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Linking Climate Change Adaptation and Disaster Risk Management for Sustainable Poverty Reduction

Mexico Country Study

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- A study carried out for the Vulnerability and Adaptation Resource Group (VARG) with support from the European Commission

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Foreword

This report has been produced as part of the project 'Linking Climate Change Adaptation and Disaster Risk Management for Sustainable Poverty Reduction', funded by the **European Commission** on behalf of the **Vulnerability and Adaptation Resource Group (VARG)**. VARG is an informal network of bi- and multilateral institutions aiming to facilitate the integration of adaptation to climate variability and change into development processes through sharing of information and experiences.

The report is based on a review of secondary information, a series of meetings, interviews and follow-up communications with experts in México, and discussions during an international VARG workshop in Geneva, Switzerland in October 2006 hosted by United Nations International Strategy for Disaster Reduction and sponsored by DFID, DGIS, GTZ, OECD and SIDA.

We are extremely grateful for the assistance and continuing input given to the project by all the country experts consulted, VARG and the participants in the international workshop (see Appendix 2).

The findings from this study and the country studies in Kenya and Vietnam are summarized in the synthesis report for the project.

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- German Agency for Technical Cooperation (GTZ): international workshop
- Organisation for Economic Co-operation and Development (OECD): international workshop
- Swedish international Development Cooperation Agency (SIDA): international workshop

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List of Acronyms and Abbreviations

CENAPRED	National Centre for the Protection of Disasters
CESPEDES	Centre for the Study of the Private Sector and Sustainable Development
CIESAS	Research Centre for Social Anthropology, México
CICC	Inter-Ministerial Commission on Climate Change
CICY	Centre for Scientific Research in Yucatan State
CNA	National Water Commission and National Meteorological Services
COLMEX	El Colegio de México
DFID	UK Department for International Development
DRM	disaster risk management
DRR	disaster risk reduction
ENSO	El Niño Southern Oscillation
EWS	early warning system
IADB	Inter-American Development Bank
INE	National Institute of Ecology
INEGI	National Institute for Geographical Statistics and Information
INIFAP	National Institute of Forestry, Agricultural and Animal Research, México
IPCC	Intergovernmental Panel on Climate Change
FONDEN	National Fund for Natural Disasters
FOPREDEN	National Fund for the Prevention of Disasters
GCM	global climate model
OECD	Organisation for Economic Cooperation and Development
MDG	Millennium Development Goal
NGO	non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
SEDSOL	Ministry of Social Development
SEGOB	Ministry of the Interior
SEMARNAT	Ministry of Environment
SENER	Ministry of Energy
SINAPROC	National Civil Protection
SST	sea surface temperatures
UNAM	National Autonomous University of México
UNDP	United Nations Development Programme
UN-ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UN-ISDR	United Nations International Strategy for Disaster Reduction
UNFCCC	United Nations Framework Convention on Climate Change
VARG	Vulnerability and Adaptation Resource Group

1. INTRODUCTION

This report has been produced as part of the project 'Linking Climate Change Adaptation and Disaster Risk Management for Sustainable Poverty Reduction', carried out for the Vulnerability and Adaptation Resource Group (VARG) with support from the European Commission. The general objective of the project is to assess, within a poverty reduction perspective:

- how and under which conditions can current disaster risk management practices help prepare for climate change;
- under which circumstances does climate change require changes in disaster risk management approaches;
- what lessons can be learnt from the exercise that could inform wider adaptation policy.

The project uses grounded examples in México, Kenya and Vietnam and exchange of experiences across those contexts to provide insights into how a more integrated approach to disaster risk management (DRM) and climate change adaptation can be built. The country studies are designed to identify the extent to which current disaster management practices reflect future adaptation needs and assess what changes may be required if such practices are to address future risks, especially in low-income settings. Although risk assessments form part of the studies, we place the emphasis on the institutional capacity and constraints/opportunities within the policy process. Each study is based upon a review of secondary information and a series of interviews and meetings with a number of agencies, researchers, government departments and NGOs during a five-day visit by members of the project team. Following initial analysis of these findings, further comment, feedback and input was received from country experts, several of whom subsequently participated in an international VARG workshop held in October 2006 at which the findings and implications of the studies were discussed.

This document consists of five sections. Section 2 provides a national overview of present and future risks from extreme weather events and current approaches to DRM and climate change adaptation in México. This is followed in Section 3 by a case study designed to illustrate at a finer scale the implications of climate change for DRM approaches and practice. Drawing on the previous sections, Section 4 then presents an institutional analysis (for the country as a whole), assessing progress in integration of DRM and climate change adaptation and setting out a series of factors that may be contributing to or hindering that process. The concluding section, Section 5, commences with a summary statement on the extent to which present approaches may help prepare for climate change, before presenting a series of preliminary recommendations as to how approaches may need to change in order to meet future challenges. Key points discussed in the latter sections are also listed in tables, including a final summary table listing the main issues and possible means by which they could be addressed.

NB The usage of terms relating to risk, vulnerability, disaster management and adaptation in this report is based primarily on standardized definitions provided by the United Nations International Strategy for Disaster Reduction (UN-ISDR). Please see 'Working Terminology' at the end of the document (Appendix 3).

2. OVERVIEW

2.1. COUNTRY BACKGROUND

Established as an independent country in September of 1821 and with a federal constitution in February of 1917, México is a Federal Republic and has a Presidential democracy. The Republic is formed by thirty-one Federative States (Figure 1), with 2,430 municipalities, and a Federal District (México City as the capital), which is made up of 16 political delegations. The total population of México is currently around 102 million (UNDP 2004) and, according to the National Council on Population (CONAPO, 2000), the rate of population growth is around 1.2% (Table 1). The total area of México covers 1,972,550sq km and although the average density is 51.7 people per sq km, there are great disparities between states (CNA-SEMARNAT 2002).

With a per capita GDP of US$ 6,500 in 2004 (OECD 2006), the highest per capital income in Latin America, México is classified as a middle-income country. Although gains have been made in health and education, low and inequitable growth has kept overall poverty rates high (Verner, 2005). México still faces huge inequalities between rich and poor, north and south, urban and rural. A report on Mexico's progress towards the Millennium Development Goals suggests that major social inequalities remain, reducing adaptive capacity (UNDP, 2005). According to 2000 data, 53 percent of the country's population is poor (living on less than $2 per day), while close to 24 percent is extremely poor (less than $1 per day). The rural population is currently 24.8% of total compared to 75.2% of total as urban population, and the poor are mainly focused in rural areas (Verner, 2005). México State has the highest population and the highest population growth is found in the States of México, Quintana Roo, Aguascalientes and Baja California. Some of the poorest States are Chiapas, Veracruz, Oaxaca and Yucatan (World Bank Southern States Development Policy, 2003). Although the 1994-1995 financial crisis thrust millions of Mexicans into poverty, there has been rapid progress in building a more modern, diversified economy, with some investments towards improving infrastructure and tackling the root causes of poverty. Despite this progress, achieving the Millennium Development Goals remains a challenge for México.

Figure 1. Map of México

México has a more open economic and political system than in the past and is integrated with the world economy. The country has been a member of the North American Free Trade Agreement (NAFTA) for ten years and belongs to the Organisation for Economic Cooperation and Economic Development (OECD). It has investment grade in the financial markets, regulated macroeconomic management, which has managed to keep the economy relatively resilient. The GDP stood at US$ 619.4 billon in 2004 (OECD, 2006), with 4.1% agriculture, 26.4% industry (manufacturing, mining, energy and construction), 20.5% commercial (including tourism), 10.5% transportation and communications, and 38.5% from services and financial sectors (INEGI, 2006).

The Mexican government has chosen to focus on administration, infrastructure and the environment to increase competitiveness, strengthen institutions and provide environmental sustainability and resilience to risk. The country is vulnerable to natural hazards, including earthquakes, drought, tropical cyclones and volcanic activity. The World Bank has estimated that during the past decade, as much as 35% of México's lending earmarked for infrastructure has been diverted to pay for the costs of (Mexican) natural catastrophes (Freeman, 1999). Vulnerability to natural hazards is exacerbated by social and economic circumstances. Population and economic activities are inversely related to water availability with less than a third of total runoff occurring within the 75% of the territory where most of the country's largest cities, industrial facilities and irrigated lands are located. This has resulted in over-pumping of aquifers and disputes over water supply (González and Magãna, 2006). The arid nature of some of México's Central and Northern States means that water availability is a constant pressure, such that the droughts caused by unusually dry spells have substantial impacts on the economy and environment. Therefore, irrigation is not economically viable in some regions, increasing agricultural vulnerability to drought.

México suffers from a number of environmental problems arising from the vast amount of deforestation that has taken place in order to create agricultural and cattle ranching land (US Library of Congress, 2005). Soil erosion has become a serious problem in México because of the arid nature of the climate. In 1985, the government classified almost 17 percent of all land as totally eroded, 31 percent in an accelerated state of erosion, and 38 percent demonstrating signs of incipient erosion (US library of Congress, 2005). Without vegetation cover, topsoil is easily lost in high winds of flooding which often accompany tropical cyclones. The removal of ground cover also increases vulnerability to landslides, which often occur when hurricanes bring heavy rainfall. These impacts greatly affect the subsistence livelihoods of the rural poor.

In 2001, nearly 18 million were engaged with agricultural activities, a figure that has been declining (Presidency of the Republic, 2002). Livelihoods tend to consist of agriculture, livestock breeding, fishing, small business, temporary work and manufacturing industry labour supply. Over 28% of México is agricultural land, although most remains owned by commercial agribusiness. The legacy of struggles for land by the poor still dictates local land use patterns and management options. Another 28% is forest and 20% is rainforest, while over half is poor-quality scrubland often used for extensive grazing.

Table 1. Summary characteristics:

POPULATION	102 million	GOVERNANCE SYSTEM	Presidential democracy
GDP US$ PER CAPITA	6,500 (2004)	NUMBER OF STATES	31 and Federal District
LIFE EXPECTANCY	73.6 years	AREA	1,972,550sq km
LITERACY RATE	90%	RURAL - URBAN	25% - 75%
ACCESS CLEAN WATER	88%	MORTALITY RATE <5YRS	24 per 1000 (2004)

2.2. CLIMATE HAZARD AND DISASTER PROFILE, AND POTENTIAL CLIMATE CHANGE IMPACTS

2.2.1. Current climate patterns (means)

México is split roughly into two climatic regions along the Tropic of Cancer. The North experiences mean annual average temperatures of 20-24°C, with cool temperatures in winter months and a hot summer. The South has a more uniform tropical climate with hot conditions throughout the year and an annual average temperate of 24-28°C. Rainfall varies widely, with season and location. Most regions receive between 600-1000mm per year, with some experiencing arid or semi-arid conditions (receiving only 300-600mm per year), whilst the wettest regions of the southeast receive over 3000mm per year (Magaña *et al.*, 1999; CENAPRED, 2001).

2.2.2. Current climate extremes (observed)

Along with landslides and forest fires, México is prone to drought, flooding and tropical cyclones. These are considered the main hazards associated with climate change and variability (Bitrán, 2001; CENAPRED also document the principal disasters in an annually updated series). Rainfall in México varies inter-annually and with season and location. Many regions, particularly in the north and central regions, have arid or semi-arid climates, and already experience substantial pressures on their water resources and frequent drought. When rainfall does occur, it is often intense, causing flooding, landslides and soil degradation.

The El Niño Southern Oscillation (ENSO) heavily influences the inter-annual climate variability and inter-annual rainfall variations in México. In El Niño years, the seasonal rainfall cycle is stronger, with higher probabilities of more intense winter precipitation in northern México and less summer precipitation over most of the country. The reduced summer precipitation that often occurs during these periods has caused severe droughts in past years. Most notably the 1997/8 El Niño event caused México to experience its driest year since 1945. The drought was marked not only by its longevity, but also by its geographical extent, as most of the country was affected. March to May is generally dry over most of México, but these months were extreme, with most areas recording less than 20 percent of their average rainfall.

México lies within both the North Atlantic and Eastern Pacific tropical cyclone belts. Both coast lines are affected annually between June and November, bringing sea surges, high winds, heavy rain, landslides and coastal and riverine floods. Tropical cyclones in the region are classified according to air pressure or wind strength, ranging from tropical depressions (wind speeds up to 62 km/h) through tropical storms (62-118 km/h) to hurricanes (more than 118 km/h) (Rosengaus *et al.*, 2002). Hurricanes are further classified, following the Saffir-Simpson scale, into categories 1-5, with the most powerful (category 5) developing wind speeds of over 250 km/h. Individual cyclones tend to rise and fall between categories as they progress across the region.

According to CENAPRED (2001), in an average year, four or five tropical storms and hurricanes are likely to make landfall in México and cause severe damage. Whilst both México's east and west coasts are vulnerable to tropical cyclones, those affecting the East coast tend to be most frequent and more violent. Table 2 gives an indication of the return periods for hurricanes and named tropical storms for a number of locations on México's east coast. According to CENAPRED (2001), the percentage of population potentially at risk from tropical cyclones is highest in Baja California Sur, Sinaloa, Colima and Jalisco on the west coast and Tamaulipas, Campeche, Yucatán and Quintana Roo on the east coast.

ENSO affects tropical cyclone activity, with El Niño events bringing mixed fortunes for México. The strongest known relationship between El Niño occurrence and tropical cyclones is a decrease in risk for activity and intensity during El Niño years over the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico (Landsea et al, 1999). Conversely, over the eastern Pacific Ocean, off the western coast of Mexico, the probability of the number of intense tropical cyclones increases during El Niño summers.

Table 2. Return periods for hurricanes and named tropical storms for locations in Mexico

CITY	BRUSHED/HIT	AVERAGE BETWEEN DIRECT HITS	LAST IMPACT (PREVIOUS IMPACT)
Cancun (Quintana Roo)	2.50 years	11.25	October 2005-Wilma (1995-Roxanne)
Merida (Yucatan)	2.60	9.64	July 2005-Emily (2002-Isidore)
Cozumel (Quintana Roo)	2.81	7.5	October 2005-Wilma (2005-Emily)
Tampico (Tamaulipas)	5.19	13.50	October 2000-Keith (1996-Dolly)
La Pesca (Tamaulipas)	6.13	19.28	October 2000- Keith (1995-Gabrielle)
Vera Cruz (Veracruz)	10.38	67.50	October 2005-Stan (1955-Janet)

[Source: Hurricanecity, undated]

2.2.3. Impacts of current climate extremes

Climatic extremes have widespread impacts on Mexican society, economy and environment (Bitrán, 2001). México is already sensitive to variations in rainfall, especially those brought about by El Niño events. Drought is the most significant impact for most regions, with water deficits in summer droughts generating shortages for domestic use. The 1997-98 Mexican drought affected most areas of its economy and up to 50% of México's deciduous forest was damaged by drought and forest fires (IPCC, 2001). Much of the agriculture in México is rain-fed and therefore highly susceptible to the variability in rainfall from year to year. In terms of the livelihoods of the poor, the impact of drought on fisheries and agriculture can be particularly severe, such as maize production (USGCRP, 1999). Small-scale farmers in the dry-regions are particularly vulnerable, for whom irrigation schemes are not economically feasible and the access to resources such as credit, information, technological assistance and crop insurance is limited (Eakin, 2005). Naturally dry conditions and variable rainfall regimes also makes the land vulnerable to desertification, largely caused by deforestation and the use of inappropriate farming approaches (Working Group on Climate Change and Development, 2006).

The impacts of tropical cyclones are not limited to the destructive effect of high winds. The strongest tropical cyclones affecting México in previous years have often been characterised by storm surges and heavy rainfall causing widespread flooding, wave damage and landslides (CENAPRED, 2001). The worst disasters (such as Hurricane Gilbert, 1988; Hurricane Opal, 1995; Hurricane Isidore, 2002) have affected hundreds of thousands of people across several states. The 2005 North Atlantic Hurricane Season was particularly anomalous, bringing three highly destructive tropical cyclones to México, starting with Hurricane Emily, which affected both southern and northern states on the east coast in July. In October 2005, Hurricane Stan caused flooding in seven Mexican states, displacing 370,000 people. Stan was followed just 18 days later by Hurricane Wilma, which hit México's Yucatan peninsula, bring further heavy rainfall and extensive flooding, and displacement of over 300,000 people. More recently in September 2006, Baja California was hit by category 2 Hurricane John, causing sea surges and damages estimated at $60.8million (the impacts of tropical cyclones are discussed in more detail in section 3).

2.2.4. Climate change projections and implications

The projected changes in temperature and precipitation, as simulated by a range of socio-economic and General Circulation Models, are shown in Figure 2 for the period 2070-2099 for Central America (IPCC Data Distribution Centre 2005). Results from these climate models show increases in temperature of between 2°C and 8°C, but depend upon scenario, location and season (and it should be noted that these increases derive from models that have been argued to have large systematic biases). Projections in temperature suggest an increase by 8°C for Northern México and 6°C in Central México. Changes in precipitation for México are more uncertain, ranging from a slight increase (+5%) for all seasons to a major decrease (as low as -40%) for all seasons. These suggest that a marked reduction in rainfall in most seasons is most likely, but with a likelihood of increasing and possibly more intense precipitation during the wet season (IPCC Data Distribution Centre, 2005). Further significant changes in climate may possibly occur through changes in the regime of ENSO with climate change: though evidence at present on this is highly uncertain, some climate scientists have suggested there may be increases in the strength, duration and/or frequency of El Niño events.

The dominant impact for México is likely to be a combination of the increases in background temperature (leading to increased evapotranspiration) and overall decreases in annual average precipitation, which are likely to result in severe pressures on available water resources, especially in the interior. Drought and desertification will be a particular concern in areas that are already experiencing reduced water availability. Should El Niño events also intensify with changes to ENSO, this may result in yet more incidences of major drought.

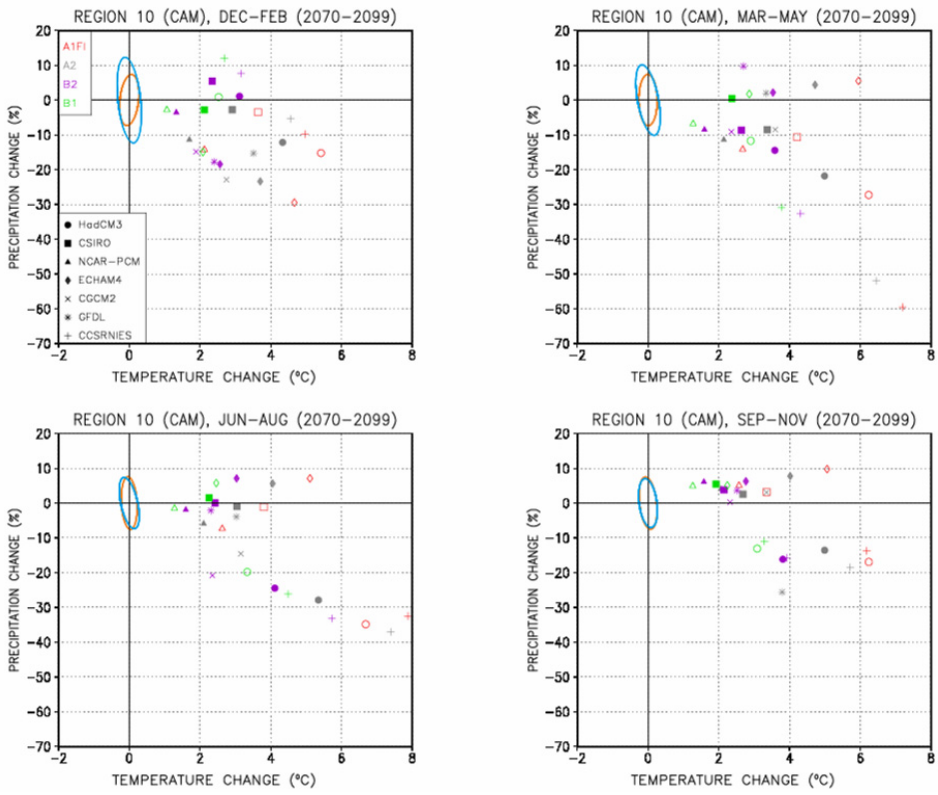


Figure 2. Projected changes in temperature and precipitation for Central America

(IPCC Data Distribution Centre, 2005)

There is still scientific debate over the link between tropical cyclone intensity and human-induced climate change (Dunion and Velden, 2004; Walsh, 2004; Trenberth, 2005). Notably, the 2004 and 2005 Hurricane Seasons in the region were extremely active with sixteen and thirty named storms

respectively. However, both interannual and interdecadal variability make it difficult to identify long-term trends. There are two key questions to consider: will tropical cyclone intensity change; and will tropical cyclone frequency increase as a result of a changing climate? Changes in either of these will strongly impact upon the climate change risk associated with México.

There are a number of factors to suggest that intensity at least is likely to increase, but limited evidence to suggest that frequency will increase. The physics of the climate system suggest that more energy available will produce more favourable conditions for tropical storms and hurricanes to develop and enhance their strength. One observational study suggests a marked increase in intensity of tropical cyclone activity during the past 40 years in the Caribbean (Emanuel, 2005). Other observational changes on sea surface temperatures (SSTs), which are closely linked to tropical cyclone energy, also support a proposed change in intensity and possibly frequency. The SSTs in the Caribbean during 2005 were at record levels (greater than 32ºC, coincidentally spawning a major coral bleaching event), and there has been an observed increase in SSTs both in the Caribbean but also off the West coast of Africa where they are spawned (Emanuel, 2005). Tropical cyclones are spawned in regions where SSTs are greater than 26ºC: as this area expands as a result of rising temperatures, the geographical extent of as the area in which tropical cyclones exist is also likely to grow. Some climate models show an increasing shift from category 3 storms, up to category 4 (Figure 3) (Knutson and Tuleya, 2004; Pielke *et al.*, 2005; Hoyos *et al.*, 2006).

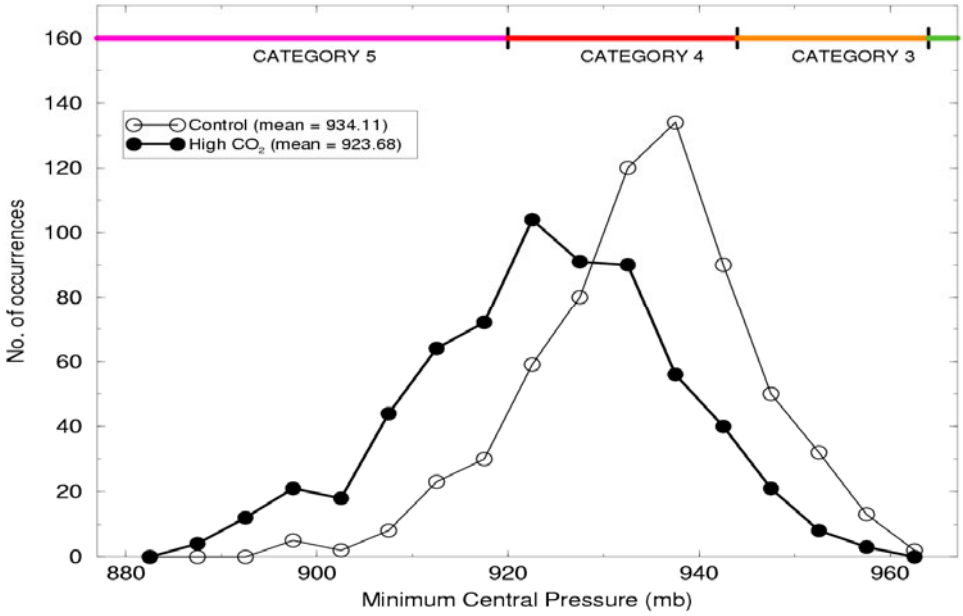


Figure 3. The change in the likely occurrence of different categories of Caribbean hurricanes as a result of climate change

(Emanuel, 2005)

The inter-annual future patterns of tropical cyclones are likely to be complicated still further by any changes in ENSO, given the strong links that have been demonstrated between current tropical cyclone activity and El Niño events. These are likely to bring mixed fortunes for México under a changing climate. Potential increases in strength and/or frequency of El Niño events under a warmer climate would indicate that during El Niño years, tropical storms and hurricanes striking México from the west (Pacific) may increase in frequency/intensity whilst the risk from those from the east (Atlantic) may reduce in those years. However, it is important to stress again that the underlying future trend is likely to be an increase in tropical cyclone risk for both coasts in most years.

2.2.5. Impacts of climate change: weather extremes and vulnerability

CENAPRED/CEPAL have sought to illustrate a link between climate change, the occurrence of weather-related disasters, and their effects on poverty and, using data from 1980-2005, show an increasing importance of hydrometeorological phenomena (with a growing socio-economic impact) directly proportional to climate change (Bitran, 2001, p.10). Drought increase is likely to become one of the most consequential issues for México if warming occurs as climate models predict. The human and social costs of drought are likely to increase because there is no reconstruction process that may have a positive economic impact in terms of generating investment and employment. Iincreased drought occurrence is likely to put further pressure on water resources, especially in the arid central and northern regions, where water resources are already stretched (Conde and Gay, 1999). This will impact severely on agriculture, causing problems for subsistence and commercial farmers and also damaging the wider Mexican economy through reduced yields in crops for export, such as maize and coffee. Studies using crop models have demonstrated yield losses of up to 60 percent in maize (IPCC, 2001) and up to 78 percent reduction in coffee production (Gay *et al.*, 2004), which will disproportionately impact the poor. Farmers and ranchers in the northern states of México may be more vulnerable to climate change impacts than those of the southern states of the US (Vasquez-Leon *et al.*, 2003) because while a multi-year drought is considered as a problem that causes economic losses in the U.S., in México, the event may mean catastrophic loss of livelihoods and severe suffering for the rural population. The ongoing problem of desertification in México also exacerbates vulnerability to climate-related water shortages and crop failures as land fertility is reduced further.

Pressure on water resources in the future are likely to be heightened further by projected increases in population and industrial growth. Whilst population growth rates have slowed significantly over the last few decades, overall rates of 1.18% are still notable, particularly as this growth is greatest in Central and Northern regions, and urban areas, where water resources are under most pressured (Conde and Gay, 1999). México's cities are densely populated, and high poverty rates (53 percent) means that overcrowding, inadequate hygiene and lack of sanitation already cause considerable health problems (CEPAL, 2004). If urban population continues to increase this problem will become worse, and conditions are likely to deteriorate as temperatures rise and drought-related water shortages increase (Gonzáles and Magaña, 2006).

Though the effect of intensified El Niño events will be a complicating factor, overall there is likely to be an increase in annual tropical cyclone risk from both coasts of México (Goldenberg *et al.*, 2001; Bitrán, 2003; Bell *et al.*, 2006). Recent years can be seen as indicative of how a changing global climate may enhance existing threats in Mexico, and that increased level of tropical cyclone threat may be one of the earliest effects of climate change for the region (although it is important to restate that much uncertainty remains regarding tropical cyclone activity and variability over time). All forms of tropical cyclone can be highly damaging: though not as powerful as hurricanes, tropical storms can bring very high levels of rainfall and subsequent floods. Together with risk to human life and health, strong winds, waves and floods threaten to damage physical infrastructure, disrupt transportation and other sectors, and damage homes, crops and livelihoods. Changes in the intensity of tropical cyclones are likely to cause ever greater losses, and may undermine recovery efforts leading to vicious circles of increasing vulnerability, despite improved early warning systems. Present and future impacts of tropical cyclones on agriculture, housing and livelihoods are addressed further in section 3.

Climate change may also exacerbate the effects of future hydro-meteorological hazards in a more indirect way, by increasing underlying vulnerability, especially of the poor. If changes in mean climate conditions create pressures, for example, on smallholder farming livelihoods, they can under-

mine the income, resources and ability of farmers to cope when disaster events occur. Climate change may also alter the underlying distribution of disease pathogens and their vectors. Many regions of Latin America are expected to experience increases in occurrences of diseases such as malaria, dengue and cholera (IPCC, 2001), each of which has the potential for outbreaks following hazard events such as storms, floods and drought. Particularly concerning for México, is the projected shift in geographical distribution of dengue fever, which suggest increasing probability of dengue epidemics (Gagnon *et al.*, 2002, Hopp and Foley, 2001).

2.3. APPROACHES TO DISASTER RISK MANAGEMENT IN NATIONAL POLICY

México has developed a national system for disaster risk management that now comprises the formal and informal interactions between government-linked institutions, financial mechanisms, regulations and policy, as well as community-driven initiatives and the role of nongovernmental organisations (Freeman *et al.*, 2003). México is also part of the sub-regional disaster reduction organisation, Centro de Coordinación para la Prevención de los Desastres Naturales en América Central (CEPRDENAC). This subsection outlines some key disaster risk management institutions operating in México and discusses their approach.

2.3.1. Ministry of the Interior, General Directorate of Civil Protection of Government and the National Civil Protection System (SINAPROC)

Civil Protection was founded in 1986 as a Federal response to the 1985 earthquake disaster in México City and provides the central structure for coordinating disaster interagency response activities, as well as rehabilitation and reconstruction at federal and sub-national levels (Figure 4). It has some capacity for pre-disaster planning, especially in terms of emergency preparedness but less for long-term disaster risk reduction. This system requires the mobilisation of linked institutions and skills: for example, the National Meteorological Service, National Water Commission (CNA) and the Ministry of Environment and Natural Resources (SEMARNAT) provide direct technical support. Between May and November, observation and related telecommunications networks constantly monitor weather systems, providing updated satellite imagery every 30mins. These bulletins and warnings are passed on to Civil Protection three times each day, who then alert civil defence units in the risk zone. Application of technologies is promoted for prevention and mitigation, training given and advice on protection and preparation in case of a disaster disseminated (SEGOB, 2005). There is a particular responsibility for protecting lives, restoring public services and homes and many on the ground activities are linked with external NGOs.

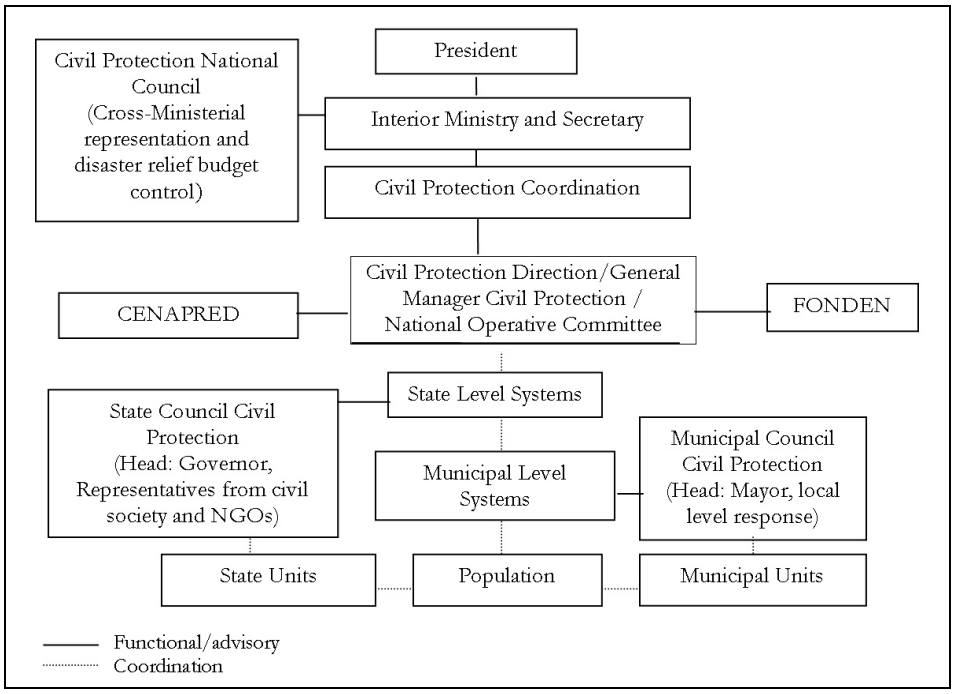
Researchers at CIDE (Center for Research and Teaching in Economics) and UNAM recently assessed the institutional design and organisation of Civil Protection and its implications within decentralisation policies (Arellano-Gault and Vera-Cortes, 2005). They concluded that it currently has a fragmented perspective of disaster management and should develop a more open approach to public participation and engagement.

Although overseen by the Ministry of Interior, governance by the Civil National Protection Council (created in 1990) approves policies, practices and resources allocated to disaster research, public education (through education systems and disaster prevention) and response programmes. The council is also charged with influencing State Disaster Laws, relationships with other public agencies and controls spending of the Disaster Relief Budget through the State Systems of Civil Protection. The Finance Ministry controls the Disaster Relief Budget each year. The legal framework of Civil Protection Activities was issued in April 2000. The specialised role of the army within the structure

allows the imposition of military rules and decision-making structures during emergencies and within 'disaster zones'. A guide to disaster prevention (SEGOB, undated) and a colour-coded system of alerts, with increasing states of emergency, are linked to actions coordinated by SINAPROC:

- Pre-warning – possible disaster – local authorities to begin preventive actions;
- Warning – imminent disaster – preparedness for search and rescue;
- Alarm – damage occurring – local emergency declared;
- Emergency – health/security risk exceeds state capacity – start emergency programme;
- Disaster – key structures damaged in more than one state – president declares disaster, Federal response measures required.

Figure 4. Organisational structures of Civil Protection



(after Arellano-Gault and Vera-Cortés, 2005)

2.3.2. Ministry of the Interior, National Centre for Disaster Prevention (CENAPRED)

The National Centre for Disaster Prevention (CENAPRED) was established in 1990 to complement the Civil Protection system by furthering research, training and technologies that would help the government prepare and respond to disasters. The Centre was funded by the Japanese government following the 1985 earthquake in México City. Chaired by the Interior Minister, CENAPRED's board is composed of representatives from Federal Ministries and determines the centre's research agenda and appointments.

The majority of employees are engineers and natural scientists. As a result, the organisation has focused on earthquake, landslide and volcano hazard. More recently, CENAPRED has attempted to assess technical input from other sources on more diverse risks, including floods and tropical cyclones (though there remains only a limited focus still on drought). A hazard diagnosis tool for risk has been produced, together with a methodology for a risk atlas at State and Municipal level. It is being developed to assist in identifying areas of high vulnerability to hazard, improved instrumentation of early warning systems. CENAPRED is responsible for disseminating scientific information to various stakeholders and participates in international knowledge management (e.g. with UN-ISDR).

Other activities include weather-related monitoring, development of meteorological radar, assessment of the vulnerability of infrastructure to different types of hazard and analysis of government performance in relation to socio-economic indicators. The most recent technical tool developed is an early-warning system called System of Hydro-Meteorology Warning (SIAT), which includes a System of Alert for Tropical Cyclones (SIAT-CT). SIAT is designed to assist government agencies in immediate disaster planning actions, especially to give early warning of flooding.

Uniquely, CENAPRED has attempted to bridge the gap between academic research and government, for example by channelling research applications developed university researchers (at UNAM) to the Ministry of the Interior and pursuing an active dissemination approach (Bitran Bitran, 2001-3). Since 1995, CENAPRED has participated in government Scientific Advisory Committees, increasing communication between scientists and policy makers working on disaster risk management. The Hydrometeorology Committee assesses weather-related disasters and advises SINAPROC on prevention tasks, while the Social Sciences Committee covers urban planning, migration patterns and economic planning. CENAPRED participates with the international policy community (e.g. the coordination of the Mexican report for the UN-ISDR in 2005 that outlined México's existing commitments as the National Programme of Civil Protection 2001-2006, the National Development Plan 2001-2006, development of institutional networks, loss models and financing, improved integration between mitigation and coping) (CENAPRED 2004).

2.3.3. Disaster funds and financial risk transfer mechanisms

In 1996, the government established a **Natural Disasters Fund (FONDEN)** for post-disaster reconstruction of non-insured public infrastructure (schools, hospitals, roads and bridges), areas of environmental value and compensation to low-income producers for crop and livestock losses or housing damage (UNDP, 2000; Kreimer *et al.*, 1999). FONDEN attempts to limit the impact of costly disasters on budgeted programmes of development as payments are triggered by government declared disaster. Supported by the Ministry of Finance and Public Credit, the financial tool includes three instruments (a revolvable fund, program and trust fund). There are limits to the amounts distributed per beneficiary and rules, such as livestock owners eligible only for drought payouts when cumulative rainfall is below either 50% of its historical average or historical minimum for two consecutive months (Ministry of Finance, 2000). The use of parametric rules for triggering payments has helped to remove an ad hoc dimension in the declaration of catastrophes. Temporary employment programmes, which are generally part of the relief effort, could be structured to implement mitigation measures such as stronger infrastructure in wind-prone areas or to build flood protection.

The development of a **new Fund for the Prevention of Disasters (FOPREDEN)** was put forward by CENAPRED, UNAM and COLMEX in 2002 to address concerns with FONDEN (Skees *et al.*, 2002, and forthcoming report by COLMEX), and was brought into law by 2004. Unspent funds from FONDEN are not returned to the government at the end of the year, with FOPREDEN receiving the main percentage and FONDEN a smaller percentage. COLMEX has recently evaluated FOPREDEN's design for coherence and priorities aimed at reducing vulnerability through prevention. Congress defines the budget (70% fund, 30% state resources) with applications coming from different levels of government (e.g. for risk identification/GIS, social awareness, infrastructure, capacity building and community participation), although not all areas have put forward proposals.

In the past, budgetary allocations to FONDEN have not been sufficient to cover obligations, with needs often double the available budget (e.g. 1998 budget of $227million, $500million spending requirement) (Kreimer *et al.*, 1995). Shortfalls are often made up by diverting funds from other government budgets but

the process of transferring cost through government purchase of disaster insurance, essentially for the trust fund, is now underway (FONDEN interview and presentation). Contracting transfer of risk through insurance policy in México, known as catastrophe insurance or bonds, solves the problem of relying on the state of the national economy and increases potential reserves. Transferring risk by issue of bond in the international capital market with characteristics similar to reinsurance could then be released to government after a disaster otherwise the principle and investment would be retained (Miller and Keipi, 2005). FONDEN could also establish a line of credit with a financial institution (Mechler, 2005). The World Bank established a Disaster Management Facility in 1998 to assist countries such as México with management of natural disaster risk, in collaboration with other organisations (e.g. UN-ISDR).

In addition to formal financial risk transfer mechanisms, subsistence farmers practice **traditional weather risk management** and have developed local stages of reducing, mitigating and coping with these risks (e.g. self-insurance through the accumulation of buffer stocks or diversification of income generating activities, including collective projects, varying cropping practices/resistant technologies or undertaking seasonal migration, marriages across regions, investment through borrowed funds). At the household level, risk reduction consists of reducing vulnerability to an existing risk by mitigating its potential impact on an individual's physical integrity, assets and income. Given that vulnerability is often the result of collective choices (location, group activities, public infrastructure, environmental degradation), risk reduction strategies to natural disasters at the household level are limited. Although smallholder farmers tend to use low risk – low return technologies, subsistence farmers using rainfed cropping depend on a single growing season and those with small land holdings are forced to rely on remittances to cover losses (Skees *et al.*, 2002). For small farmers, insurance needs to reflect the agricultural production and diversity of their farm and livelihoods.

Mutual farmer organisations, or *Fondos de Aseguramiento*, tend to be commercially-oriented small farmers and there are over 200 in operation across México. *Fondos* collect premiums creating reserves to pay indemnities and cover operational costs. However, in the event of disaster weather events the reserves are not sufficient to cover the losses, breaking the coping mechanism. Research by the World Bank identified drought, excess humidity and frost as the main perils, but risks depend on the location and so some are exposed to more than one weather hazard (e.g. flooding and tropical cyclone damage) that may increase in frequency with future climate change. ASRCA is an agency housed in the Agriculture Ministry and provides technical advice and guaranteed price for crops and until recently AGROASEMEX sold crop insurance directly in competition with private providers by transacting a weather derivative based on crops and regions. Government risk management and emergency aid programmes have also crowded out most private sector initiatives, which can lead to risk taking and dependency on public disaster relief (Skees *et al.*, 2001; Hess *et al.*, 2003). Government social welfare programmes, such as OPORTUNIDADES, are designed to assist vulnerable rural communities. At the community level, the level of investment in disaster mitigation and preparedness is less than optimal because activities are limited to storage (for water/food during tropical cyclones), land terracing (for direct flooding) and differences in perceptions of risk within a community create difficulties in expectation (Charveriat, 2000).

2.3.4. Other contributing agencies

The Ministry of Environment and Natural Resources (SEMARNAT) has over 30,000 staff with 60% based in state delegations. The Natural Disaster Management Project financed policy and institutional reforms aimed a reducing vulnerability of infrastructure and communities to natural disasters, and capacity building activities to strengthen environmental and sectoral implementing agencies (Ministry of Finance, 2000). SEMARNAT's Environmental Management Plan means projects must

have no significant adverse environmental impacts that could exacerbate risk. A regulation to deal with procedures arising from natural disasters is used to train technical committees that manage FONDEN state resources. In addition, an ecological zoning programme will be linked to SEDESOL's land use zoning programme to provide a better basis for environmental assessment and location of infrastructure. Likewise, Ministries dealing with urban development, housing and health have recently improved a number of regulations.

The National Water Commission (CNA) and SEMARNAT are responsible for water management and drought response together with Agriculture. Basin councils created between 1994 and 1999 coordinate cooperation between federal, state or municipal governments. Included are various organizations that represent the users of the water in each watershed.

INEGI provides statistical geographic, demographic and economic information on México and coordinates the Information Development Programme, providing public service for statistical and geographic information. The Ministry of Public Education initiated a pilot scheme disseminating public information about disaster risk in Guanajuato, Nuevo Leon, Quintana Roo, Puebla and Tlaxcala.

The UNEP Latin America and Caribbean Region produced the GEO Environment Report (2003) for Latin American and the Caribbean included an initiative for Sustainable Development (ILAC), which included goals of introducing an environmental dimension in national social and economic development, as well as encouraging practical measures for reducing urban vulnerability to natural disasters. UNDP and UN-ISDR have no country offices but support associated projects (UNDP 2005a/b).

The Mexican Red Cross (MRC), founded in 1910 focuses on disaster preparedness training and emergency response, in particular saving lives and providing emergency heathcare. It has over 25,000 members, a board of directors, volunteers with over 6000 staff, and a national assembly. Funding comes from national fund-raising, the lottery and state collections. There are 486 delegations across México and although autonomous, they are not independent. This territorial division of activities permits the MRC to exercise a local approach and respond more quickly to disasters. For example, there were 300,000 external volunteers available in 2003. Emergency operations by the Disaster unit are coordinated with State and Municipal level Civil Protection and the Army, although the MRC makes its own evaluations of need. Since 2004, MRC has been working with CENAPRED for a manual on natural disasters.

2.4. APPROACHES TO CLIMATE CHANGE ADAPTATION IN NATIONAL POLICY

México signed and ratified both the *United Nations Framework Convention on Climate Change* and its *Kyoto Protocol*, as a non-Annex 1 Party and the Government has delivered two national communications on its actions and programmes on climate change and some sectoral reviews (GHG emissions inventory 1994-1998, advances concerning climate change 2001-2002, México and Climate Change, National Energy Balance by SENER 2003, Federal Electricity Commission Reports, National Commission for Energy Conservation Reports, Petroleos Mexicanos Reports, Summary report to WCDR Kobe for development of National Platforms for UN-ISDR). These form part of the assessment toward developing a national adaptation plan of action (SEMARNAT 2001). Other signed agreements include a Letter of Intention between México and the Republic of Korea, CDM Netherlands, CDM Japan Bank for International Cooperation, Memorandum of Understanding between México and Spain to cooperate on CDM activities under the scope of Article 12th of the UNFCCC Kyoto Protocol and UN agency regional activities. There are also a number of environmental, energy and health regulations and government programmes that consider the implications of climate change (Table 3).

Table 3. Regulations and Programmes that include climate change reference

ENVIRONMENTAL	> Political constitution of the United Mexican States - Articles 4, 25, 27, 73, 115 (natural resource ownership and preservation) > General Act for Ecological Balance and Environmental Protection > Forestry Act and General Act on Sustainable Forest Development > Sectoral program of agriculture, livestock, rural development and food 2001-2006 > National Forest Program 2001-2006 > National Water Program 2001-2006 > Soil Conservation and Restoration Program > National Program of Environment and Natural Resources 2001-2006 > Research through the Water, Environment and Society Research Program (PAMAS), the Mexican Institute of Water Technology (IMTA), National Water Commission > Pollution/emissions research carried out by Environmental Information System (SIMA), National Center for Environmental Research and Training (CENICA), Environmental Quality Center (ITESM, CCA), Metropolitan Environmental Commission.
ENERGY	> Political Constitution of the United Mexican States - Articles 25, 27, 28. > Ruling Act of Article 27th of the Constitution concerning oil > Public Electricity Service Act > Energy Sector Program 2001-2006 > Act for energy use in the agriculture sector (Ministry of Agriculture) > Research and Technology Development Program of the Energy Sector 2002-2006 > Strategic energy research is carried out by Electric Research Institute (IIE), Mexican Petroleum Institute (IMP) and the Mario Molina Center.
HEALTH	> Ministry produced series of state-level programmes related to public health
OTHER	> Act of the Federal Public Administration - organizational basis for centralised and decentralised administration, as well as Federal agencies, particularly the Ministries of Energy (SENER) and Environment and Natural Resources (SEMARNAT). > Federal Act on Metrology and Standards - framework for technical mandatory standards > National Autonomous University of México (UNAM) - climate change modelling, environment-social linkages, vulnerability and adaptation options (e.g. Energy Research Center (CIE), Atmospheric Sciences Center, Research Center on Ecosystems, Institute of Sea Sciences and Limnology, Institute of Ecology, Institute of Geography, Institute of Engineering, and Programs on Energy and the Environment). Links with Inter-American Institute for Global Change Research (IAI). Vulnerability to climate change - Center for Scientific Research and Higher Education of Ensenada (CICESE), Northwest Center of Biological Research (CIBNOR), Interdisciplinary Center of Marine Sciences (CICIMAR-IPN), College of the South Border (ECOSUR) and Advanced Studies Research Center – Merida Unit (CINVESTAV). El Colegio de México – weather-related disaster in Coahuila (2004), and Yucatan and Tamaulipas (hurricane “Emily” 2005). > INE research with UNAM on urban health atmospheric pollution, greenhouse gas emissions in the México Valley Metropolitan Area, scientific and technological capacity, vulnerability and regional adaptation, future water management and mechanisms to substitute irrigation, cost of transfer, and increasing demands by the growing urban population. Other focal areas: land use changes resulting from climate change, structural territorial reorganisation, improvement in early warning systems for El Nino, hurricanes and flood to understand trends and assist with longer term decision making, and mechanisms to enhance participation of the poor in strategies > CANCUN Association of Hotels, Emergency Plan for Tropical Cyclones 2005

(Source: http://www.ine.gob.mx)

In April 2005, an Inter-Ministerial Commission on Climate Change (CICC) was established as an authority coordinating national policies development on climate change (Figure 5). The CICC is responsible for incorporating adaptation actions across different sectors, developing legal frameworks to achieve this and updating commitments to the UNFCCC. SEMARNAT is responsible for coordinating climate change policy through the CICC and the Mexican Committee on GHG emission reduction - Clean Development Mechanism/sequestration projects (a working group of the Commission created in 2004) (Martinez and Fernandez, 2004). More specifically the National Institute of Ecology (INE) created in 2001 within SEMARNAT is mandated to carry out this role, as well as promote (with the Ministry of Education) research and development cooperation, inventory updates, human resources and dissemination. In April 2006 the Ministry of Finance was incorporated into the CICC.

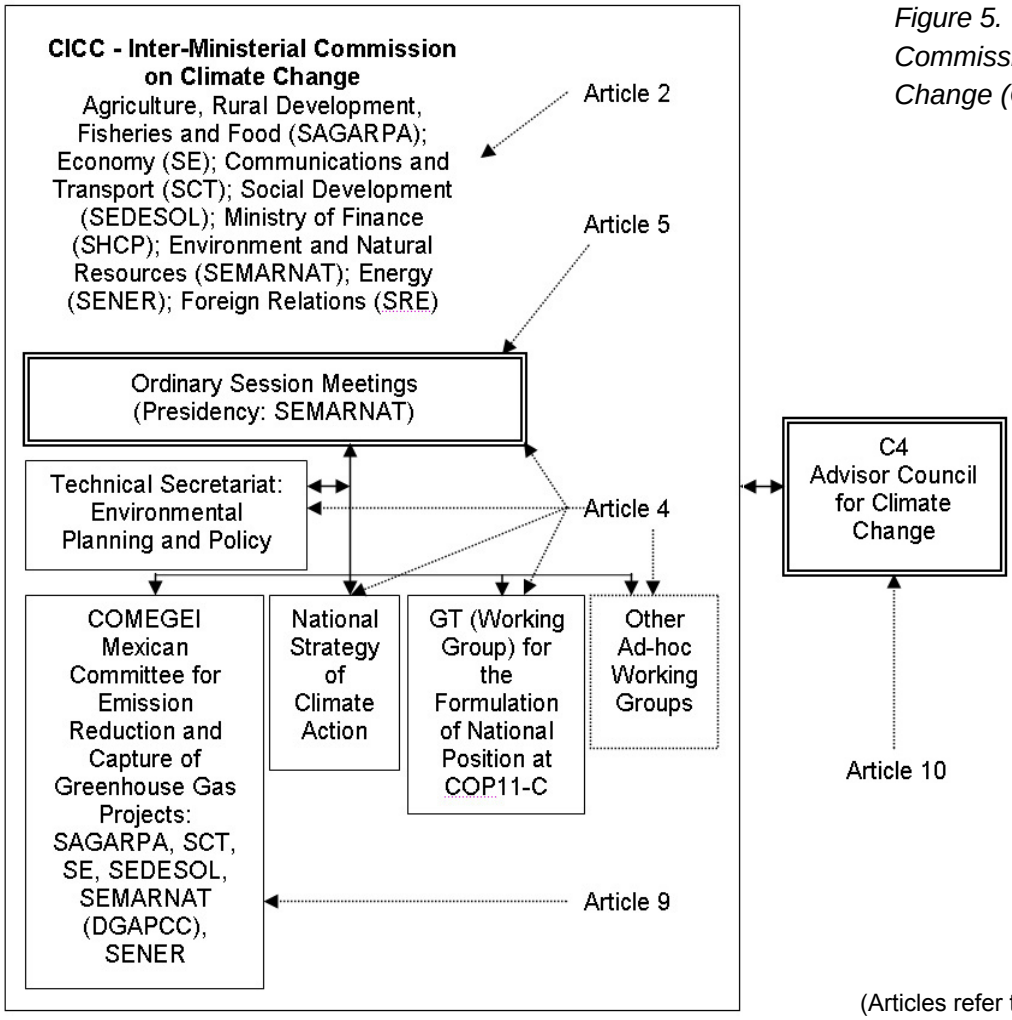


Figure 5. Inter-Ministerial Commission on Climate Change (CICC)

Some key areas of government poverty reduction strategy include strategies to reduce vulnerability to climate change with the National Development Plan 2001-2006. Verner (2005) highlights small farm sector intensification; improved employment opportunities in commercial agriculture; growth of rural non-farm sector; migration of the young; and provision of safety nets for those trapped in poverty. Upstream measures, such as safe location, design, construction of structures, infrastructure and settlement, education, health as dealt with separately to disaster management and seen as a development goals. Examples include: scientific advisory committees have been set up, standards for civil works initiated, engineering advances made, schools retrofitted to withstand high winds and

hospital readiness standards. Poverty reduction frameworks include the CONTIGO framework to integrate multiple dimensions of well-being and public action into a life-cycle approach, the OPORTUNIDADES program to target the extreme poor (with an emphasis on evaluation by SEDESOL) and the introduction of the *Ley de Desarrollo Social* is a potentially valuable attempt to institutionalize social development strategy and in particular provide more continuity across government administrations. These policies do not target income growth or informal enterprise in order to build resilience to climate disasters in the future.

Government programmes of decentralisation and liberalisation strategies have shaped institutional adaptation to drought in particular, changing the dynamics of future vulnerability to climate change risk. Besides the development of future climate change scenarios (IPCC, 2001; Magaña, 1999; Sanchez *et al.*, 2004), research at UNAM (Conde, 2003; Eakin, 2005) has highlighted how shifts in crop types in irrigation districts (from maize and wheat to crops such as alfalfa and tomatoes) consume more water, leading to a drop in the groundwater level. *Ejidos* operated areas (cooperative land tenure established after the Mexican Revolution) tend to experience higher crop losses to drought than private landowners with more than five hectares. Their vulnerability results from their less productive land allocations, less irrigation and poor access to credit or inputs. Institutional responses to drought include agricultural subsidies and emergency relief measures, with guaranteed crop prices. Financial restructuring has resulted in a significant decline in support, increasing uncertainty and associated environmental risks. The fertiliser parastatal FERTIMEX was privatised in the early 1990s and prices now near international market price. Vulnerability is compounded by less than 10% of farmers having crop insurance. Although agriculture contributes a small portion of México's GNP, it is important to rural stability and national political strategy. Drought exacerbates the effect of economic crises in the agricultural sector and stresses water supplies for rapidly growing cities, both leading to reduced capacity to adapt to climate changes and forcing many people to leave agriculture completely. Decentralisation of management, improvements in infrastructure and potential for seasonal climate forecasting have improved recovery.

Multi-lateral influences on development - World Bank Country Assistance Strategy 2005-2008 - examples of projects include on-going support to poverty reduction (primarily infrastructure, education, health), México Decentralisation Project (completed in 2001) and the Rainfed Areas Development Project (completed in 1999 enabling 28,000 farmers to invest in irrigation and drainage, soil conservation and livestock or crop production). There have however, been concerns that short-term investments increase vulnerability by raising exposure to drought but in the long-term (interview researchers at UNAM). Other significant regional influences include UN agencies such as the regional activities of the UN-ISDR to mainstream disaster risk reduction, UNEP, or UN-ECLAC.

3. CASE STUDY: YUCATÁN STATE

The state of Yucatán lies in the north of the Yucatán Peninsula in south-east México (Figure 6), a region that is particularly prone to tropical cyclones and associated hazards such as storm surges, flooding and forest fires. Because of the current and future risk from such hazards and their widespread impact on the livelihoods of the poor, the state was selected for a more detailed risk assessment and analysis of policy and practice, highlighting both how current DRM approaches may help to prepare for climate change and how they may need to alter. In this study, the focus of attention is placed particularly on protection of the livelihoods and assets of the poor in relation to potential increased risk in future from tropical cyclones. The aim is that the material in this section provides a case study example that will help ground and inform the national-level institutional analysis in section 4.

Figure 6. Location of Yucatán state

3.1. INTRODUCTION

Yucatán state has a land area of 43,183 sq km and a coastline of approximately 350km on the Gulf of México. Like most of the Yucatán Peninsula, the state is predominantly of low elevation (with few sites higher than 100m). The total population of the state recorded in the 2000 census was 1,658,210, with over 700,000 residing within the metropolitan area of the capital city Mérida. The census recorded one third of the state's population as ethnic Maya, biased in spatial distribution toward rural and economically marginalized areas. Of the economically active population of the state, 17.2% were in the primary (agriculture and fisheries) sector, 28% in the secondary (manufacturing) sector, and 54.6% in the tertiary (services) sector (State Government of Yucatán, undated a).

In terms of social and economic geography, the principal contrast is between the state's main urban centre and its largely rural hinterland. Indeed the city of Mérida and surrounding region is the largest and most economically diversified centre in the entire Yucatán Peninsula (State Government of Yucatán, undated a; Peña Chapa et al, 2000). Its expansion originated from economic activities related to henequen (natural fibre from agave) production and processing and it now has mining, industry, commercial and service activities (Battlori *et al.*, 2000). Decline in the agricultural sector in the state has contributed to urban growth (State Government of Yucatán, undated b). The key trading port is Progreso which has helped increase economic growth in manufacturing, cattle farming and recently, with developments to the port's infrastructure, cruise ship tourism.

Though other small urban areas exist, most of the remainder of the state is rural, with an economy based largely on primary production – mostly agriculture (cattle, fruit, maize) and apiculture (Yucatán is México's top producer of honey), with fishing also in the northern coastal belt and forestry largely in the east of the state. In much of the rural hinterland the majority of inhabitants are Maya, with a heavy reliance on maize crops and subsistence agriculture. There tends to be relatively high out migration in these areas, especially of the young, with the growth of *maquiladoras* (assembly plants) in the Mérida area and the development of the major tourism centre of Cancun in neighbouring Quintana Roo (Battlori *et al.*, 2000; Eastmond *et al.*, 2000; State Government of Yucatán, undated c).

Yucatán state has the fourth highest level of poverty in México, with 37% of the population classed as living in extreme poverty (State Government of Yucatán, undated a). Though poverty exists in the Mérida area, it is in the rural hinterland of Yucatán state where it is most extensive, especially in areas comprised of local indigenous communities. The rural communities suffer from relatively poor transport, health and education infrastructure. Of the 106 municipalities that comprise the state of Yucatán, 77 are classed as of high marginality and 5 of very high marginality: almost 98% of the people who live in the latter are Maya (State Government of Yucatán, undated a). The eastern part of the state is the poorest. Poverty and economic marginalization have exacerbated the vulnerability of poor farmers to weather-related hazards (State Government of Yucatán, undated c).

3.2. HAZARDS AND VULNERABILITY

The major climatic hazard for Yucatán State, now and in the near future, is the passage of severe tropical cyclones (State Government of Yucatán, undated a). Tropical storms and hurricanes are an annual threat at present between June and November, and any adverse changes in their intensity of frequency in this region would exacerbate those risks.

Flooding from high seasonal (non-storm) rainfall also occurs in most years but tends to be a localized problem. Most of the Yucatán Peninsula has permeable limestone bedrock that supports few permanent rivers, although severe flash floods can occur in some localities. Drought risk is generally considered low at present and Yucatán State does not have major water deficits now (though distribution problems exist). However, some parts of the state experience a relatively dry climate and are marginal areas for agriculture (State Government of Yucatán, undated c), and following several months without rain in 2004-2005, parts of the state suffered decline in farming production and increased risk from wildfires. Climate scientists have pointed to the possibility in the future of changes in precipitation intensity and seasonality, resulting in changes in groundwater levels, and posing the possibility of increased risk from either or both of these types of hazard.

Given the particular importance of cyclonic weather systems for present and future disaster risk in the state, we focus here on the threat from hurricanes and tropical storms.

3.2.1. Tropical cyclones: current risk

Yucatán state is one of several Mexican states that are frequently exposed to the impacts of hurricanes and tropical storms. These include storm surge damage along coastlines, wind destruction, high water levels and flooding from extreme rainfall, and increased danger of forest fires in subsequent dry seasons (Konrad, 2003). The highest risk areas tend to be along the northern coast, in the east of the state (where tropical cyclone strikes are most frequent) and in the far south, where hilly terrain and a convergence of river catchments has caused flash floods with depths of up to several metres.

As well as bringing risk of death, injury and disease, and damage to homes and infrastructure, these hazards have major effects on the livelihoods of the poor. Many subsistence maize farmers are at particular risk because the growing season for their crop coincides with the storm season. Maize cultivation is often combined with beekeeping, which can be severely affected by high winds that strip pollen from trees and damage beehives. Catches of octopus – one of the major catches for small-scale fishermen – can decline by as much as two thirds following major tropical cyclones, and high winds and waves threaten to damage fishing boats. After the passage of major cyclones, the risk of forest fires is typically heightened in the following dry season, because of the accumulation of dead wood on the forest floor.

Table 4 shows the dates and nature of major hurricanes that have been recorded in the state since the 1950s. Other storms that have hit the state reached hurricane strength at later stages of their track, including Hurricane Brenda (1973), Hurricane Diana (1990) and Hurricane Opal (1995).

Table 4. Recent hurricanes that have impacted on Yucatán

HURRICANE	YEAR	DATE OF ARRIVAL	STRENGTH ON ARRIVAL
Charlie	1951	August 20th	category IV
Hilda	1955	September 17th	-
Beulah	1967	September 17th	-
Gilbert	1988	September 15th	category V
Isidore	2002	September 22nd	category III
Emily	2005	July 18th	category IV
Wilma	2005	October 22nd	category IV

(Sources: CENAPRED/National Hurricane Centre, NOAA)

It is illustrative to record in more detail the impacts of some of the major tropical cyclones that have affected Yucatán in recent years.

Hurricane Gilbert 1988

Hurricane Gilbert, a category 5 storm, was one of the most powerful on record with winds up to 250km/hr, and brought widespread disaster to Yucatán state. Damage across the Peninsula was estimated at between 1-2 billion dollars (US) and over 60 000 homes were destroyed (countrywide). Most damage in Mérida was caused by flooding. Hurricane Gilbert produced between 4.5m and 6m of surge along the Yucatán coast. Maize production declined to 10% of the normal annual figure in 1988 due to the effects of the cyclone, and the event led in part to an economic downturn in the state (State Government of Yucatán, undated c). Its passage also reportedly damaged important fisheries in Yucatán, such as octopus.

Hurricane Isidore 2002

Hurricane Isidore hit Yucatán state on September 22nd 2002 as a Category 3 storm. It was unusual in that it took a southerly deviation as it moved north of the Yucatán Peninsula, causing a direct hit on Yucatán state (figure 7). Its minimum central pressure of 934 mb occurred at 1200 UTC 22 September, just before landfall near Puerto Telchac on the north coast of Yucatán. Hurricane Isidore stalled over northern Yucatán for 36 hours, gradually weakening to a tropical storm before exiting back into the Gulf of México. During that time, it caused immense impacts across the state, with severe damages reported in 85 of the 106 municipalities (State Government of Yucatán, undated d). The coastal sea surge and heavy rain resulted in much of the coastal zone and low lying agricultural land in the hinterland becoming flooded. Maximum flood levels of more than 6m depth were reported in flash flood sites in the south of the state (Goldacker *et al.*, undated). Across the state nearly 36,500 houses were destroyed and 22% of all homes were damaged (State Government of Yucatán, undated d). Nearly a third of all fishing boats were damaged. Physical damage in the poor rural communities was extensive, with many villages (pueblos) severely impacted and simple dwellings destroyed by Hurricane Isidore's winds. Though there was no loss of life from injuries or drowning, outbreaks of cholera were reported, linked to disruption in the clean water supply.

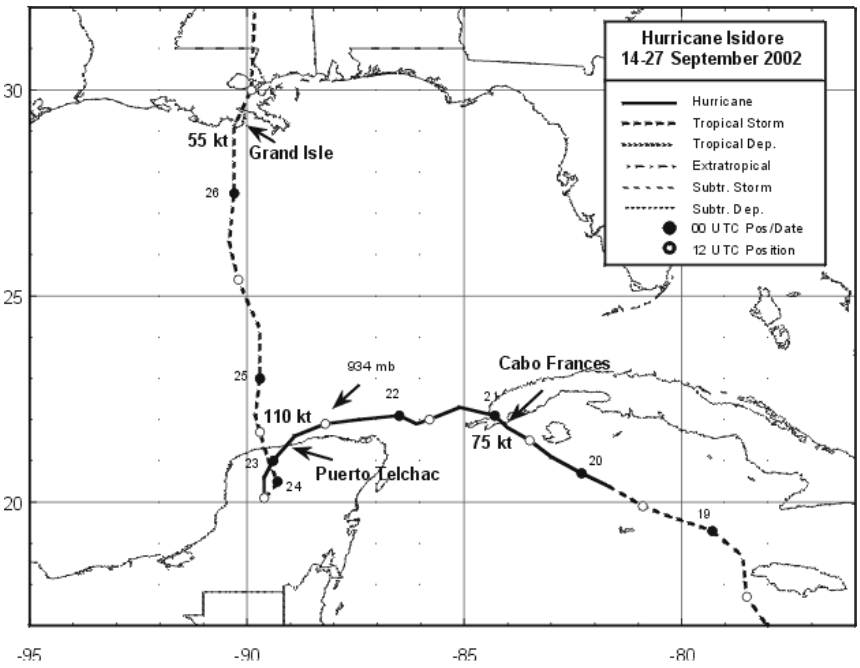


Figure 7. The track of Hurricane Isidore, September 2002

Note the strong southerly deviation as the hurricane moved in a north easterly direction that resulted in the hit on Yucatán State (Avila, 2002).

Most economic sectors were severely damaged by the hurricane, but losses were especially high in agriculture (State Government of Yucatán, undated c). There was loss of over 70% of some crops, widespread deaths of livestock and loss of agriculture infrastructure. Ku Vera and Rodríguez Buenfil (2003) report that 8.2 million poultry were killed (41% of the state's total for that year); 70,000 pigs; and 140,000 beehives were lost (50%) across the state. 75% of pig farms were damaged and 70,000 pigs drowned. 90% of cattle farms were damaged in Tizimín municipality (where the hurricane made landfall). The state government estimated the total cost of damages caused by the disaster in all sectors as 7.3 billion pesos (State Government of Yucatán, undated d).

Hurricane Emily 2005

Hurricane Emily crossed the north of the Yucatán Peninsula on 18th July 2005, entering as a category IV hurricane from the east (CENAPRED, undated). The storm had been tracked across the Caribbean and the entire state was put on alert the day before. Almost 36,000 people were evacuated to shelters. During its 4-hour passage across Yucatán state, Hurricane Emily diminished in strength to category I, but still caused major damages, largely from powerful winds (Emily did not result in major floods). Disaster was declared in 52 municipalities, and 11 of these received a total of over 500 million pesos of aid from FONDEN. No loss of life, injury or disease outbreaks were recorded, but nearly 11,000 homes were severely damaged, over 58,000 tonnes of crops destroyed, 41,000 beehives damaged and 3,000 livestock farming units were affected, with the highest rates of loss in the east of the state. Hurricane Emily was one of the earliest of a series of tropical cyclones that struck or threatened the Yucatán Peninsula in the 2005 season. A similar strength storm, Hurricane Wilma, also affected the east of the state in October that year: the forest destruction caused by the two storms was expected to lead to elevated fire risk in the east of the state in the following dry season.

3.2.2. Tropical cyclones: climate change and future risk

Tropical cyclones will continue to pose a threat to Yucatán State, and, though any intensification of ENSO may reduce risk in El Niño years, on balance the year-on-year magnitude of cyclonic hazards is likely to increase. As the climate system changes it is expected that the intensity of severe (Category 3-5) hurricanes will rise. It is difficult at present to assess whether frequency will increase; however, it can be argued that the conditions that spawn tropical cyclones will become more favourable as the atmosphere and oceans warm. In the 2004 and 2005 Atlantic Hurricane Seasons, tropical cyclones were extremely active, with 2005 having the greatest number of recorded tropical cyclones ever recorded for the Caribbean region: 27 tropical storms, of which 15 became hurricanes and 4 reached category 5 strength (including Emily and Wilma). Assessing future risk is made yet more difficult by the possibility of change in tropical cyclone trajectories through the region: part of the uncertainty in extreme event projections.

As a recent workshop held in Mérida underlined, though modelling difficulties and uncertainty remains, linked in part to inadequate access to long-term meteorological data for much of the state, it is a likely consequence that tropical cyclones in the Yucatán region will become more intense, more frequent and perhaps spread over a lengthening season in future decades (Orellana, 2006; Mariño, 2006). Should settlement patterns remain static, sea level rise may also contribute to the threat along the coast from storm surges (Ortiz and Mendez, 1999). It is likely therefore that there will be increasing exposure in Yucatán State to high winds, floods, coastal inundation and forest fires, posing a continuing threat to life, especially in the coastal zones, damaging shelter, infrastructure and assets and severely affecting the livelihoods of vulnerable populations in coastal and agricultural zones. Disaster risk is therefore likely to increase in this state, unless the severity of the hazard is counter-balanced by effective risk reduction measures.

3.3. CURRENT POLICY AND PRACTICE

3.3.1. Disaster management system

The State's structure for disaster management has developed greatly in recent years, particularly in terms of hurricane preparedness and emergency response, according to several commentators from national and local levels. Advances at the state level have to large extent been replicated at munici-

pal level. The impact of Hurricane Gilbert in 1988 was a major stimulus for an improved system of preparedness and the impetus was raised again after the next catastrophic disaster arrived in the form of Hurricane Isidore in 2002.

The state system of civil protection (Protección Civil de Yucatán), operating under an updated state civil protection law (2002), has the principal role for organizing disaster management in Yucatán and coordinating activity in the municipalities. A governing council with 60 representatives from different branches of state government and the private sector oversees the work of an executive unit based in Mérida (whose operational budget has increased from 300,000 to 8 million pesos since 2000 according to interviews with State Civil Protection). Local units also exist at municipal level, and the system is complemented with the involvement of voluntary groups and community representatives. Tropical cyclone risk and associated forest fires take up much of the system's attention, and the programme document detailing responsibilities, risks and actions for tropical cyclones is updated on annual basis (PROCIVY, 2005). The programme has three sub-programmes on 'prevention', 'aid' and 'recovery'.

The prevention sub-programme includes analysis of risks, training courses, communication, and preparation of alert systems and evacuation sites, as well as ensuring the organization is in place at state and local levels for emergency response. Most of this work is therefore equivalent to preparedness, an aspect of disaster management that reportedly has developed tremendously in the state in recent years. In the identification of risk-prone zones the CENAPRED risk atlas is now applied, and both physical and social aspects of vulnerability are taken into consideration. Dissemination of information to the public on hurricane preparedness includes annual leaflets and advertisements on television. A 5-colour tropical cyclone alert system has been introduced, and the state now has 1800 designated evacuation shelter sites in buildings such as town halls, schools and churches across all municipalities.

Tropical cyclone movements across the Caribbean are tracked using access to international storm monitoring systems, and as the alert level rises public warnings are issued through the media in Maya as well as Spanish. Evacuation announcements are issued from 36 hours before expected landfall and bus transportation is provided for evacuees that do not have access to private cars. Two forms of evacuation shelter exist: temporary shelters open just during the passage of the storm; and *'albergues'* for longer-term shelter while post-disaster assistance is required and damage to homes is repaired. During the emergency phase the civil protection system coordinates action across sectors, including the distribution of food, water and medical relief resources. Support from the Red Cross plays a key role in helping the state organize and undertake alerts, evacuation and relief.

Long-term relief activity and actions under the recovery sub-programme converge, as coordination of the provision of basic needs continues (PROCIVY, 2005). The disaster management system also includes action by the state administration to direct public funds for economic and social recovery. The state government undertakes evaluations of populations severely affected, issues disaster declarations and may solicit relief funds from federal sources such as FONDEN and FAPRAAC, as well as open new state-level programmes in housing reconstruction and support for farmers to restart farming activities. In conjunction with SAGARPA, for example, the state may assist low-income agricultural groups such as henequen and maize farmers and beekeepers (State Government of Yucatán, undated c).

From a relatively low baseline prior to 2000, the disaster management system in Yucatán appears to have made great gains. An effective structure for preparedness and response exists, and implementation on the ground is improving. A report by CENAPRED on Hurricane Emily praises the timely response to alerts and evacuation orders by government, business and the general public, and notes the consequent lack of any deaths or injuries. However, it also poses a caveat: 'there is still a long way to go in the field of preventive measures, hence it is recommended to take the success of this

experience cautiously' (CENAPRED, undated [2005/6], p72). The State Development Plan for Yucatán 2001-2007 endorses the civil protection system, and places strategic importance on ensuring the programme is promoted across state sectors, in the municipalities and in society at large (State Government of Yucatán, undated a). It lists 4 main objectives and 3 policies to strengthen civil protection, expressed in Table 5.

Table 5. Objectives and policies for civil protection in the current Yucatan Development Plan

OBJECTIVES	> Establish actions that mitigate the effects of disaster events. > Provide training, coordination and information on mitigation actions for the inhabitants of the State and the institutions related to civil protection, before, during and after events. > Promote in the judicial framework the modification of laws and regulations in order to harmonize procedures > Coordinate adequately the institutions responsible for public security in the State and others related to civil protection.
POLICIES	> Effective provision of attention and information to society, without discrimination, before and during disasters. > Efficient and adequate prevention to avoid natural disasters where possible. > Improvement of coordination among institutions involved in civil protection.

[Translated from State Government of Yucatán (undated a) p40-41]

Both in the objectives and the policies of the development plan there are references to strengthening measures for the mitigation and avoidance of disaster. Interviews and document sources strongly suggest that at present there remains a lack of capacity in the disaster management system for promoting preventive aspects of risk reduction, especially those designed to reduce or avoid losses to property and livelihood. The formal governmental structures for disaster management presently function principally in terms of preparedness, emergency response and recovery. Though sectoral authorities in the state clearly engage in policies and activities that contribute to the mitigation of disaster risk (see below), there has been less strategic cross-sectoral attention to such aspects of risk reduction - a situation largely reflecting the national structures in place for disaster management. In the State Development Plan for Yucatán 2001-2007, discussion of weather hazards and disasters is limited to the section on public security and civil protection strategies (State Government of Yucatán, undated a). Neither is there specific reference to long term risk reduction measures in the development plan's supplementary documents (including those on infrastructure, on health, and on agriculture and fisheries), with the sole exception of the State Environment Programme 2001-2007, where disaster prevention efforts are expressed principally in terms of monitoring of tropical cyclone risk and policies for ecosystem protection (State Government of Yucatán, undated b).

Though sectoral policies explicitly for tropical cyclone risk reduction for the poor and their livelihoods are not evident in the state, there are many sectoral activities that incorporate risk reduction actions and the need to build them into disaster management is widely recognized within and outside government. A recent case study of a drinking water system in the north of Yucatán, for example, argues the cost-effectiveness of tropical cyclone mitigation measures for the water supply infrastructure (García Sosa and Espadas Solis, 2004). There have also been elements of risk reduction in recent local-scale development projects in Yucatán. Some of these governmental and non-governmental activities will be highlighted in the discussions that follow in this section.

3.3.2. Climate change adaptation

To date, climate change adaptation has had a low profile within Yucatán state: indeed climate change itself is not mentioned anywhere in the state's development plan or its supplementary documents, including the environment programme. Though we know of no state-level policy or institutional structures concerning climate change *per se*, we do note recent political and academic activities and an externally funded project that relate explicitly to climate change concerns.

Interviewees noted that the State Governor in Yucatán has recently engaged in discussions of climate change adaptation needs, including attendance at an IPCC Working Group II meeting held in Mérida in January 2006. Shortly after the IPCC meeting, several Yucatán politicians and government staff took part in a series of round table stakeholder discussions on climate change risks and responses as part of a symposium organized by the Centro de Investigación Cientifica de Yucatán (CICY). Such engagement of key politicians could provide an important impetus for the process of integrating future risk into present disaster management. It was suggested that political interest in adaptation is stronger in the south and south east of México, because current exposure to tropical cyclones has made politicians more sensitive and aware to potential climate change risk. Interviews with sectoral government staff also indicated a growing attention to climate change in long-term planning, especially within the environment sector, which is trying to have greater influence over other ministries to promote more sustainable investments that take into account future disaster risks.

One of the major limitations to taking forward an adaptation agenda has been the supply of climate information and data, particularly from some parts of the Yucatán region (Orellana, 2006). Nevertheless, research activity on climate risk, climate variability and modelling of climate change in Yucatán state is under way at institutions in Mérida (e.g. CICY, Centro de Investigación y Estudios Avanzados, Universidad Autónoma de Yucatán) and in Mexico City (e.g. UNAM). Researchers working on the region were brought together in Mérida in January 2006 to attend the symposium noted above on Climate Change and its Consequences for the Yucatán Peninsula. Much of this work is focusing explicitly on tropical cyclone patterns and trends in the region, including a new initiative recently commissioned by INE. Scientific knowledge gained from such research will aim to provide an underpinning for progress with adaptation efforts including education, awareness-raising and risk management. A government interviewee also felt there was a need for studies on the links between climate change, tropical cyclone risk and disease incidence, in order to establish if preventive health measures in pre-hurricane periods should to take into account change in risk (to date only limited reports by the Health Authority INSP have covered malaria and dengue fever).

Since 2003, UNDP-México has been working in the Yucatán region, with support from government, on a participatory project designed to foster local risk management capacity in the face of present and future hazards. The Local Management of Risk in the Yucatán Peninsula Project has worked in 100 communities in 10 micro-regions, including four zones of Yucatán state. The aim has been to strengthen and develop local management plans and capacity in activities such as evacuation, emergency relief and health care, damage assessment and economic recovery, and to establish a network of trained local-level experts in disaster management. International funding is currently being sought to expand the geographical scope of the project and build in an explicit attention to potential changes in hurricane risk resulting from climate change (UNDP México, 2005a).

3.4. ADAPTATION NEEDS/OPTIONS

On the positive side, there is an existing momentum toward more holistic disaster management in major recent advances within Yucatán state, manifested to date especially in terms of tropical cyclone preparedness and efforts to reduce risk to human life. There are also growing efforts to integrate future change in risk into disaster management efforts overall (disaster risk reduction at different time scales).

Notably, there is an existing flexibility built into the civil protection planning process, with the recognition that the tropical cyclone programme must be yearly updated prior to each hazard season to reflect changing parameters of various drivers of hazard and vulnerability, including population/settlement changes, new constructions and changes in watercourses. Such flexibility of approach in current disaster management procedures may facilitate the incorporation of adaptation to climate change into planning, given the continuing uncertainty over the precise nature of that change.

On the other hand there is likely to be an increasing impact of tropical cyclones and associated sea surges, floods and fires in the state that are likely to put stronger pressure still on lives, assets and livelihoods of the poor. The possible threats from elevated intensity and frequency of tropical cyclones were highlighted by the record season of 2005, which repeatedly activated the state's alert system, prompted large-scale evacuations and caused major damages (even more so in states close by such as Quintana Roo and Chiapas). The heightened tropical cyclone activity has raised the perception that risk may already be rising in the short- rather than the long-term. There may also be changes in seasonal rainfall patterns, possibly bringing more frequent floods or drought, exerting yet more pressure in sectors such as small-scale maize agriculture that are already struggling on the economic margins. Arguably, climate change heightens a broader need for long-term and preventive risk reduction actions in different sectors, including both structural and non-structural mitigation. The following are a series of specific issues that need to be addressed if current disaster risk management practices are to be applicable to future weather-related risks (*see also the list of key points in Table 6*).

Mainstreaming holistic DRR

The concept of holistic disaster risk reduction is written into the civil protection programme, but the current institutional structure does not appear to have the capacity, resources and political mandate to drive and coordinate mitigation action at present. The system has become effective at protecting lives – a tremendous achievement in itself – but less so the assets on which people depend. Moreover, the gains that have been made in enhancing civil protection appear to have rested partly on the commitment of key individuals in the state system, whose position itself may be at risk because of electoral cycles. Given the long-term nature of climate change, enhancing adaptation may require investment not only in broader risk reduction measures, but in staffing and institutional structures that can provide assurance of continuity between administrations, including plans that have legalized status. It also requires a recognition that risk reduction and adaptation is 'the work of everybody – all government agencies and all citizens' (interview with state official).

Protection of livelihood assets

By broader risk reduction, we are referring especially to pre-event stages of the disaster management cycle (prevention, mitigation and preparedness) and to actions geared not just toward protecting lives but also to protecting shelter, property and the resources on which household income depends. Protection of such assets is especially critical for the rural poor. In principle emergency protection of these could be included in preparedness and alert messages – e.g. how to shelter live-

stock safely, protect fishing boats and temporarily secure homes to protect them from wind damage. To some extent advice on these is provided by sectoral government, including information campaigns to farmers and fishermen by the Ministry of Agriculture, Rural Development, Fisheries and Food. INIFAP have also produced fact sheets for farmers on recommendations from forecasts and how to start their own monitoring networks. But there is also scope for more permanent mitigative measures to protect infrastructure, homes, equipment, crops and livestock.

Structural measures and land use planning

The vulnerability of coastal settlement in Yucatán to storm surge and sea level rise is likely to become an increasing topic of contention in the coming decades. During orange-level tropical alerts in the state municipalities along the entire coastal strip are likely to be evacuated. Presently, there are few coast protection structures along the shore, and their high-cost is likely to prohibit construction in any but the most densely-settled or urbanized sites. Some 200 million pesos have reportedly been spent on beach restoration at Cancun (in neighbouring Quintana Roo) after Hurricane Wilma, but there are insufficient resources to give the resort any improved level of beach protection. Experience of recent record years for tropical storms has also reportedly generated public reaction in the region to development in vulnerable sites and the cost and sustainability of maintaining settlement in high-risk areas. There may be a need for further government intervention in terms of ownership and possibly even the resettlement/relocation of communities. Resettlement has already happened for two communities in the south of the state after the flash flood devastation caused by Hurricane Isidore. But relocation is also costly, and raises major issues of land availability and its suitability for settlement. As a politically contentious action, it is also likely to require strong scientific evidence of levels or changes in risk. At least, it is recommended that there should be an increased commitment to see land use planning as a possible tool for risk reduction and adaptation.

Household-scale adaptation

Adaptation in terms of hurricane risk reduction can also be fostered at the individual household scale. Crop diversification and inter-cropping is likely to strengthen farming livelihoods against risk, reducing the chance that entire harvests will be lost to wind or flood damage. According to a state official, adaptive programmes need to focus especially on how to change farmers' attitudes – they tend to resist new ideas of what they should grow or how. Protective structures can be built for livestock and stronger and better-designed beehives can be less susceptible to storm damage (Rosales Gonzalez, 2002). Relatively simple modifications to housing have the potential to enhance protection of homes against possible changes in intensity of tropical cyclones. Dickinson and Castillo (2003), for example, report on a participatory housing innovation project in San Crisanto on the Yucatán coast. Initial experiments in building low-cost stilt houses received a boost after Hurricane Isidore made landfall close to the town in 2002, bringing widespread flooding and property destruction. The stilt houses proved resistant to the wind and water damage. State government and the Red Cross has also worked with communities in Yucatán to repair and reduce damage to dwellings, and encouraged people to build stronger homes in the first place. In an interview, a representative of the Red Cross stressed the benefits of participatory work at local level in terms ownership and sustainability of household risk reduction measures.

Traditional coping capacity

Another possible adaptive strategy stressed by some interviewees was the possibility of learning from the past, especially from the traditional practices of the Maya who long lived with tropical cyclone risk using relatively simple technologies. Presently public policies seldom draw on traditional coping mechanisms – in part, reflecting popular demand for modern materials and methods. Konrad (2003), Faust and Bilsborrow (2000) and García Acosta (2002) have stressed the adaptive nature of former Mayan society. Traditionally, Maya avoided risky areas with their settlement patterns, especially coastlines. Farming systems were complex, with a mixture of intensive and extensive techniques and crops, possibly as a buffer against natural hazards. Among the traditional practices still in evidence in Maya today, housing is perhaps the most prominent. Many domestic dwellings are still constructed in the traditional Mayan styles, including houses with rounded walls and roofs that are better able to withstand storm winds. Traditional palm-leaf roofs are effective in regulating daytime temperatures and tend to be divided but not broken by high winds during storms. However, one interviewee pointed out that the heavy rain they can then let in to the house destroys modern possessions such as televisions, and the palm used to build the roofs is now becoming scarce. It is important to critically evaluate traditional practices, and recognise that society, environment and tropical cyclone hazard have undergone important changes, but it may be that efforts in long-term adaptation to risk for the poor still have something to learn from the past. Traditional water management technologies and skills are also seen to be able to complement modern practices, especially if drought and intense rainstorms also increase.

Integration with poverty reduction and sustainability

Finally, several participants in the study stressed that the key to promoting adaptation to future risk for the poor was to combine attention to poverty and vulnerability: to focus on strengthening wellbeing and income as a means of promoting long-term resilience. This approach to reducing vulnerability already has taken root: after Hurricane Isidore, for example, the government decided to provide chili and papaya seeds to small-scale farmers to promote alternative crops that are more profitable. If it can be combined with measures that can also mitigate physical damage and promote sustainability the approach is even more robust. Again after Isidore, a combined reforestation and conservation programme was established in the centre-north of the state to both re-plant and give long-term protection to the feeding sources for bees. The recovery or reconstruction phase after tropical cyclone events can therefore provide an opportunity for long-term adaptation with broader co-benefits for poverty reduction. In Yucatán, housing reconstruction programmes after tropical cyclones include provision of cement houses alongside typical houses of the poor. These houses have much improved sanitation facilities, and through a federal funded program, families are given health education tips and encouraged to use them. The houses may be lived in permanently or used as storerooms that provide temporary shelter during storms. These structures were developed together with the Yucatán College of Engineers and can withstand 400km/h of wind – significantly stronger than any storm yet recorded in the region.

Table 6. Towards adaptation in Yucatán

- Maintain momentum toward greater preparedness and risk prevention
- Continue to encourage flexible/updatable disaster management planning
- Extend actions toward protection of homes and incomes of the poor (assets and livelihoods) through both preparedness and mitigation
- Broaden understanding and ownership of risk reduction/adaptation agenda among people and government institutions
- Provide institutional structure and staffing with longevity to face the long-term challenges
- Consider greater use of land use regulations for risk avoidance
- Consider resettlement of communities in the most high-risk zones
- Strengthen resilience of small-scale agriculture through e.g. crop diversification and agroforestry; more robust equipment
- Strengthen resilience of dwellings of the poor e.g. through use of stilt houses or more wind-resistant structures
- Assess the potential of traditional coping mechanisms (low-cost) in farming, housing, water management to contribute to sustainable DRR
- Develop and promote adaptive practices that can simultaneously contribute to poverty reduction and sustainable development

4. INSTITUTIONAL ANALYSIS

This section combines findings from the desk review, the case study and discussions with key experts to explore more broadly at national-level the current progress in integrating adaptation and disaster risk management in México, across different sectors and weather-related hazards. Subsection 4.1 provides a summary of progress, discussing advances that are contributing either directly or indirectly toward inter-linkage. Subsections 4.2 and 4.3 then draw out a series of mechanisms (positive) and barriers (negative) that appear to have shaped how effective that process has been to date: for ease of comparison, these points are organized under a common set of themes.

4.1. PROGRESS IN INTEGRATION

In México, some progress has been made in **institutional integration** between DRM and climate change adaptation, with significant examples within SEMARNAT/INE and CENAPRED. SEMARNAT, with scientific support from the INE, has concentrated effort on improved **coordination**. This has been especially important for the creation and coordination of the Inter-Ministerial Commission on Climate Change (CICC), activities toward IPCC 4AR and the 3rd UNFCCC communication focusing on climate science, rural-urban environmental planning, vulnerability and emissions. However, reference to climate change adaptation in relation to extreme events is articulated in the 3rd UNFCCC communication mainly in terms of an increased need for a comprehensive disaster risk reduction approach (especially prevention, mitigation and vulnerability reduction).

The **identification and evaluation of risk** is the responsibility of CENAPRED and the centre has developed new technical approaches and hazard diagnosis, and has made progress with preparedness through early warning systems for rapid onset extreme events. INEGI also provides advanced hazard maps and vulnerability indices. CENAPRED argues that there is an urgent need to integrate assessments of underlying causes of risk and longer-term vulnerabilities with the hazard tools. Although it presently sees increases in social vulnerability as the main cause of increasing disaster risk, (Interview with officials from CENAPRED), such an approach may also be sensitive to the dynamics related to climate change. The new risk mapping system may be able to fulfil this role by providing a flexible adaptation tool that could be developed to improve capacity to prepare for and deal with future changes. These ideas are currently under discussion by State level Civil Protection directions. Close links between CENAPRED, INE, the Meteorological Service and university researchers at UNAM working on climate models and socio-economic behaviour has fostered inter-agency communication.

Flexibility – a key component of adaptation under conditions of uncertainty - is also evident in other areas of DRM and response. Although Mexican Civil Protection has a responsibility firstly for preparedness, emergency response and relief, with an emphasis on the protection of human life rather than broader aspects of disaster mitigation and vulnerability reduction, great improvements and awareness now exists (e.g. mortality figures following Hurricanes Emily and Wilma were extremely low). The structure operates at national, state and municipal level, offering a cross-scale network of communication. Particular improvements in flexibility at state level were highlighted in section 3, which describes the yearly updating process for the tropical cyclone response programme for Yucatán. Work with on-the-ground agencies has enhanced cross-sectoral capacity, creating joint disaster preparedness efforts to become more flexible and responsive at the local level. Civil Protection

has recently recognised the importance of embracing **community-based responses** (another key aspect of long-term adaptation). As existing governmental and non-governmental projects underline, it is important to build on existing coping and adaptation capacities of communities, especially in terms of improved livelihood resilience and adaptive capacity to risk (Eakin, 2005). For example, the PRESISMO special programme has sought to address local problems for the poor, CENAPRED and the Red Cross initiated a manual for on-the ground response operations, there are new regulations to ensure Civil Protection works with local communities (32 new laws) and economic enhancement strategies within the National Development Plan now provides for livelihood resilience (although several interviewees commented strategies these were perhaps too ambitious to be implemented).

Progress has also been made in **financial frameworks** for addressing longer-term reduction in vulnerability and better DRM, with advice from multi-lateral organisations such as the World Bank. While FONDEN has a focus on post-disaster evaluation of loss and relief spending, the newly created fund for disaster prevention FOPREDEN, is now able to part-fund projects aimed at reducing vulnerability and has recently been exposed to review. Integration is important because historically there have been fewer financial activities in risk prevention or risk mitigation than in preparedness and response (Interview with officials at UN-ECLAC).

4.2. CURRENT MECHANISMS/INCENTIVES

Drawing on the findings presented so far in this report, we highlight a series of existing mechanisms and incentives that are currently fostering integration or have the potential to do so (*see also Table 7*). These are listed under a set of themes common to each country study.

4.2.1. Climate and hazard information

Increasing science expertise and collaborative initiatives between academic researchers and government agencies provide mechanisms to integrate and improve information on climate and hazards.

The science base is growing, in particular the focus on hurricanes patterns and trends in the region, with a new initiative recently commissioned by INE. Both INE and CENAPRED have begun to develop reputations as a centre of excellence for science of hazard/risk and international networks. Climate science expertise has also improved and universities in both México City and the States, as in Yucatán case study, have established themselves amongst the leading experts in the region.

4.2.2. Communication of risk and planning tools

Communication of science on short-term and long-term risk is being enhanced through specific institutional initiatives, with information exchange in national and regional centres, and is being reflected in increasingly flexible planning tools for DRM.

Both CENAPRED and the INE communicate science to policy makers and the public thus providing a mechanism to better promote consideration of climate change impacts within the disaster and development agenda. Examples of this forum include current cooperation with the Red Cross for a manual on natural disaster prevention, with UNAM researchers contributing to models and adaptation options for the IPCC review and the building government awareness through consultancy projects. Civil Protection has begun to develop an updatable planning process, which can act as precursor to a flexible approach to adaptation: see the dynamic nature of civil protection plans in Yucatán State. There is also an in-built flexibility in information provision for risk planning in CENAPRED's on-going risk atlas.

4.2.3. Coordination

Integration is being improved through new structures and policy that facilitate inter-agency liaison and development of national and regional partnership networks

The Inter-Ministerial Commission for Climate Change is an opportunity for high-level institutional co-ordination and continuity and a chance to help build a culture of risk by mainstreaming at all levels and across all sectors. It is a potential mechanism for developing a tiered approach to identifying multiple stressors, as well as an opportunity to generate a more holistic policy on climate change adaptation. The INE, which has been chairing the CICC, has increased communication between Ministries and created a portal for information using GEF funds, which has greatly improved the information for those with internet facilities. The INE's collaborative initiatives offer a link between research, business and government. The National Development Plan for 2007-2011 can also act as a tool to improve linkage between DRM and climate change adaptation.

4.2.4. Political momentum and institutional capacity

Attention to the importance of integration has been heightened by recent extreme weather-related events, especially hurricanes and drought, with institutions becoming more open to an anticipatory approach and new cross-sectoral initiatives.

Recent disasters, especially during the tropical cyclone season of 2005, have helped to raise the profile of climate change in the political agenda. The threat of climate change and perceptions of increasing risk and vulnerability provide an opportunity to make further advances in risk prevention (e.g. a recent presidential statement on the dangers of 'reconstructing risk' after Hurricane Stan hit Chiapas and the State Governor's involvement in initiating agency/research coordination in Yucatán). There is recognition at policy level that integration of climate change adaptation into broader development across sectors, environment and disaster policies is necessary to address underlying vulnerabilities. International commitments through UN conventions create incentives for compliance in adaptation policy. A number of interviewees noted improved institutional adaptive capacity through the increasing recognition of a need for cooperation and an anticipatory approach by key actors. Civil protection is developing the political will needed to move from a reactive to preventative emphasis and has implemented flexible working plans accordingly at State level. Likewise, there are growing incentives for partnerships with multilaterals organisations to enhance local capacity and awareness with state policy makers (e.g. UN-ECLAC works on projects on poverty gendered livelihoods and property rights with water resources/UNEP has played a role in raising awareness of links between deforestation and catchment management).

4.2.5. Grassroots capacity and community involvement

Opportunities to build on traditional knowledge and increasing engagement of communities in disaster risk planning and vulnerability reduction, using a top down-bottom up perspective.

Cooperation also needs to be developed at the local level (Conde and Lonsdale, 2005). Local NGOs and multilateral resources already play an important role in involving communities to ensure investment in pre-disaster capacity/livelihoods rather than just disaster relief. The ongoing process of decentralisation and development of accountability in the state system will undoubtedly help local level work on adaptation and vulnerability reduction. NGOs in community conservation, livelihoods and disaster response already tend to focus on working with decentralised state and municipal governments, because this makes actions easier to coordinate and improve local adaptive capacity initia-

tives. Adaptations are often at grassroots level and the process of decentralisation offers the decentralisation of stakeholder involvement as well as the decentralisation of science (e.g. data tools, monitoring data compliance, capacity building etc).

4.2.6. Financing adaptation

There are mechanisms and incentives that increase options for financing adaptation/integration in existing disaster risk management policy in México.

Besides investment from national budget allocations (e.g. by Ministries of Energy Agriculture and Water), the development of private sector risk reduction and risk transfer mechanisms are beginning to provide incentives for disaster mitigation. Financial tools with a disaster risk reduction planning focus (e.g. FOPREDEN and FOPRAAC) offer a means of improving resources to include social development and adaptation to climate change in DRR. GEF funds has also been used to support policy development and awareness raising and these and other sources of international funding or regional partnership with donor agencies could be exploited to support national activities (e.g. UN Special Climate Change Fund, development banks). Although the promotion of insurance markets have not been targeted at disasters per se but at the consequences of a type of disaster (e.g. rainfall index), with modification the mechanisms have potential for different types of disaster (Dayton-Johnson, 2004).

Table 7. Existing mechanisms and incentives that have helped, or may help, foster integration

- Growing science base and development of contribution towards IPCC 4AR offers a mechanism for identification of priorities and agenda setting.
- Training workshops and specific forums via government agencies (e.g. CENAPRED) and academic centres that bring together specialists from different agencies and research centres for expertise and information sharing and the development of risk assessment planning tools (at both national and state level).
- In-built flexibility in risk planning and information provision (e.g. civil protection plans in Yucatán state or CENAPRED's proposed risk atlas).
- Use of structural mechanisms for information transfer and inter-agency coordination such as the INE.
- The Inter-Ministerial Commission for Climate Change provides a mechanism for inter-ministerial liaison and international commitments create incentives for compliance in adaptation policy
- Applied science development creates opportunities for improved coordination with NGO and multilateral organisation's international programmes.
- Raising political and institutional interest in climate-related disaster risk and preventive/anticipatory approaches.
- Projects that build on existing localised coping and adaptation capacities.
- Possibilities for coordinating funding mechanism such as a FONDEN or FOPREDEN and creation of incentives that support mitigation.
- The Global Environment Facility provides an incentive for inter-agency partnership.

4.3. CURRENT BARRIERS TO INTEGRATION

Here we highlight a series of barriers to linking climate change concerns with disaster risk management in México *(see also Table 8).*

4.3.1. Climate and hazard information

Integration in understanding national risks from climate change and hazards is still fraught by inadequate data information and state level assessments.

Integration requires a strengthening of the current information base. The weather services report poor weather station coverage for fine-scale monitoring, resulting in gaps or unreliable input to forecasts and the need for better ground-truthing of data for risk assessments. More considered agenda setting is required within the Meteorological Service, which does not currently hold an official position on climate change (interview with officials from the CNA). Climate models need long-term data to develop robust scenarios.

4.3.2. Communication of risk and planning tools

Integration in the use of planning tools and approaches to risk have been held back by weak communication channels, especially between the research community and decision-makers.

Clearer linkages need to be expressed between disaster risk, climate change and poverty and communicated to policy makers in terms that can be understood. A lack of understanding of climate change impacts reduces the political (and electoral) momentum for integration. Problems in communication may already limit the capacity of decision makers to create a range of response options to current risk. There is confusion amongst policy makers between forecasting in the short-term and long-term robust scenarios, partly because of a lack of clear information, which makes it difficult for policy makers to engage in the debate. The problem of different time-horizons, language and interpretation makes it difficult to inter-relate issues. There is a need to 'build bridges' between researchers and decision makers, especially with those that practice social science and assess vulnerability/development as their perspectives have not been well integrated into disaster policy or adaptation actions. Difficulties in communication also between Ministries and have been partly responsible for restricting the progress of the CICC. While there is increasing recognition in donor agencies of the need to mainstream DRR there are limited tools to assist with the process at the national level, especially for targets and indicators (a finding by other studies e.g. La Trobe, 2005).

4.3.3. Coordination

Integration is hampered by the separation of primary responsibility for climate change and disaster management between environmental and civil protection arms of government, and their associated research institutions.

While considerable progress in integration has been made, overall a pattern of institutional fragmentation still exists within México, with the separation of primary responsibility for climate change and disaster management between the army, the Red Cross, environmental and civil protection arms of government, and their associated research institutions. Climate change adaptation, in particular, is also relatively isolated from the development agenda by its location (institutional) within the environmental sector. This is unfortunate, given that environmental issues include by definition poverty and development in Mexican policy, even in the National Environment Programme for 2001-2006. This problem is not unique to México. Fragmentation combined with insufficient political coordination is

also apparent within current disaster management, across the institutions concerned with assessment of risk, emergency response and recovery. The fragmentation is not only structural but also reflected in human capacity, with a large concentration of different types of technical expertise in CENAPRED, SEMARNAT and UNAM for example. There is also a lack of integration within agencies, for example CENAPRED has a division for pre-disaster and another for post-disaster information. There is limited regional coordination in planning.

4.3.4. Political momentum and institutional capacity

Political dynamics have slowed progress in institutional integration, including a lack of staff continuity in Ministries and there has been inadequate formalisation of mechanisms and structures needed to facilitate an integrated flexible national policy.

Electoral cycles in México act as a major impediment to actions addressing long-term issues, resulting in discontinuity between administrations in many programmes. The resulting funding competition between Ministries and turnover of key staff 'champions' means that governmental decision-making may lack skills and capacity to drive the necessary responses to disaster risk and climate change. The resulting lack of awareness has limited agenda setting, with recommendations and advances made are becoming often lost (e.g. a lack of continuous stakeholder involvement in urban water management in Sonora). For example, concerns exist about the longevity of the newly created Inter-Ministerial Commission for Climate Change, which will need to develop political strength with the change of political administration in December 2006, particular to integrate the Ministry of the Interior. Political cycles can encourage action for political motives e.g. 'gatekeepers' at national, state and local level who control access to, and timing of, disbursement of prevention and reconstruction funds from FONDEN and FOPREDEN. Researchers at UNAM indicated that the timing of response is essential during extreme drought.

The under-development of strategic approaches to risk prevention/mitigation at both National and State level, especially in terms of loss of assets, hinders long-term approach to reducing vulnerability of the poor to climate risks. There remains also a lack of prioritisation of climate change in formal policy structures. While the National Development Plan deals with economy, poverty and sustainable development and the National Environmental Plan deals with environmental management, neither clearly articulate linkages between poverty, disaster risk and climate change. This problem also at exists at State level, where for example climate change itself is often not mentioned in State development or environment plans (e.g. Yucatan State). This is partly the result of a lack of political understanding, with many officials admitting the need for capacity building.

4.3.5. Grassroots capacity and community involvement

Insufficient attention has been paid to the linkage between poverty and vulnerability to climate change risk, and the need for capacity-building at the local level

While it is important to continue facilitating community participation in disaster risk planning, vulnerability must be directly addressed because the most vulnerable have limited adaptive capacity to cope during disasters, and their vulnerability may be increased under future climate change risk. Raising awareness of risk and the need for adaptation to climate change is not enough. Direct linkages between risk/climate and poverty need to be highlighted, and the structural factors that shape social vulnerability and adaptive capacity need to be addressed. Advances made in communication of risk to communities have not been adequately combined with local-level capacity building, such that people can act to build their resilience in the longer-term (e.g. overcome lack of resources or

skills, trade coordination and local commercialisation, or create new options that increase livelihood flexibility). Communication of risk information should not mean dependence on autonomous action, which is unlikely to reduce long-term vulnerability. While the population is not fully aware of the implications of climate change impacts, grassroots opportunities or ways to adapt traditional skills, this will fuel a lack of commitment by politicians. Existing research in this area (e.g. CIESAS) would be more closely incorporated into Government planning.

4.3.6. Financing adaptation

Integration is restricted by short-term financing horizons and a lack of mechanisms for financing cross-sectoral/scale coordination and the building of adaptive capacity, with disasters continuing to divert resources away from development programmes.

There are a number of reasons for the lack of investment. Policy makers have found it hard to evaluate cost-benefit analysis for prevention activities. While there is a need to invest in development, reducing vulnerability and identifying probabilities of risk, this is not a priority when short-term political returns are often necessary. Officials from CESPEDES admitted that costing of future disasters or adaptation needed has not been well addressed and that the private sector will need to develop financial incentives to consider this. Although UN-ECLAC have development tools for cost-benefit analysis this has only been applied to certain sectors. Politically, climate change is now on the agenda because of pressure from the private sector, which sees the CDM as a tool to conduct business as usual, rather than deal with reducing current vulnerability and emissions. There are few incentives for the private sector to adapt or mitigate. Catastrophe insurance has been proscribed in most areas and has not been extended to cover meteorological risks, leaving no possible application to support future extreme events linked to climate change or variability. With series of disasters (e.g. the impact of the 2005 season with three major events affecting many states, some more than once) resources available, especially at state level, have been seriously depleted. FONDEN currently uses its resources to support government infrastructure that by law should have been insured and variable funds since 1996 (from 5,000 million pesos to 200 million) have made it difficult to integrate plan longer-term support for adaptations. Congress gave FONDEN approximately US$50 million in 2005 but year on year the fund requires more money than budgeted. FOPREDEN has had limited public exposure and therefore has not spent as much money as expected on prevention.

Table 8. Existing barriers to integration

- Inadequate data provision for forecasting and need for more state level assessment to generate climate change and hazard information that can be used for agenda setting
- Meteorological Service does not currently hold an official position on climate change
- Weak communication channels between the research community and decision-makers
- Institutional fragmentation (both structural and reflected in human capacity)
- Lack of mechanisms for cross-sectoral coordination between DRM and adaptation/environmental institutions, especially at State level
- Limited political coordination, leadership or formalisation of policy within proscribed windows
- Limited engagement and understanding of the implications of climate change impacts at the grassroots
- Short-term funding horizons, with inadequate spending on prevention

5. CONCLUSIONS & RECOMMENDATIONS

5.1. CONCLUSIONS

México faces increased risk from drought and tropical cyclones. GCM scenarios suggest an increase in temperature, reduction in rainfall in most seasons, but with a likelihood of increasing and possibly more intense rainfall during the wet season. There may be an increase in the strength, duration and frequency of El Niño events. Water availability is likely to be a problem in the interior and urban areas. Intensity of tropical cyclones is likely to increase further in the region (possibly combined with an increase in frequency, according to some scientists), highlighting a particular urgency in integrating these concerns into current disaster risk planning.

The ongoing development of a more strategic approach to risk, with in-built flexibility has been an important step for México and one which is essential to achieve coordinated planning in DRM that mainstreams climate change risks, in order to minimise vulnerability across different sectors and at different scales. There are a number of mechanisms and existing institutional structure that could be built upon in México in order to achieve better-integrated DRM and climate change adaptation. Both CENAPRED and INE are involved with different aspects of risk identification, prevention policy, and communication of science, and there should be better incentives for strategic coordination. The CICC has the potential to resolve the divide between capacity of the state and lack of incentives for the private sector (interview with officials at the Energy Ministry). There have been advances in communication of science and the assessment of risk within academic and research centres in México.

While there have been a number of measures and policy initiatives there has been limited coordinated action that considered future risk. However, with the prospect of increased risk of drought and hurricane activity, and persistent vulnerability of the poor, there will be a serious impact on health, poverty-reduction, national agricultural economy and food security, particularly in the coastal areas and arid interior regions. Increased future risk of weather-related disasters as a result of climate change may lead to catastrophic loss of livelihoods and suffering for the rural population if an integrated development and DRM agenda is not initiated in México now. Increases in resilience and adaptive capacity to plan, prepare, respond and mitigate weather-related disasters are necessary to manage changing conditions. Although it is important to get incentives for integrated disaster mitigation and adaptation right, it will continue to be necessary during extreme disasters to provide emergency relief and a safety net for the extreme poor, such as the provision of relief, evacuation and compensation during and after tropical cyclones. It is essential that a coordinated and flexible approach is developed. There are a number of specific priorities that would improve future linkage.

5.2. RECOMMENDATIONS

We present here a series of recommendations, drawing from input to the México study, from feedback from country experts and from an international VARG workshop held in Geneva 2-4th October 2006. The recommendations are made with multi-hazard and cross-sector consideration, and highlight mainly aspects of technical and institutional capacity, and means to strengthen the policy process for linking climate change and disaster management in the context of poverty reduction.

5.2.1. Climate and hazard information

Technical improvements/downscaling in climate models and integrated risk information

There is a need for better coverage of meteorological networks and ground-truthing, and improved quality of information for calibration and resolution of climate models, particularly with downscaling on output for region and sector and technical improvements in incorporating complex data, including social-economic scenarios.

Broader understanding on how climate change will impact on specific locations

More research is needed not just in climatology but also in understanding the multi-layering of risk between climate, disaster and different aspects of human vulnerability which are likely to vary from place to place and have specific consequences (e.g. via patterns of disease prevalence). Hence, research is required that is specific to context (e.g. linking detailed vulnerability maps to different problems e.g. water, health) in order to get a more detailed understanding of how risk might change and thereby inform adaptation priorities.

5.2.2. Communication of risk and planning tools

Invest in development of user-specific models and application products targeted at different groups to improve understanding of risk and promote adaptation measures.

Climate science integration into policy and planning can only be met by sustained investment and capacity building, particularly through collaboration between the research community and agencies that communicate to policy makers. Development of user-specific models and application products is necessary to identify key entry points (e.g. for economic trade-off analysis and downscaling in water demand; formulation of mega disaster scenarios such as major hurricanes damaging the Campeche offshore oil fields, Tabasco-Veracruz petrochemical facilities or highly populated areas; the aggregation of meteorological/climate information with other types of risk information such as the risk mapping projects undertaken by CENAPRED).

Build bridges to increase communication between scientists and decision-makers

Invest strategically in applied research and personnel in agencies who can act as ‘translators’ of such research. Integration requires specialist translators with capacity to convey science in a form that is accessible and meaningful to policy-makers (including the recognition that scientific uncertainty over future change will never be resolved). Researchers at UNAM felt that it was the role of academia to propose how to bridge the gap, although a specialised agency should action these ideas (e.g. through training forums). One problem, for example, is the difficulty of applying conventional cost-benefit analysis to preventative action (which reinforces an institutional barrier to investment in risk reduction). The research community needs to provide and demonstrate the use of probabilities of risk.

Pro-actively use land-use planning powers to reduce risk

Application tools need to include pro-active development planning, especially stronger use of land use planning in risk-prone coastal zones or areas at risk of flash floods (e.g. governing the location of settlements and critical facilities), as well as land use control/regulations for building construction.

5.2.3. Coordination

Provide a single coordinating framework to oversee existing DRM and climate change adaptation structures, in order to facilitate cross-sectoral and multi-scale coordination, and build on regional partnerships.

There are currently many agencies and divisions of government responsible for providing leadership roles in different components of DRM, development and climate change adaptation through different sectors. For example, SEMARNAT focuses on adaptation to climate change, while CENAPRED and Civil Protection focuses on hazard risk, preparedness and response. It is essential that an inter-ministerial body, such as the CICC, is able to coordinate more broadly climate change and disaster risk over different timescales, building on advances on emissions reductions. This is especially important to coordinate simultaneous slow-onset disasters such as drought and rapid onset disasters such as tropical cyclones. In addition, the CICC could provide a link for improved coordination in international cooperation between México and the region and become a mechanism for feedback to different Ministries. Investment needs to be made in the authority and coordinating capacity of the environment ministry, including at provincial level.

Provide a stronger role for the Inter-Ministerial Commission for Climate Change

In the first year the interests of the CICC have focused on emissions and the CDM rather than future disaster risk and development (although an Ad-hoc Adaptation Working Group is now being developed) and that it has yet to be seen as an inclusive forum for regularly reviewing activities. It is also important that CENAPRED and the Ministry of the Interior (SEGOB) are integrated into the CICC. The CICC should be more inclusive and be formally mandated through its chair (SEMARNAT) to develop frameworks to enhance consistency, communication, coordination and responsibility within government and with other agencies. Currently, the legal framework for disaster prevention and protection is not well coordinated with environmental law in México, nor does environmental law and planning adequately consider adaptation to future climate change.

Ensure better coordination of activities or joint programmes with a specific regional focus

Inter-disciplinary researchers could play a more direct and sustained role in policy development and delivery to help articulate a research agenda that targets mainstreaming and linkage. External agencies could increase support for initiatives that develop improved regional collaboration. At a provincial level, one possible mechanism would be to invest in the coordinating capacity of the Ministry of Environment (to analyse and advise on investments in other government sectors in terms of future risks). This would build on the current momentum with the Environment Ministry. An opportunity also currently exists for enhanced collaboration between the civil protection system, research and agencies such as the Red Cross, which all have skills and facilities for training.

There needs to be increased collaboration between farmers, producer associations, the private sector and local government.

Public support for the development of administrative and technical capacity in civil agriculture organisations is needed because disaster mitigation must be situated within the market economy (for infrastructure improvements, regulation, economic benefits).

5.2.4. Political momentum and institutional capacity

Develop structures that facilitate continuity of policy

The government must capitalise on elevated priority and awareness following major weather-related disasters in México to provide continuity in the integration agenda. For example, the CICC could additionally incorporate research agencies and function as a mechanism to provide a longer-term view or 'oversight' outside times of disaster.

Invest in capacity building of decision makers

In addition, investment is required in capacity building within Ministries and disaster agencies to understand risk information at different timescales. The interviews indicated a deep-rooted confusion between preparedness and prevention within senior Ministries. Sensitization and capacity building of decision makers on DRR and the future of climate change impacts on DRM could be improved by workshop forums and increased communication between the research community and policy makers. The promotion and strengthening of regional and inter-country partnership with relevant agencies, development banks and research institutes can help to ensure institutional capacity building and that the implementation process adheres to concrete timelines and has dynamic results. Examples of success from the Caribbean region could be incorporated.

Mainstream DRM and adaptation by tackling underlying vulnerability and the protection of assets

Targeting underlying vulnerability, especially in marginal areas through economic empowerment of communities and protection of assets prior to disasters, is important for both slow onset-disasters such as drought and rapid disasters such as tropical cyclones. There needs to be increased investment in DRM projects that take a broad approach to adaptation, (combined with broader aspects of poverty reduction and/or environmental sustainability) because interventions that bring multiple and immediate benefits are politically more attractive and likely to be sustained. The housing example in the Yucatán case study illustrates the potential importance of incorporating a role for rural populations and municipal governments to preserve initiatives over the long-term.

Promote flexibility of approach wherever possible in DRM practice and related development to accommodate future changes

Successful linkages have been made where flexibility has been built into the policy process and incorporated increased priority towards improving rural livelihoods (with inherent flexibility) and their resilience to 'shocks', as illustrated throughout the institutional review, interviews and case study. Examples include CENAPRED's proposed risk atlas, State Civil Protection plans, and reviews of the process of 'mainstreaming' through the CICC). This is essential, as risks from disaster events (associated with future climate change) are likely to change.

5.2.5. Grassroots capacity and community involvement

Support mechanisms that enhance state level awareness to reduce vulnerability

Short-term political timeframes have generated 'gatekeepers' to resources at state level and the process of political decentralisation would create more state level awareness, transfer of science and local capacity building. With more resources and transparency of decentralised responsibilities, it may be possible to develop better partnership with communities.

Build partnerships with local communities

Facilitating community participation and ownership is essential to incorporate local coping mechanisms and local NGO initiatives, as well as identifying diverse priorities. In this process, it is important marginal groups do not become further excluded from the policy process, as community-based solutions are essential in the short-term (as emphasised by UN-ECLAC projects). For example, local institutions could be part of the process of implementation of interventions aimed at reducing future climate vulnerability to extreme events (e.g. in diffusing information, promoting local organisations and in coordination). Local perceptions need to be included in order that obstacles to practical adaptation are reduced, and should incorporate resource access capacity, perception of risk and local priorities. Planting cash crops in drought areas often entails new and high economic risks whereas locally-appropriate technologies, economic diversification and drought-resistant cropping may be more practical in some locations (Interview with researchers at UNAM).

Invest in local capacity building that can respond and plan for diverse contexts

The donor community should be encouraged to invest in local-level capacity building projects, and not just national-level institutional capacity. State level analysis suggested that there are successful local-level lessons, which build on local knowledge (e.g. traditional skills in housing, diversification of crops or livelihood activities). Better coordination is needed to promote mechanisms for shared learning of successful action (this has already been initiated by some states e.g. Yucatán). While these capacities should be recognised as a resource, 'empowerment' as well as 'protection' requires access to resources, assistance in Municipal-level organization, recognition of land/water rights, and support markets for drought-adapted farming etc.

There will need to be different methodologies for different zones and communities, as well as acknowledge of continuing trade-offs between disasters and development. This requires flexibility in the planning process and opportunities to learn from the past (e.g. in hurricane-resistant housing design in Yucatán or improved irrigation schemes for small-scale commercial agriculture in the northern states).

5.2.6. Financing adaptation

Integration is dependent on better resource mobilisation

States need to have mandate to allow spending on prevention before disasters, linked through other cost-sharing institutions such as the development of new financial tools. Mainstreaming of climate risk concerns into government planning would help in the short-term.

Improve coordination between FONDEN and FOPREDEN

It is essential that there is better coordination between current financial tools. Fluctuating budgets for financial tools have made it difficult to plan, and while insurance can transfer risk for Disaster Funds, coordination of activities needs to remain within policy dialogue. FONDEN should redistribute its coverage to support more informal activities, such as small-scale commerce and services, such as manufacturing workshops, on which the poor are often dependent. Appropriate infrastructure is also necessary for crop changes, including access to credit.

Increased incentives for private sector investment

Although the state and federal government has tried to promote a culture of insurance, the cost and lack of confidence inhibits smallholder farmers. More could be done to ensure that the private sector

remains in policy dialogue in order to facilitate financial support for adaptation projects, especially initiatives that provide benefits at the local level.

Increased regional and international partnerships to foster awareness of international funding mechanisms

International funding options (such as the GEF) have been used to finance awareness about mainstreaming climate change and disaster risk management. However, regional and international partnerships, as well as links with donor agencies and development banks, could also be increased to facilitate funding awareness, initiate partnership projects and provide training (e.g. poverty reduction projects by UN-ECLAC consider disaster risk impact and provide access to regional funding; or training for key ministries to mainstream climate risk reduction in practice).

Drawing both on sections 4 and 5, Table 9 (overleaf) provides a summary of the key issues and associated recommendations relating to linkage between DRM and climate change adaptation in México. Within the column headed ‘Activities’, actions that might be appropriate for donor support have been highlighted.

Table 9. Summary of key points

ISSUES	RECOMMENDATIONS	ACTIVITIES
> Inadequate data provision for forecasting > Need for downscaling of existing climate change and hazard information that can be used for agenda setting > Limited consideration of social science perspectives in hazard analysis	**Support technical advances in identification and evaluation of risk**	> Invest in user specific models and application products > Improve meteorological networks and ground-truthing (Meteorological Service to generate official position climate change) > Improve climate model calibration and resolution > Build on forums for data integration and exchange (e.g. existing centres, National Communication preparation, creation of meta-scenarios)
> Weak communication channels between research community and decision makers > Limited engagement and understanding of the implications of climate change at grassroots	**Build bridges to increase communication between scientists, decision makers, NGOs and communities**	> INE mandate to increase awareness (invest in SEMARNAT) > Role of Inter-Ministerial CICC and regional links > Build on existing forums and centres to bring together expertise (e.g. as workshops, training forums, invest in 'translators', working manuals) > Engage grassroots to build on existing coping/adaptation responses (applied science)
> Institutional fragmentation (structural/human capacity) > Limited cross-sectoral coordination, especially at State level > Piecemeal cooperation with donors and regional partners	**Provide a coordinating framework to facilitate oversight and national ownership**	> Role of CICC to generate culture of mainstreaming risk and adaptation/coordinate funding (include Ministry of Interior) > Cross-sectoral liaison by integrating existing disaster and hazard structures (e.g. CENAPRED, Civil Protection) and Ministries (Environment, Agriculture, Energy, Finance etc) > Create incentives for compliance in international commitments
> Limited political coordination, leadership or formalisation of policy within proscribed windows	**Develop structures that facilitate continuity of policy**	> Invest in implementing structures with clear responsibility and applied science, points of contact > Build partnerships with local communities
> Urgency in dealing with increased risk from drought and hurricanes as result of climate change > Poverty and high vulnerability	**Mainstream DDR and adaptation (brings multiple benefits and politically attractive)**	> Tackle underlying vulnerability/poverty > Invest in 'climate-proofing' development agenda and increase awareness of DRR in projects > Support projects that protect livelihood assets and invest in local capacity

ISSUES	RECOMMENDATIONS	ACTIVITIES
> Difficultly in managing weather-related disaster impacts on diverse contexts (multi-layering of risk) > Uncertainty in future impact	**Promote flexibility of approach where possible**	> Allow risk plans and information provision to be updated regularly (e.g. risk mapping, civil protection guidelines, environmental and housing regulations in risk-prone areas, etc)
> Short-term funding horizons, with inadequate spending on prevention	**Increase funding priority, regional partnerships and coordinate financial tools**	> Coordinate FONDEN and FOPREDEN to increase spending on prevention > Reduce variability in Disaster Trust Funds by incorporating risk transfer mechanisms and donor partnerships > Increase collaboration between farmers, producer associations and private sector > Invest in institutional capacity building, collaborative projects and networks (to increase awareness of international funding)

Specific areas where donor agencies could engage

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Mexico Country Study - Annexes

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APPENDIX 2 - EXPERTS CONSULTED

- •Initial meeting (Patricia Romero Lankao, Fernando Aragon, Karina Martinez, Gavin Tench, Rene Garduno Lopez, Victor Magana, Cecilia Conde, Alejandro Nadal, Mauricio Ugalde, Rosa Maria Jimenez, Michel Rosengaus Moshinsky, Roberto Quaas Weppen, Sergio Puente, Rubem Hofliger, Victor Becerril, Julia Martinez, Francisco Szekely, Boris Graizbord, Alfonso Mercado)
- •Julia Martinez, Adrian Fernendez, Juan Carlos Arredondo, INE, SEMARNAT
- •Cecilia Conde, Victor Magana, Rene Garduno, Carlos Gay Centre for Atmospheric Studies, UNAM
- •Rubem Hofliger (Coordination Director), Victor Becerril FONDEN
- •Roberto Quaas Director CENAPRED, Marcos Davelos, Enrique Ortiz
- •Rosario Alvarez, The Nature Conservancy
- •Sergio Puente COLMEX Social Sciences
- •Michel Rosengaus Moshinsky Met Service CNA/Water
- •Ricardo Zapata Focal Point Disaster Evaluation UN ECLAC
- •Ubaldo Ugalde Inclan, Carolina Fuentes SENER Climate Change
- •Fernando Tudela SEMARNAT
- •Virgina Garcia Acosta CIESAS
- •Alejandro Lorea CESPEDES
- •Diego Masera UNEP
- •Isaac Oxenhaut Head Disaster Management, Mexican Red Cross
- •Roger Orellana CICY Merida Yucatan
- •Xavier Moya UNDP Merida Yucatan
- •Enrique Alcocer, Joel Herrera, Civil Protection for Yucatan
- •Prof. Roger Antonio González Herrera, Minister, Ministry of Rural Development and Fisheries of Yucatan
- •Francisco Zetina Espinosa, Ministry of Social Development of Yucatan
- •Javier Enrique Sosa Escalante, Ministry of Ecology of Yucatan.

APPENDIX 3 - WORKING TERMINOLOGY

For the purposes of this project we have adopted and used the following definitions, based primarily on UNISDR terminology (see http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm):

Risk	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.
Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
Vulnerability	The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.
Coping capacity	The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster.
Adaptation	Adjustments in response to actual or expected climate change or its effects ('anticipatory' or 'proactive' adaptation is adaptation that takes place before impacts of climate change are observed)
Disaster	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.
Disaster risk management	The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.
Mitigation	Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. NB In terms of climate change 'mitigation' has a distinct meaning: it refers to human efforts to reduce the sources of (or enhance the sinks for) greenhouse gases.
Preparedness	Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.
Relief / response	The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Recovery	Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.
Disaster risk reduction (disaster reduction)	The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.
Capacity building	Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk.