000) and Ilam (population 4,000).

Generally, houses in Nepal are of two to three stories, built with stone, brick with cement mortar, and brick-mud mortar (commonly called mud-brick). Collapses occurred mainly in the mud-brick houses and in those with no framing. Damage resulted mainly from failure to bond corner walls, secure gable walls, provide lintels over openings, and secure roof structures. Houses of framed construction or reinforced concrete suffered no damage at all.

The main objectives of the World Bank-financed emergency housing reconstruction project, which was approved in March and signed in April 1989, were the following:

(i) assist the government in implementing its loan program to reconstruct houses damaged in the earthquake;

(ii) improve construction standards and develop a national building code, including the incorporation of earthquake-resistant features into buildings through planning and development control regulations;

(iii) provide technical assistance and training for the housing sector to address long-term needs; and

(iv) address the environmental impact relating to the excessive use of timber in buildings and building products manufacture.

The government's program, of which the World Bank-financed project is a part, together with technical assistance and training funded by UNDP, addresses recovery and mitigation in a real way. In the recovery process, the government quickly recruited and trained 300 engineers and overseers. In this effort, the Swiss Disaster Relief Organization assisted in providing logistical support in the field operations. The functions of the engineers and overseers are to

(i) bring affected households and the banks together for the purposes of administering the loan program. To date about $10 million equivalent has been lent to affected households in a program that was initiated formally on November 16, 1988;

(ii) advise affected households on basic building techniques and low-cost ways of incorporating earthquake-resistant features in reconstructing houses;

(iii) certify, at least in the District Headquarters and urban areas, that earthquake-resistant features have been incorporated into reconstruction, so that households can qualify for the second tranche of their loans;

(iv) train 1,200 rural workers to promote low-cost sanitation and smokeless stoves; and

(v) facilitate the collection of the housing loan.

A program advisor, who is an expert in disaster management, has also been retained to help the government to implement and monitor its reconstruction program, including its housing component.

In order to mitigate the effects of future disasters, long-term technical assistance and training is to be provided which will address the following:

(i) disaster management;

(ii) preparation of a national building code incorporating earthquake-resistant features;

(iii) epicentral and seismic mapping;

(iv) development of a housing strategy and related studies;

(v) new building products development for domestic use and a study of alternatives to timber building; and

(vi) housing sector project preparation.

In mid-December 1988, the government requested emergency assistance to rehabilitate schools damaged in the earthquake. Negotiations for a Bank-financed project were successfully concluded in May 1989. The objectives of the project are the following:

(i) rehabilitate about 2,350 schools;

(ii) ensure those schools which are not included in the first year's construction program have temporary accommodation sufficient to permit education through the 1990 monsoon season;

(iii) combine the tradition of substantial community responsibility for the financing and construction of schools into the project; and

(iv) develop and introduce an appropriate level of cost-effective earthquake-resistant technology into reconstructed school buildings.

The project components are the following:

(i) schools rehabilitation, including reconstruction;

(ii) provision of construction implements, equipment, and vehicles;

(iii) support for consultants services (for assisting in the establishment of monitoring, supervision and accounting systems, and review of schools designs); and

(iv) assistance with project administration.

The government has also approached the Asian Development Bank for emergency assistance in reconstructing roads, bridges, and public buildings damaged in the earthquake.

The 1987 floods caused extensive damage, again in the Eastern and Central Regions. The government requested emergency assistance from the World Bank to repair and rehabilitate roads and bridges. In the Terai, the flat area bordering India, damage resulted from heavy scour as well as from changes in stream and river courses, which caused the failure of river channelization, protection, and river bank stabilization works at approaches to bridges, culverts, road embankments, and other drainage structures. In the hills and the northern parts of the affected regions, damage was caused by geological and other interlinked geo-dynamic phenomena, such as successive damming up and breaking through caused by landslides in upstream catchment areas and rivers, resulting in the failure of protection works and washout of road sections.

The government's response was to provide immediate relief to the affected population, notably with food, shelter, medicine, and construction materials. The armed forces were used to initiate temporary clearance works. The donor community assisted the government in preparing a flood damage assessment report, which was completed by the end of 1987 for the roads sector.

The World Bank-financed Road Flood Rehabilitation Project was approved in June 1988, and signed in September. Its objectives are the following:

(i) deliver immediate assistance to the Department of Roads to repair, rebuild, or replace priority components of flood-damaged road infrastructure;

(ii) help finance the first three years of the program's works, ensuring that priority is given to elements which would facilitate resumption of road transport activities;

(iii) help the Department of Roads accelerate implementation of urgently needed schemes to protect investments that survived the 1987 flood; and

(iv) develop and implement a post-monsoon damage monitoring system which would enable the department to assess and respond quickly and effectively to urgent damage repair and rehabilitation needs.

Prevention and Mitigation in Mexico

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Natural Hazards: Context and History

Because of Mexico's location in an intertropical area and its setting on the conjunction of three tectonic plates, the country represents, like most of its neighbors in Central America, a case of a nation with unusually high exposure to natural hazards. As evinced by historical records, by far the most violent and consequential among these hazards have been earthquakes and hurricanes. However, it should not be ignored that other hazards, such as volcanic eruptions, forest fires, and droughts, which may occur with less frequency or produce more insidious effects, also carry considerable potential for loss and form a permanent and serious threat to the country's economy and population.

Earthquakes are undoubtedly the most severe natural hazards with which Mexico is confronted. Risk from earthquakes is permanent in at least 60% of the territory, with the probability of occurrence of shocks of extremely high

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intensity concentrated primarily on the states bordering the Pacific coast and their vicinity. Seismic risk results principally from shocks caused by the subduction of the oceanic Rivera and Cocos Tectonic Plates under the continental Mexico Plate; normal faulting earthquakes within the

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subducted oceanic plate, and shallow crustal earthquakes in the continental plate also occur.

"In addition to a large share of the population, a substantial proportion of Mexico's industrial capacity and virtually all federal government institutions are situated in areas of hazard."

Seismic activity is permanent and intense. Between 1900 and 1985, 34 earthquakes of a magnitude greater than 7.0 on the Richter Scale were recorded - in comparison to five quakes of the same magnitudes which struck California over the same period of time. Of these Mexican tremors, five were of a magnitude greater that 8.0 on the Richter Scale, which is equivalent to the magnitude of the 1985 Mexico City earthquake. Despite the lack of appropriate recording systems, at least 23 major earthquakes were reported during the last century. Data for earlier periods are obviously more scant, but can be found as far back as pre-colonial times, with an earthquake first being mentioned in an Aztec chronicle for the year 1475.

Recurrence of major shocks in different segments of the plates appears to vary from 30 to 70 years. In the past, damage was frequently extensive, especially in urban centers and in cities like Guadalajara, Mexico City, and Oaxaca, which suffered repeatedly from severe destruction. The vulnerability of urban centers to seismic shocks was most vividly demonstrated by the earthquake of September 1985, which affected Mexico City, exacting a toll of at least 8,000 lives, leaving 30,000 injured, destroying or damaging beyond repair over 100,000 dwellings, and causing between US$4 and 5 billion worth of material loss to buildings and industrial plants.

Hurricanes and tropical storms principally strike the vicinity of the Caribbean and Atlantic coasts; but their effects resulting from intense precipitation and associated river flooding can reach far inland and over extended areas. Hurricanes on the Pacific coast are noticeably more frequent, though in general, they are less severe than those on the Caribbean coast. The Jalisco coast, located on the Pacific, experiences storm conditions an average of 70 days per year.

Storms on the Caribbean coast, conversely, tend to be significantly more violent and destructive, as last demonstrated in September 1988 by Hurricane Gilbert. This storm, which ravaged the Yucatan Peninsula and subsequently the Tamaulipas coast and inland northern Mexico, was reportedly one of the strongest atmospherical disturbances ever recorded in the Western Hemisphere, with winds that at their peak reached over 180 miles per hour and storm surges which rose to heights of at least 20 feet in landfall areas. The toll on human life of about 200 people may seem high; however, considering the violence of the storm, the number of casualties was relatively moderate, thanks largely to a well-functioning warning and evacuation system in the affected coastal areas of the Yucatan and Quintana Roo.

Material losses, however, were considerable. The tourism industry on the northern Quintana Roo coast is likely to require several years of reconstruction to fully recover. This is reinforced by the extensive reduction of beaches, the severe damage to off-coast coral reefs, and the disturbance to the overall coastal ecosystem to an extent which still awaits being fully assessed.

Impressive though Hurricane Gilbert was, it was by no means exceptional. In 1955, Hurricane Janet totally wrecked the city of Chetumal, leaving only four buildings intact, and claimed at least 500 casualties throughout Quintana Roo. In 1967, Hurricane Beulah struck the island of Cozumel, destroying at least 40% of all housing and battering the northern coast of the Yucatan before causing catastrophic flooding throughout northern Mexico and southern United States.

Natural disasters have punctuated the history of Mexico with almost regular occurrence. However, as population growth and economic development have progressed, particularly since the beginning of this century, the number of inhabitants and the amount of capital assets at risk have increased at a rapid rate. Expanding urbanization has drawn an increasingly higher number of inhabitants into areas that present considerable seismic risk. It is estimated that at least 30% to 40% of the population, and probably up to 50% of its urban component, live in areas of significant seismic risk. In addition to a large share of the population, a substantial proportion of Mexico's industrial capacity and virtually all federal government institutions are situated in areas of hazard. Likewise, the tourism industry is located almost in its entirety in areas of high risk to earthquakes or hurricanes, or as in the cases of Acapulco, Ixtapa, and other resorts on the Jalisco/Michoacan coast, to both these hazards.

Prevention and Mitigation: Past and Present

Because natural hazards were traditionally considered as acts of God that could not be predicted let alone averted, prevention and mitigation of their possible damaging effects was for a long time given only limited attention. Emergency relief following a calamity was dealt with primarily on an ad hoc basis, generally by state and local authorities, or in the event of major disasters, by calling on the armed forces for assistance. Although gradual sophistication of surveillance and monitoring technology led to progressive improvements in disaster reduction, particularly in the fields of hurricane warning and emergency evacuation, a major turn around in the official attitude towards hazard prevention and mitigation occurred only in the wake of the 1985 earthquake.

The response to this calamity was twofold. On one hand, the government undertook countrywide initiatives to enhance the static prevention of losses from earthquakes and hurricanes as well as from other hazards. The government ordered the rapid updating of building codes in all 32 states in accordance with the latest results of engineering research in Mexico and abroad. Within a month of the 1985 earthquake, an emergency building code was adopted for Mexico City. By late 1988, draft codes had been prepared for all other states under the auspices of the National Coordination Committee (Comite Nacional de Apoyo y Seguimiento) and the governments of the respective states, with assistance from other governmental agencies, professional bodies, and academic institutions. These codes are currently being reviewed by legal authorities of the states and are expected to be approved in the course of this year.

On the other hand, the government decided to build up the civil defense organization and to integrate civil defense into a national system (Sistema Nacional de Proteccion Civil), equipped with a coherent institutional and legal framework. Following up on the establishment of the National Reconstruction Committee (Comision Nacional de Reconstruccion), created for the purpose of coordinating the reconstruction effort and preparing the basis for a medium- and long-term hazard prevention and mitigation strategy, a working group (Comite de Prevencion de Seguridad Civil) was set up in 1986. This new working group defined the institutional and operational conditions required for the creation of a national civil defense system. Early in 1989, the committee's findings led to the present administration's decision to create a directorate (Sub-Secretaria de Proteccion Civil) within the Department of Interior (Secretaria de Gobernacion) specifically in charge of all matters related to civil defense.

The responsibilities which this new directorate has been assigned are the following:

(i) to prepare and/or help prepare appropriate, institutionally and technically coherent policy approaches to problems of hazard prevention and mitigation at the levels of federal, state, and local government; and

(ii) to oversee and, where necessary, ensure inter-institutional coordination of all activities related to mitigation and emergency assistance in the case of an occurred disasters.

To this effect, the directorate would be in charge of ensuring compliance with the civil defense requirements of new industrial, commercial, social, and residential investment in the public and private sector; preparing contingency plans for hazardous industrial plants; and assisting public- and private-sector entities in establishing guidelines for emergency situations. Given the newness of this institutional setup, it is evidently premature to make any judgement about the appropriateness of its design and the efficiency of its operational structure. However, the recent earthquake of last April provided a timely testing ground for some of the new arrangements and showed that most of these arrangements were capable of operating rather satisfactorily.

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Although gradual sophistication of surveillance and monitoring technology led to progressive improvements in disaster reduction, particularly in the fields of hurricane warning and emergency evacuation, a major turn around in the official attitude towards hazard prevention and mitigation occurred only in the wake of the 1985 earthquake.

World Bank Involvement

Bank involvement in the prevention and mitigation of natural hazards in Mexico has been relatively recent and essentially linked to the Earthquake Rehabilitation and Reconstruction Project. This project, for which a US $400 million loan was approved in spring 1986, was intended to address the immediate reconstruction and relief needs following the 1985 Mexico City earthquake and to initiate the implementation of a long-term strategy aimed at the efficient prevention and mitigation of future natural disasters. To this end, the project included funding for an extensive research program in the areas of seismology and seismic engineering, for the aforementioned updating exercise of building codes, and the implementation of programs to structural reinforce schools and health care facilities in various states exposed to seismic risk. All in all, the implementation of this project has been crowned with considerable success and it is expected to be completed by the end of this year.

Following up on these earlier efforts, the Bank begun in 1988 the preparation of the Natural Hazard Mitigation Project. As currently designed, this project would follow a two-pronged approach by (a) expanding upon the structural reinforcement programs of school buildings and health care facilities initiated under the preceding project, and extending these programs into geographical areas not covered previously; and (b) providing institutional, and if necessary, material support to the entities in charge of organizing and improving the civil defense system at the level of the federal government (Sub-Secretaria de Proteccion Civil) and of selected state or local governments, such as that of Mexico City (Departmento del Distrito Federal).

Mitigation Efforts at the Municipal Level: The La Paz Municipal Development Project

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The World Bank's La Paz Municipal Development Project provides an insightful case study of locally based development in support of disaster mitigation as advanced by one of Bolivia's most entrepreneurial institutions, the Municipality of La Paz, and a young and very dynamic mayor. The project was prepared in 1986 and approved in 1987, but its composition was different from what was initially anticipated and quite unconventional in respect to previous projects in the area. A third of the funds went to mitigate disasters, mostly landslides and floods, which had been plaguing the city since its founding in the sixteenth century. A third of the project was allocated for management upgrading, and another third was appropriated for equipment, mostly in the transport sector. One may wonder why we designed the Municipal Development Project with this unusual approach when conventional projects had been well-formulated in the past.

"La Paz can best be characterized as a city that is experiencing a continuous earthquake...After ten years of flooding and landslides, damage to public and private property is exactly the same as if an earthquake registering an 8.0 on the Richter scale had hit."

The city of La Paz has one million inhabitants. It is located between 3,500 and 4,000 meters above sea level on the edge of the altiplano plateau, on which Lake Titicaca lies 4,000 meters above sea level. The city's vulnerability arises from its location in a narrow valley of impermeable bedrock surrounded by very steep slopes with highly erodible soil. When the unstable terrain becomes saturated with water, it just slips down with imaginable consequences: the city loses between 15 and 300 houses each year, usually with loss of life, and

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considerable damage is sustained to public and private property.

"During the initial stages of the project, many of us on the project team were quite pessimistic about the prospect of risk reduction. We believed that La Paz's dynamic geology had taken a tremendous toll throughout the centuries and provided a nearly insurmountable problem; human intervention could perhaps minimally solve La Paz's predicament. Any risk abatement measure would simply be pouring money into an endless pit. However, as the project was formulated, we became much more optimistic that a disaster mitigation program could be successfully designed and implemented in a cost-efficient way."

La Paz can best be characterized as a city that is experiencing a continuous earthquake. Earthquakes strike from time to time. In La Paz, however, after ten years of flooding and landslides, damage to public and private property is exactly the same as if an earthquake registering an 8.0 on the Richter scale had hit. The city is continuously suffering from landslides. The more than 200 rivers that crisscross the city further saturate the unstable soil. About half the area of La Paz is unsuitable for development, and of course, the city has no capacity to enforce any type of land-use plan which aims to restrict settlement in hazardous areas.

La Paz's pervasive vulnerability makes risk reduction imperative yet complex because of its many dimensions. First, the city lacks essential infrastructure. A third of the population is without water, more than half does not have proper sewerage facilities, three-quarters of the area has no rainwater drainage system, and more than three-quarters of the streets are not cobbled in any way. On more than a third of the slopes, not only are there no streets, let alone cobbled ones, but there are no stairs. Stairs are especially important in La Paz because its precipitous slopes make road transport impossible throughout a large portion of the city. This tremendous lack of infrastructure means that the city is always in need of basic infrastructure and cannot forego investment for these basic needs to fund elementary safety measures for hazard reduction.

The second dimension of risk mitigation is the limitation imposed by administrative and institutional incapacity to design and enforce land-use plans. In a city where it is simply dangerous to live in certain areas, the local government is unable to police its population or to collect taxes from the landlords or tenants who reside in hazardous areas for investment in precautionary measures. When public investments are damaged, and once property owned by the residents or landlords are inevitably destroyed, then these people become what is commonly called in Latin America *flajelados*, or victims. Then the city becomes obligated to assist these victims, especially if their property has been completely devastated. Typically the scenarios is as follows: Peasants move onto hazardous sites prohibited for settlement by law. They cut down the trees which stabilize the highly erodible soil to construct their homes. Then, they live on the site for a year or two. When the rains come, their houses simply wash away, and the city must then attend to the families for free because they are victims.

The third dimension of the problem

is therefore the need to educate the citizenry about disaster control. It is said that La Paz has the best and the most difficult population. The best because it consists mainly of peasants who know how to build very well under the harsh climatic conditions of La Paz. They are a highly skilled population. On the other hand, these peasants come directly from rural areas with low population density and scant tree cover. They possess little knowledge about the problems of deforestation or the importance of tree cover for landslide prevention. Typically, they do not understand that using urban rivers for garbage disposal causes floods, which in turn saturates the surface of terrain and further exacerbates flooding and landslides.

While preparing the Municipal Development Project, the Bank's project team, which I was responsible for, realized that any viable hazard reduction program would need to address these three critical dimensions. However, during the initial stages of the project, many of us on the project team were quite pessimistic about the prospect of risk reduction. We believed that La Paz's dynamic geology had taken a tremendous toll on the city throughout the centuries and provided a nearly insurmountable problem; human intervention could perhaps minimally solve La Paz's predicament. Any risk abatement measure would simply be pouring money into an endless pit. However, as the project was formulated, we became much more optimistic that a disaster mitigation program could be successfully designed and implemented in a cost-efficient way. Simultaneously, we uncovered numerous lessons.

The first lesson of the project was that the risk of landslides and flooding could be measured. The project's early phase involved hiring a team of eco-geologists and urban planners to conduct geomorphologic and hydrologic analyses of the city. We obtained a detailed, ten-year record of the occurrence and damaged caused by floods, mudslides, landslides and obstructed rivers. Using this data, a map was drafted to delineate areas of risk for land-use planning.

The second lesson was that the risks could be quantified. From the map and collected data, individual hazards were identified and classified according to their cost and possible severity. That is, the technical team analyzed the cause of each hazard from the ten-year record and prioritized the risk according to its consequence, whether it would be relatively small or very extensive. The most severe hazards were notably landslides, mudslides, and floods. The team ascertained with a reasonable degree of confidence the total cost of damage. With this analysis, the team prepared a pre-investment program for risk reduction.

"With this minimal level of funding, disaster mitigation could be affordable, cost-effective, and within the realm of La Paz's needs."

The third lesson was that risk mitigation could be quantified and programmed. For every zone within city limits and for every type of risk, the imminence of each disaster was identified. With a detailed description of origin and consequence of each risk, the likelihood of a disaster was measured as possible, probable, or imminent. The team ascertained whether the hazard would occur during the next rainy season, or three to five years later. Risk reduction measures were defined and prioritized accordingly. These measures may have prescribed extending canalization, rebuilding containment walls, or cleaning up a river. The team screened the city and then prioritized a whole series of prevention/mitigation works. Disaster reduction consisted of constructing flood, landslide, and erosion control works along drainage basins, and setting up solid waste collection and equipment maintenance systems.

The project's final lesson was that risk reduction could be addressed with measures affordable to the city. After prioritizing the risk-reduction works, we calculated that disaster prevention and preparedness would cost $500,000 in 1987 and total about $2.5 million, or $2.50 per capita, if adequate maintenance was provided. This amount is far exceeded by annual losses from natural disasters, estimated at $8 per capital. With this minimal level of funding, disaster mitigation could be affordable, cost-effective, and within the realm of La Paz's needs. Once the work was prioritized, we looked at the institutional set up needed to accomplish the task. We realized that the city needed a special administrative structure, one that organized normal maintenance and investment procedures during the eight months of the dry season, and one that could shift its entire operational system for the four months of flooding and landslides during the rainy season. During months of high vulnerability, the administration would attend to emergency response and mitigation almost exclusively.

In addition, our efforts were directed at providing the municipal resources to achieve the project's objectives. With the project component to improve the municipality's management, revenues could be generated and technical capacity expanded to prepare and execute general urban development projects. The city's investment capabilities would grow. In 1985, La Paz, with its one million inhabitants, invested $300,000, or 30 centimes per capita. This amount is very small. Investment grew to $7.5 million in 1987, and we estimated that investment will reach $9.0 million in 1989. In fact, we calculated that the municipality could invest $18.0 million per year, or $18 per capita, a figure which is quite acceptable in view of the country's low income.

To ensure the project's success, a set of conditions for municipal and financial management was established. These conditions were attached to the credit agreement as a part of the "Investment in Modernization Program." The objective of the exercise was to support works in hazard reduction through technical assistance and financial and municipal management. In particular, disaster management and emergency readiness was to be institutionalized within the municipal government. Agencies responsible for different aspects of disaster reduction were coordinated into a coherent organizational framework, contingency plans to facilitate communications following a disaster were prepared, and an early warning system was established. In additional, civil servants would receive training on various disaster-related topics, and a pilot program to educate and involve the community in disaster prevention and preparedness activities was set up.

Perhaps the La Paz Municipal Development Project could not measure up to Californian standards, but it could certainly reduce the loss of life and obviate considerable damage to public and private property in La Paz.