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MEXICO

REVIEW OF THE MEXICAN NATIONAL CIVIL PROTECTION SYSTEM

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Foreword

Civil protection plays a key role in ensuring the safety and well-being of citizens and in building economic and social resilience to disasters. Good civil protection can literally make the difference between lives saved or lost, and in the time it takes for society and the economy to recover after major events. Mexico, a country exposed to frequent tropical storms, powerful earthquakes and devastating floods, has been a frontrunner in this area. The National Civil Protection System is a core public service which relies on a unique mix of institutional capacities and the co-ordination of resources at all levels of government.

This *Review of the Mexican National Civil Protection System* is the first country review under the newly established OECD High-Level Risk Forum. The report offers a unique review and analysis of the system since its inception in 1986. It provides evidence-based policy advice on how to move risk management policy forward, and highlights priority areas to translate objectives into action, prevention in particular. It builds on a thorough process of policy dialogue with Mexican stakeholders drawing on state-of-the-art expertise from other countries exposed to disasters, including Chile, Italy and the United States.

According to the review, the Mexican National Civil Protection System has made much progress over the years. Although extreme events continue to disrupt economic activities, they now result in relatively few human casualties. This, in itself, is an impressive sign of Mexico's progress, reflecting both technological advancements, such as sophisticated early warning systems and modern building codes, and the wide sharing of a culture of safety. Mexico has also established itself as one of the leading countries in the financial management of disasters, through the Fund for Natural Disasters (FONDEN) and the Fund for the Prevention of Natural Disasters (FOPREDEN).

Despite progress, our study underlines that improving prevention policy should remain a priority. Improper land use and territorial and urban planning contribute heavily to the vulnerability of Mexico's population and economy to natural hazards. These issues need to be addressed in a broader framework for prevention to contribute to sustainable long-term economic development, while at the same time addressing the most pressing policy challenge for disaster risk reduction.

Risk management policy is about leadership and governance. The OECD *Review of the Mexican National Civil Protection System* can help build further momentum for policy implementation as a new General Law for Civil Protection was recently passed. Maintaining engagement with citizens and businesses will be essential. Further international co-operation, an area where Mexico has demonstrated that it can take the lead, will also be fundamental to sharing lessons and pooling best practices.

This report highlights a number of options that the current administration may wish to consider for setting up an ambitious, cohesive and inclusive strategy for risk management for civil protection. The OECD stands ready to continue to support Mexico in this important policy area for promoting better policies for better lives.

Angel Gurría

Secretary-General

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This peer review of risk management policies is the first produced under the auspices of the OECD High-Level Risk Forum, under the direction of Rolf Alter, Director of Public Governance and Territorial Development. Stéphane Jacobzone, Deputy Head, Reform of the Public Sector Division, provided guidance and direction throughout the process and liaised with Mexican authorities to agree upon the scope and process of the review.

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Acronyms and abbreviations

AIE-PEMEX	Atlas of Strategic Infrastructures of Mexican Petroleum (*Atlas de Infraestructuras Estratégicas de Petróleos Mexicanos*)
AMEXCID	Mexican Agency for International Development Co-operation (*Agencia Mexicana de Cooperación Internacional para el Desarrollo*)
AWS	Automatic weather station (*Estación Meteorológica Automática*)
CAT	Tsunami Warning Center (*Centro de Alerta de Tsunami*)
CECIS	European Union Common Emergency Communication and Information System (*Sistema Comun de Información y Comunicación de Emergencia de la Unión Europea*)
CENACOM	National Communications Centre (*Centro Nacional de Comunicaciones*)
CENAPRED	National Centre for Prevention of Disasters (*Centro Nacional de Prevención de Desastres*)
CFE	Federal Electricity Commission (*Comisión Federal de Electricidad*)
CGPC	General Co-ordination of Civil Protection (*Coordinación General de Protección Civil*)
CIRES	Centre for Seismic Instrumentation and Record (*Centro de Instrumentación y Registro Sísmico*)
CNE	National Emergencies Committee (*Comité Nacional de Emergencias*)
CNO	National Operations Center (*Centro Nacional de Operaciones*)
CONACYT	National Council for Science and Technology (*Consejo Nacional de Ciencia y Tecnología*)
CONAFOR	National Forest Commission (*Comisión Nacional Forestal*)
CONAGO	National Conference of Governors (*Conferencia Nacional de Gobernadores*)
CONAGUA	National Water Commission (*Comisión Nacional del Agua*)
CONAPO	National Population Council (*Consejo Nacional de Población*)

COPARMEX	Mexico Business Association (*Confederación Patronal de la República Mexicana*)
CRAE	Regional center for emergency response (*Centro Regional de Atención de Emergencias*)
D.F.	Federal District (*Distrito Federal*)
DGFONDEN	General Directorate of the Fund for Natural Disasters (*Dirección General del Fondo de Desastres Naturales*)
DGPC	General Directorate of Civil Protection (*Dirección General de Protección Civil*)
DRM	Disaster risk management (*Manejo de Riesgos de Desastres*)
FEMA	United States Federal Emergency Management Agency (*Agencia Federal de los Estados Unidos para el Manejo de Emergencias*)
FONDEN	Fund for Natural Disasters (*Fondo de Desastres Naturales*)
FOPREDEN	Fund for the Prevention of Natural Disasters (*Fondo para la Prevención de Desastres Naturales*)
GIS	Geographic information system (*Sistema de Información Geográfica*)
GLCP	General Law for Civil Protection (*Ley General de Protección Civil*)
GRAME	Regional group for emergency response and management (*Grupo Regional de Atención* y Manejo de *Emergencias*)
HDI	Human Development Index (*Índice de Desarrollo Humano*)
IBWC	International Boundary and Water Commission (*Comisión Internacional de Límites y Aguas*)
IIASA	International Institute for Applied Systems Analysis (*Instituto Internacional de Análisis de Sistemas Aplicados*)
IMTA	Mexican Institute of Water Technology (*Instituto Mexicano de Tecnología del Agua*)
INEGI	National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía*)
INIFED	National Institute of Physical Infrastructure for Education (*Instituto Nacional de la Infraestructura Física Educativa*)
IPCC	Intergovernmental Panel on Climate Change (*Grupo Intergubernamental de Expertos sobre el Cambio Climático*)
JICA	Japan International Co-operation Agency (*Agencia Japonesa de Cooperación Internacional*)
MXN	Mexican pesos (*Pesos mexicanos*)
NBCP	National Board of Civil Protection (*Consejo Nacional de Protección Civil*)

NOAA	United States National Oceanic and Atmospheric Administration (*Administración Nacional Oceánica y Atmosférica*)
NPCP	National Program of Civil Protection (*Programa Nacional de Protección Civil*)
PAHO	Pan-American Health Organization (*Organización Panamericana de la Salud*)
PEMEX	Mexican Petroleum (*Petróleos Mexicanos*)
PRAH	Programme of Risk Prevention for Human Settlements (*Programa de Prevención de Riesgos en los Asentamientos Humanos*)
PTWC	Pacific Tsunami Warning Center (*Centro de Alerta de Tsunamis del Pacífico*)
R-FONDEN	Loss Estimation for Federal Risk System (*Sistema de Estimación de Pérdidas para el Riesgo Federal*)
SAH	Hydrometeorological Alert System (*Sistema de Alerta Hidrometeorológica*)
SAS	Earthquake Warning System (*Sistema de Alerta Sismica*)
SASO	Earthquake Warning System for the State of Oaxaca (*Sistema de Alerta Sismica para el Estado de Oaxaca*)
SAVER	Analysis and Visualization System of Risk Scenarios (*Sistema de Análisis y Visualización de Escenarios de Riesgo*)
SCADA	Control and Data Acquisition System (*Sistema de Control y Adquisición de Datos*)
SCT	Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*)
SECTUR	Ministry of Tourism (*Secretaría de Turismo*)
SEDENA	Ministry of National Defense (*Secretaría de la Defensa Nacional*)
SEDESOL	Ministry of Social Development (*Secretaría de Desarrollo Social*)
SEGOB	Ministry of the Interior (*Secretaría de Gobernación*)
SEMAR	Ministry of Navy (*Secretaría de Marina*)
SEMARNAT	Ministry of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*)
SEP	Ministry of Public Education (*Secretaría de Educación Pública*)
SHCP	Ministry of Finance (*Secretaría de Hacienda y Crédito Público*)
SIAT – CT	Early Warning System for Tropical Cyclones (*Sistema de Alerta Temprana para Ciclones Tropicales*)

SIMBAD	System of State and Municipal Databases (*Sistema Estatal y Municipal de Bases de Datos*)
SINAPROC	National Civil Protection System (*Sistema Nacional de Protección Civil*)
SINAT	National Tsunami Warning System (*Sistema Nacional de Alerta de Tsunamis*)
SITEL	Online System of State Territorial Information (*Sistema de Información Territorial Estatal en Línea*)
SMN	National Metorological Service (*Servicio Meteorológico Nacional*)
SRE	Ministry of Foreign Affairs (*Secretaria de Relaciones Exteriores*)
SSN	National Seismological Service (*Servicio Sismológico Nacional*)
UNAM	National Autonomous University of Mexico (*Universidad Nacional Autónoma de México*)
UNDP	United Nations Development Program (*Programa de las Naciones Unidas para el Desarrollo*)
UNISDR	United Nations International Strategy for Disaster Reduction (*Estrategia Internacional para la Reducción de Desastres de las Naciones Unidas*)
USAID	United States Agency for International Development (*Agencia de los Estados Unidos para el Desarrollo Internacional*)
WHO	World Health Organization (*Organización Mundial de la Salud*)
WMO	World Meterological Organization (*Organización Meteorológica Mundial*)
WTO	World Tourism Organization (*Organización Mundial del Turismo*)

Executive summary

Over the past two and a half decades, Mexico's National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) has achieved significant improvements, notably in its planning, response and recovery capacities. Similar to many OECD countries, however, SINAPROC now senses the need to shift focus toward risk prevention. Its recent legislation promotes a forward-looking approach aimed at avoiding or reducing damages before they occur, and is consistent with placing climate change adaptation at the core of the country's strategic vision for development. These improvements have enjoyed strong political support at the federal level and buy-in from most SINAPROC stakeholders, which should be continued to foster resilience and to keep pace with increasing economic and social vulnerabilities.

Legal and institutional frameworks for civil protection

Mexico's federal and state civil protection laws reflect milestones in the incremental process to establish a national system of integrated risk management. They provide a legal basis to move beyond the traditional focus of emergency preparedness, response and recovery, calling for disaster risk reduction actions and prevention based on common guidelines for risk assessments. Implementation of the 2012 General Law on Civil Protection provides an opportunity to strengthen co-operation in these respects and fix priorities to better align sub-national programmes with federal policies.

Mexico's national territory is exposed to a high level and wide range of natural and man-made hazards. The country's geographical and topographical characteristics generate a variety of severe exposure to relatively frequent, extreme natural hazards such as earthquakes, tropical storms and floods. In addition, significant disparities amongst the population in wealth, income and education, create the conditions for elevated social vulnerability to these exposures.

SINAPROC was established to improve Mexico's civil protection capacities following the devastating Mexico City earthquakes of 1985 (which according to official data caused 4 541 casualties and, according to the National Centre for Prevention of Disasters (*Centro Nacional para la Prevención de Desastres*, CENAPRED), destroyed 412 buildings, damaged 3 124 buildings and caused over USD 4 billion in economic damages). Mexico is not alone in facing mounting economic consequences of disasters. The 1985 disaster revealed to Mexico the same lesson that has driven many countries to initiate structured policy changes, namely that *ad hoc* co-ordination efforts for the response to and recovery from large-scale disasters are inefficient at best and ineffective at worst. This reveals the need for a comprehensive and systematic approach to the co-ordination of disaster response and recovery.

SINAPROC is meant to co-ordinate groups of institutions, functional relationships and programmes that ensure links between the civil protection capacities of the public, private and social sectors. At its core is the aim to achieve a system of integrated risk

management, bringing together professionals responsible for, *inter alia*, emergency co-ordination and response units, scientific research, early warning systems and the financing of reconstruction. One of its key challenges is simply to ensure that the many federal, state and municipal civil protection services function as a flexible whole together with companies, volunteer organisations and research institutes from different sectors.

The architecture of SINAPROC is well suited to include the broad operational, strategic and administrative challenges associated with large-scale emergency response and disaster financing. Its flexible institutional framework is supposed to encourage participation from federal government agencies while at the same time integrate competent bodies from highly autonomous states and municipalities. It has succeeded at integrating diverse emergency response and monitoring capacities from the public sector, especially at the federal level. However, formal connections with the private sector and volunteer organisations are less developed. A clear function of leadership and co-ordination is assigned to the General Co-ordination for Civil Protection (*Coordinación General de Protección Civil*, CGPC), which is crucial to ensure that institutions responsible for a wide range of response capabilities such as the Ministry of Defense (*Secretaría de la Defensa Nacional,* SEDENA), the Navy (*Secretaría de Marina*, SEMAR), the National Water Commission (*Comisión Nacional del Agua*, CONAGUA) and the Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL) work together in a coherent manner. Close collaboration with the scientific community has enabled civil protection policy decisions to benefit from advances in scientific knowledge and new technological developments in risk mitigation.

SINAPROC can only perform as well as its parts are able to work together and according to coherent policies across its different sectors and especially across Mexico's three levels of government. At the federal level, General Laws on Civil Protection in 2000 and 2012 established a robust institutional and policy framework, while at the state level progress in harmonising civil protection legislation has filled the gaps of what was a highly divergent patchwork in 1985. The *Organization and Operations Manual of the National Civil Protection System* provides some clarity about the roles and responsibilities of various civil protection stakeholders, but it lacks specificity about how they should co-ordinate. It clearly identifies the primary role of municipalities and state civil protection services when disruptive events occur. If the scale of an event increases beyond the capacity of local services to manage it, however, the Army and Navy may self-mobilise to lend support. As a practical matter, many of the nearly 2 500 municipalities are rural communities that lack basic civil protection capabilities. Consequently, they rely upon state and federal resources more often than the urban centres do.

To further strengthen its strategic orientation and co-ordination through shared objectives Mexico should:

- Seize the opportunity of the 2012 General Law for Civil Protection to set priorities for integrated risk management through multi-level stakeholder consultations.
- Follow-up implementation of the 2012 General Law at state level with a dedicated monitoring mechanism and programme to establish benchmarks.
- Design the next National Programme for Civil Protection to leverage momentum created by the 2012 General Law.
- Include civil protection as a priority in the National Development Plan.

Risk assessment – the evidence base for risk management policies

SINAPROC demonstrates strong commitment to evidence-based risk management policies, and has made notable progress in the scientific understanding of natural hazards, mapping exposure of populations and valuable assets and modelling vulnerability. It has leveraged this knowledge to produce tools that inform the public of the risks they confront and to develop appropriate emergency response plans. Broader linkages between advances in risk knowledge and risk management are evident in strategies for disaster financing that are suitable in light of national risk-bearing capacity. Additional linkages could be established between its innovative tools and disaster risk reduction measures such as land use, urban development plans and risk mitigation infrastructures. This should take top priority as states begin to implement the 2012 General Law for Civil Protection, which requires the development of risk atlases to inform land-use plans.

Risk assessment provides a better scientific understanding of hazards and threats, and the vulnerability of exposed populations and valuable assets. It should take account of future projections, incorporate linkages between different phases of the disaster risk management cycle, and be conducted in an open and inclusive manner. SINAPROC has developed several tools to reinforce evidence-based risk management policies, systematically gathering and analysing data and information on hazards, exposure and vulnerabilities at the federal level, and increasingly at state and municipal levels.

CENAPRED created the National Risk Atlas (*Atlas Nacional de Riesgos*, NRA), an innovative tool that integrates information on hazards, exposure and vulnerability from the three levels of government. The NRA provides a comprehensive national view of all disaster risks, natural or man-made and its geographic information system (GIS) architecture provides an excellent visualisation of the spatial relation between hazards and the population and assets at risk. While it is mostly used to strengthen emergency response planning, the NRA is available for agencies and civil protection authorities. There is also a version available to the public on the CENAPRED website, and as its content develops over time it should increasingly contribute to raising the public's awareness of risks.

CENAPRED has established highly valuable links to the scientific community which help feed the NRA with robust data about natural hazards, particularly for earthquakes, floods and tropical cyclones; improvements are needed to better incorporate tsunami scenarios. Federal institutions provide detailed input to the NRA about population exposure, social vulnerability based on census data and exposure of federal assets (e.g. petro-chemical facilities, dams, telecommunications and electricity networks, schools, hospitals and roads). Risk atlases are less developed at sub-national levels of government, especially at municipal level due to their costs and lack of technical expertise.

The Ministry of the Interior (*Secretaría de Gobernación*, SEGOB) has, however, developed a coherent strategy to address these gaps. CENAPRED provides guidelines and technical assistance to states and municipalities to ensure their risk atlases are more than just an inventory of hazards; they should also integrate vulnerability analysis and meet standards for data interoperability with the National Risk Atlas. The Prevention Fund for Natural Disasters (*Fondo para la Prevención de Desastres Naturales*, FOPREDEN) began co-financing projects related to the elaboration and updating of risk

atlases for states and municipalities in 2004. Prior to this, only 9 of the 32 states (including the Federal District) had developed a risk atlas, but under this cost-sharing programme all but 4 have now completed one.

SEDESOL also provides financial support for the development of risk atlases at the municipal level, which follows guidelines set out by CENAPRED. Despite this collaborative effort, the results have not produced municipal risk atlases that are interoperable with the National Risk Atlas; the vast majority of municipalities still have not completed a risk atlas. Going forward it will be important to co-ordinate and strengthen financial and technical support for the development of risk atlases at local levels, which would be especially useful in support of risk-based land-use planning.

In addition to risk atlases, the federal government has developed cutting-edge risk assessment tools in support of two specific phases of the disaster risk management cycle. CENAPRED developed the System for the Analysis and Visualization of Risk Scenarios (*Sistema para el Análisis y Visualización de Escenarios de Riesgo*, SAVER), a scenario-based emergency planning tool, and the General Directorate of the Fund for Natural Disasters (*Fondo de Desastres Naturales*, FONDEN) created R-FONDEN, which inventories public infrastructure assets and models potential disaster damages to them for the purpose of refining risk-financing strategies. There is scope to strengthen ongoing efforts to link these tools and thereby improve the efficiency and comprehensiveness of risk assessment efforts throughout SINAPROC. For example, SAVER hazard scenarios could be useful for R-FONDEN, and the asset inventory of R-FONDEN should contribute to the National Risk Atlas.

But records about past hazardous events may not be representative of what will happen in the future. For example, flood exposure in ports on the Mexican Gulf coast may increase due to a rise in the sea level and changing tropical cyclone patterns. The importance of developing the National Atlas on Climate Change Impact and Vulnerability should therefore be recognised. Further research in forward-looking hazard and vulnerability analysis would help to better plan for the future challenges of risk management in Mexico, going beyond retrospective analysis of past events and including future trends such as the effects of climate change and demographic projections.

To enhance integration of risk assessment across levels of government Mexico should:

- Facilitate linkages across risk atlases at all levels, and develop synergies between SAVER and R-FONDEN.
- Harmonise federal support for the development of risk atlases at sub-national levels.
- Strengthen financial and technical support of municipal risk atlases.
- Take stronger account of potential tsunamis in risk atlases.
- Develop the National Atlas on Climate Change Impacts and Vulnerability.
- Reinforce engagement of the private sector in risk assessment processes at all levels.

Disaster risk reduction – the challenge of the future

Mexico's ambition to place disaster risk prevention on a par with emergency response may require adjustments to the institutional structures of SINAPROC. The core issue is to ensure partnerships across levels of governments that actually build greater capacity for prevention at the local level. Greater incentives combined with control and sanction mechanisms for municipalities may be needed to develop their territorial land-use policies based on risk assessment. Development of human capital in local civil protection bodies as called for in the 2012 General Law on Civil Protection could help address frequent changes in municipal government that result in short-term planning.

The correlation between economic growth and a rise in disaster damages has pressed many countries to consider mainstreaming disaster risk reduction into their development plans. This entails long-term commitment and action to strengthen the resilience of the national territory to disasters, through more sustainable territorial planning and urban development. This involves a mix of structural and non-structural measures, risk education and the development of early warning systems.

Improper land-use and territorial/urban planning contribute heavily to the vulnerability of Mexico's population, and are considered the most pressing policy challenge for disaster risk reduction. Rapid and continuous urbanisation to metropolitan areas has increased informal settlements in hazard-prone areas such as river banks or unstable hills. On this key issue SINAPROC faces a governance deficit challenge, because land-use policies are within the remit of local councils for more than 60% of Mexico's territory, and are designed with very few links to information about risks. As river beds and their surroundings are under the authority of CONAGUA, but land-use and urban planning are the responsibility of the municipalities, there is a gap in the legal and institutional frameworks. In some cases, neither side takes the initiative to prevent or expel invasive settlements. As a result, illegal housing in flood-prone areas tends to resume even after important disasters such as the Monterrey metropolitan area flooding caused by Hurricane Alex in 2010.

Earthquake of 20 March 2012

While many emergencies have been declared since 1985, the March 2012 earthquake took place during an OECD mission to Mexico, offering an opportunity to witness the overall progress in SINAPROC firsthand. A 7.4 magnitude earthquake occurred during the OECD fact-finding mission on 20 March 2012. No human casualties occurred in Mexico City and there were only negligible physical damages to buildings. These impressive results reflect improvements in the mix of structural measures (e.g. more stringent building codes) and non-structural measures (such as advanced early warning systems, a much more developed safety culture with increased public awareness and preparation, and the benefits of regular drills and massive exercises). The population remained extremely calm and was observed to execute appropriate protocols for protective measures and evacuation, demonstrating a strong safety culture, which is a positive outcome of continuous training and drills.

Particularly impressive was the reception of a precise earthquake warning 40 seconds in advance. The Seismic Alert System (SAS) managed by the Centre for Seismic Monitoring and Research sends a radio signal to Mexico City as an alert in the case of an earthquake with an epicentre located on the Guerrero coast. Since the radio wave travels much faster than the seismic wave, facilities equipped to receive the signal allow the population to prepare themselves for the arrival of the shock. A similar system is available for earthquakes affecting Oaxaca state, but efforts should be made to extend advance notice systems for sudden onset risks to the major, exposed population centres where technically feasible.

Building codes and seismic retrofit are two additional areas of disaster risk prevention policy with scope for stronger uptake. Building codes are, in theory, defined at the municipal level; however, many municipalities do not have sufficient resources to create or update them, which means construction is unregulated for seismic risks in many areas. Some municipalities have adopted the seismic code for Mexico City, which is often not appropriate for local soil conditions and other variables that determine the local level of seismic risk. The state of Chiapas provided financial support for seismic micro-zoning, a good practice that could be replicated in other states to inform the development of appropriate building codes. Furthermore, in municipalities with building codes, risk mitigation provisions often focus on earthquake risks, paying insufficient attention to countermeasures for floods, hurricanes and tsunamis appropriate to the local level of risk.

Damage risk reduction in hospitals and schools

The 1985 Mexico City earthquake hit the areas of the city with the highest concentration of hospitals. Thirteen hospital buildings of six or more floors were partially or totally destroyed, and one out of every four beds were lost. The Safe Hospital Programme was launched in 2006 to assess, classify and certify hospitals according to safety indicators in case of disaster. Hospital action plans are developed to reduce vulnerability, as well as to ensure that hospitals can evacuate their patients, maintain critical operations and provide surge medical capacity to victims in case of a disaster. According to its criteria, 200 hospitals in Mexico have been classified as safe and prepared for a disastrous earthquake.

In Mexico's 246 000 schools, 2 programmes aim at reducing vulnerability to disasters: an internal programme of school safety consisting of measures such as monthly evacuation drills, sign posting and warnings; and a programme to reduce the structural vulnerability of school buildings. The National Institute of Educational Physical Infrastructure (Instituto Nacional de la Infraestructura Física Educativa, INIFED) conducts approximately 25 000 visits per year to assess the vulnerability of schools.

Early warning systems have demonstrated their effectiveness to save lives and limit damages. In addition to the Seismic Alert System mentioned above, such systems have been developed for tropical cyclones (SIAT-CT). Significant public safety benefits would result from expanding these systems to cover the whole territory at risk and from more complete coverage of other hazards including floods and tsunamis. A harmonised system nationwide that uses the same symbols, colour coding, protocols and dissemination channels from federal to state and local levels would increase synergies and efficiencies and avoid confusion from messages from a diversity of sources. The technical agencies that operate early warning services should develop better co-ordination procedures in this respect. Partnerships with the media could help to ensure early warnings are properly communicated through all available channels, especially when there is an imminent threat.

Mexico has made major efforts to increase risk awareness through public campaigns and the national education system. Local community involvement and empowerment are well illustrated by neighbourhood councils in Mexico City and Chiapas that go door-to-door to inform local residents about risks and effective self-protection measures. The *Jornadas de Protection Civil* are also an effective programme to promote risk education. The promotion of such a culture of safety may eventually help generate broader public support for disaster risk prevention polices. Continuous efforts toward greater population preparedness, education and risk awareness, specifically for the most vulnerable (children and elderly, isolated communities, tourists) should be further supported.

To build greater capacity for prevention through new partnerships across levels of government Mexico should:

- Build greater coherence between risk management, territorial planning and urban development and adaptation to climate change.
- Territorial and urban planning should become a national priority supported by an appropriate institutional framework.
- States and municipalities should prepare under their responsibility a disaster risk prevention plan based on a risk atlas indicating structural and non-structural measures needed to prevent disaster risk in their jurisdictions.
- Extend early warning systems on the model of the SIAT-CT and the SAS throughout the national territory, particularly for flood and tsunami warnings.
- Invest more in disaster risk prevention following thorough analysis of costs, benefits and effectiveness. A practical measure to facilitate this would be to establish a registry of four to six specific building codes at the federal level that municipalities could choose from and adapt based on their risk exposure, particularly for earthquakes, floods and tsunamis.

Emergency preparedness and response – benchmarks of progress

A large number of sectoral emergency plans have been developed by federal institutions under the SINAPROC umbrella to prepare for emergency response. Inter-institutional, scenario-based plans with standard operating procedures (SOP) should be developed, however, to describe how different actors in the system are supposed to co-ordinate.

Institutional co-ordination is expected from joint action of the SINAPROC stakeholders, at the level of government affected by the situation at hand. This flexible approach entails significant autonomy in the decision-making process of the various stakeholders engaged and appears to be effective to deal with certain emergencies; however, it relies on willingness to co-operate, strong leadership in the crisis room and personal relationships. A common emergency information system and incident control system should be established to better link emergency responders from local to federal level, sharing information and establishing a clear chain of command among all SINAPROC stakeholders during an emergency. The location of the regional emergency response centres of different federal agencies should be planned in joint consultation to maximise the coverage of emergency services to rural areas. Efforts to strengthen crisis communication capacities at the federal level should be pursued, including through developing priority access to telecommunication networks for emergency responders, strengthening the national communication centres and networking the state crisis centres (Ci4s).

Emergency preparedness and response is an essential function of the state that governments must ensure to keep the public's trust. Governments need to plan and prepare for civil contingencies with specific responses to minimise suffering and damages, and to ensure business activity can resume in the most efficient, timely and targeted fashion. SINAPROC was established primarily to improve the capacity of civil protection services to co-ordinate their emergency planning and responses.

While the Army and Navy have long-established civil contingency plans (Plan DN-III and Plan Marina), some first responders at the state, and especially at the municipal level, continue to lag behind their federal counterparts. The Safe Municipality Programme was specifically enacted to strengthen co-ordination and institutional participation between the three levels of government, the private and social sectors. It promotes a common set of key capacities at municipal level such as: mitigation activities and partnerships across economic sectors and strengthening multi-stakeholder networks. Many state and municipal governments, however, have never heard of this well-designed programme, or do not see any incentive to participate in it.

The General Directorate of Civil Protection (*Dirección General de Protección Civil*, DGPC) provides a centralised co-ordination capacity for government emergency responders and stakeholders from the private sector and volunteer organisations. The 1985 earthquakes generated high capacity in Mexico's civil society to self-organise rescue missions and many volunteer groups formed at that time continue to play an operational role in emergency response and early recovery. While the legitimacy and expertise of these groups is recognised, they are meant to act within the control and co-ordination of civil protection authorities, which has created challenges related to the delivery of resources and access to disaster areas. There is scope to consider how to maximise the use of these specialised emergency response groups.

Plan Sismo

The Strategy for Preparedness and Response of the Federal Administration for High Magnitude Earthquakes and Tsunami (the so-called "Plan Sismo") represents a major attempt to more clearly define what each government agency should do in the case of a major earthquake. Plan Sismo consists of four directives decided by the President instructing and ordering federal agencies to support the population to preserve the rule of law and the governability of the country. The plan foresees procedures that run counter to normal practice. For example, the President would order the Army and Navy to activate their respective DN-III Plan and Plan Marina. States and municipalities are called to activate their civil protection councils and co-ordinate with the federal level. Organised around 3 response areas (operational, logistics and administrative), 14 working groups have been defined with their co-ordinating agencies and their members. This plan represents the first comprehensive emergency plan with clear co-ordination mechanisms, and may prove to be a major forward-looking achievement for SINAPROC that could serve as a model in contingency planning for various extreme hazard scenarios.

SINAPROC is premised on a significant degree of institutional autonomy. Co-ordinated decision making among federal stakeholders takes place through a multi-stakeholder National Emergencies Committee (*Comité Nacional de Emergencias*, CNE) and similar instances are in place at state and municipal levels. These co-ordination mechanisms have shown to be active in managing responses to major, slow-onset events such as hurricanes, but they have never been tested under conditions equivalent to those of the 1985 earthquakes. Confidence in the ability to perform under extreme conditions could be improved by developing standard operating procedures (SOPs) and defining how the various SINAPROC components are supposed to interact in case of a large-scale event.

Earthquake of 20 March 2012

"The first casualty of war is the truth – the first casualty of any major incident is communications".

An operational communications network in the aftermath of a large-scale event is a basic civil protection capacity. It enables first responders to communicate needs, to receive and transmit orders, and when possible to deliver advance warnings (tsunami alerts after an earthquake, for instance). Moreover, they serve to inform and calm the population, to provide instructions about what steps to follow to ensure their personal safety. When a rapid onset emergency occurs, one of the first reactions in the general population is a massive, simultaneous attempt to make contact with family members using cell phones. Typically this may result in congestion of the mobile telecommunications network. As a matter of policy, many countries now block access to mobile networks during the immediate aftermath to avoid a network crash, and reserve access to dedicated numbers.

When the telecommunications network became congested on 20 March 2012 following the earthquake in Mexico City, high-level civil protection officials turned to Blackberry messenger to communicate with the Office of President. Although the highest level officials are equipped with satellite-based communication devices, priority access to the mobile network should be addressed, not only for telephones, but also to transmit data (Internet, email) via satellite.

Tsunami hazards are not well linked to earthquake monitoring in Mexico, nor are prevention and preparation for tsunami as advanced as those for earthquakes. Structural and non-structural measures related to tsunamis could be better incorporated into the earthquake risk prevention. This could also include clear identification of exposed zones and safety zones, and the harmonisation of signs throughout the Pacific coast leading to evacuation routes and safety zones. Support is needed to develop modelling for tsunamis that could affect principle cities along the Pacific coast built on probable scenarios of tectonic activity along particular earthquake faults. Jalisco state demonstrated its lead in this respect with the implementation of a warning system, the development of emergency preparedness measures and the organisation of a simulation exercise with all residents and businesses for a ten-meter high event in the city of Puerto Vallarta.

Feedback mechanisms after disasters give structure to the process of drawing lessons, which helps to improve policies throughout the entire disaster risk management cycle. In the immediate aftermath of an event, there is usually a short window of opportunity to leverage public awareness and appreciation of risks to undertake policy reforms, which otherwise are unpopular. In this respect, feedback mechanisms could be instituted annually and after each major disaster. At the state level, many good practices have been collected throughout the years that should be brought to the attention of other states through biannual civil protection meetings. However, the objectives of these meetings should be altered to use such exchanges of information to lead to policy changes.

To strengthen the efficiency of emergency response through planning, co-ordination and communication mechanisms Mexico should:

- Further develop scenario-based emergency response planning.
- Establish a common emergency information and incident control system among SINAPROC's stakeholders.
- Strengthen crisis communication capacities of SINAPROC's stakeholders.
- Strengthen the co-ordination mechanisms with volunteer organisations and NGOs.
- Broaden business continuity planning efforts in the public and private sectors, particularly for SMEs.
- Maximise synergies between the General Directorates of the CGPC, moving them to a common site in a less earthquake-prone area.
- Reinforce feedback mechanisms and the sharing of good practices and lessons learnt.

Mexico as an international leader – testing innovative approaches to disaster risk financing

The federal government has successfully supported key elements of business continuity planning at all levels through the requirement of "internal civil protection programmes" in physical facilities where many persons may be present. It has also developed innovative and flexible financing solutions to strengthen disaster financing. FONDEN effectively balances the need to deliver funds rapidly for recovery/reconstruction with the need to ensure accountability in the use of public resources. It has been a driving force in encouraging states to insure their assets by conditioning financial support to repair recurrent damages to infrastructure upon proof by the owner that it has purchased insurance for the asset.

The longer a community takes to recover from a major disaster, the more unlikely it is that the local economy will recover its productive capacity. This creates a strong economic argument for accelerated financing in support of business continuity, early recovery, reconstruction and stimulating local consumption. A key quality of SINAPROC is the federal government's innovative and integrated disaster risk financing strategy, including such instruments as the federal financing scheme to provide fast recovery/reconstruction (FONDEN) and the federal prevention fund (FOPREDEN). These instruments are particularly suited to Mexico's level of economic development and high level of exposure to catastrophic risk, and could serve as a role model for other countries facing a similar profile of risks and fiscal capacity.

Disaster financing has a reliable basis in the annual federal budget, which ensures that 0.4% is reserved for this purpose. The main mechanism for disaster risk financing is FONDEN, which finances the cost of reconstruction and repairs to public infrastructure and low-income households. This budget allocation is transferred to a specific trust fund to manage and distribute post-disaster support to federal and state entities. Transparency, efficiency and accountability have been further improved through regular changes to FONDEN's rules of operations, reflecting its capacity to take into account feedback and strive for continuous improvement. For example, transfers were previously made to

states, whereas now they are made directly to contractors upon receipt of an invoice for approved works and once the state has paid its part under the cost-sharing rules.

FONDEN resources are covered by two specific insurance mechanisms that cover a certain level of public funding: *i)* an excess of loss scheme; and *ii)* a parametric catastrophe bond. In 2010, major disasters impacted 18 out of 31 states and 850 out of 2 500 municipalities, leaving FONDEN without sufficient resources to cover all of the funding requests. According to the Federal Budgetary Law, in such exceptional cases, the Ministry of Finance (*Secretaría de Hacienda y Crédito Público*, SHCP) intervenes to provide resources from available budget surplus.

The world's first government catastrophe bonds

In 2006, FONDEN issued the world's first government catastrophe bond, Cat Mex, which provided coverage against earthquakes in three specific zones in the national territory. The USD 160 million "CAT bond" was part of a USD 450 million catastrophe risk transfer strategy. Under the terms of the CAT bond, a payout is triggered if two conditions are met: i) an official state of emergency or disaster declaration is issued by SEGOB; and ii) an earthquake with a specified magnitude, depth and epicentre within the three pre-defined zones is registered. This CAT bond was renewed in 2010 and converted to a multi-risk instrument covering both earthquakes and tropical cyclones.

Given the potential impacts of climate change, and the extensive damages related to hydrometeorological phenomena over the last ten years, whether FONDEN will have sufficient annual resources is an issue. One challenge for the Ministry of Finance and FONDEN is to better co-ordinate – and influence – non-disaster related investments in infrastructure in Mexico by public and private actors to make sure they comply with and promote safety, building codes and other preventive measures.

The establishment of the FOPREDEN demonstrates the federal government's commitment to taking a comprehensive approach to risk management. It stands out amongst OECD countries as one of only a few known central government funds expressly set up to co-finance disaster prevention. The FOPREDEN budget and magnitude of the projects are still quite modest compared to recovery and reconstruction expenditures through FONDEN, as well as to major investments in structural measures of other federal agencies such as CONAGUA. The prioritisation of investments in prevention and mitigation should be performed taking the National Risk Atlas into account. Consultation and co-ordination with key federal agencies, including CONAGUA, SEDESOL, SEGOB, the Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE), the Ministry of the Environment (*Secretaría de Medio Ambiente y Recursos Naturales*, SEMARNAT) and the states and the municipalities is important to achieve optimal distribution of prevention funding. Authorities should compare major investments in structural measures for reducing risk exposure (e.g. levees) to non-structural measures (e.g. land-use controls) through appropriate cost-benefit analysis.

Despite the many risks facing Mexico's territory, the level of private insurance penetration is persistently low. While strong incentives have been set up by FONDEN to make local states and cities move towards greater risk awareness, prevention measures and insurance coverage, there is still insufficient insurance uptake amongst households and SMEs. Some stakeholders see insurance regulations as creating barriers for the insurance industry to extend penetration of property and casualty insurance coverage. Regulatory reforms to enlarge household insurance coverage could be put in place,

e.g. through some form of compulsory household insurance or model contracts for individual insurance through a standard basket. Public authorities should help to promote the uptake of insurance at the state level and in the federal agencies. For such a mandatory scheme to work, a clear mandate established by law and accompanied by a well-established sanction scheme needs to be put in place as in the case of mandatory insurance with civil liability coverage for automobiles.

To move toward a more balanced disaster risk finance strategy Mexico should:

- Implement the integration of FONDEN and FOPREDEN financial instruments to allow investing more in prevention especially in years when disaster losses are relatively low.
- Sustain FONDEN resources through a clear and accountable disaster risk financing instrument.
- Promote the development of the insurance culture through incentives or regulatory changes to enlarge household insurance coverage.
- Broaden business continuity planning efforts in the public and private sectors, particularly for SMEs.
- Continue to periodically review FONDEN to ensure its efficiency as a cornerstone of the national risk financing strategy.

Strengthening efforts for regional and international co-operation

Mexico has demonstrated willingness and capacity to co-operate with the United States in water management, meteorological hazard monitoring and response for environmental disasters that affect both territories. It has also positioned itself as a trusted regional partner through numerous humanitarian assistance missions. Its competence in technical and scientific knowledge could be further leveraged to build civil protection capacity throughout Latin America.

Disasters can have cross-border impacts, direct and indirect, which makes international co-operation a key capacity for civil protection systems. The conclusion and implementation of bilateral and multilateral agreements with neighbouring and regional countries enables sharing best practices and reliable partnerships that can be turned to in times of need. SINAPROC benefits from Mexico's involvement in many international fora related to disaster risk management policy and capacity building, such as: the UN Hyogo Framework for Action, the World Bank's Global Facility for Disaster Reduction and Recovery and the United Nations Development Programme. Cross-border co-operation in hazard monitoring for tropical cyclones and training of meteorologists is well established with the United States' National Hurricane Centre and National Oceanic and Atmospheric Administration.

Mexico has concluded several co-operation agreements with the United States to respond to disasters that occur along their shared border, especially in the domain of cross-border incidents of environmental pollution. The Mexico-United States Joint Contingencies and Emergencies Plan for Preparedness and Response to Events Associated with Chemical Hazardous Substances in the Inland Border Area provides a mechanism for preparedness co-operation and response co-ordination in relation to major incidents of environmental pollution. The 1983 La Paz Agreement established joint

working groups that deal with key cross-border environmental issues affecting the border area "100 kilometres on either side of the inland and maritime boundaries".

Whereas in the past Mexico was a recipient of international humanitarian assistance, it has become increasingly involved in exporting its civil protection expertise and providing disaster relief missions abroad, especially throughout Latin America. The Mexican Army and Navy have been particularly active in providing humanitarian assistance in the form of transport, building materials, food and medicine. Local level co-operation in relief activities is particularly present with neighbouring communities across the southern border with Guatemala.

To more fully exploit its potential for regional and international co-operation Mexico should:

- Foster the establishment of bi-national or regional co-operation agreements along the southern borders with Belize and Guatemala to formalise emergency response co-operation and establish well-defined protocols, procedures and roles.
- Further develop partnerships between the Mexican Agency for International Development Co-operation (*Agencia Mexicana de Cooperación Internacional para el Desarrollo*, AMEXCID) and SINAPROC stakeholders to share international good practices and develop capacity-building programmes with other countries focused not only on risk management, but also knowledge sharing.
- Clarify the regulatory framework for NGOs delivering humanitarian assistance.

Chapter 1

Key natural hazards and vulnerabilities

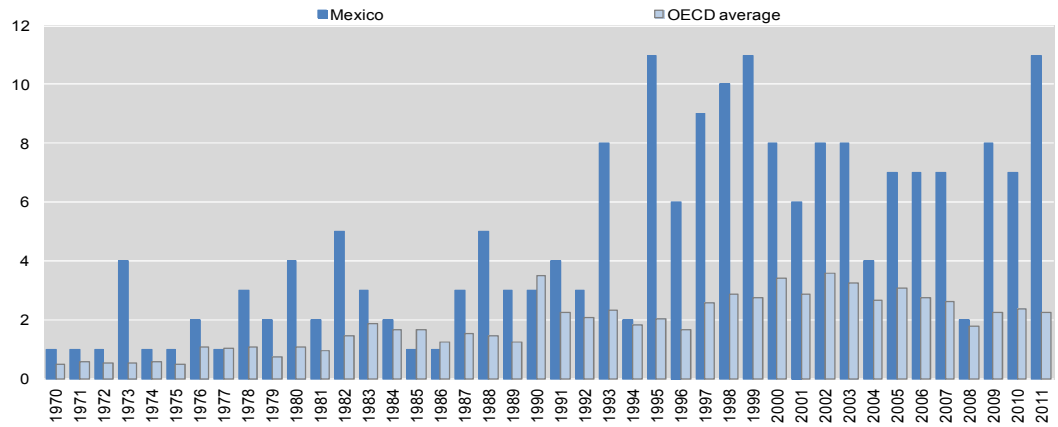
Mexico is exposed to a wide range of hazardous natural phenomena. It is one of the areas in the world with the most frequent occurrence of both severe earthquakes and tropical storms. This chapter presents the key hazards to which the country is exposed in terms of earthquakes, tropical storms, floods and other natural hazards. It discusses societal and economic vulnerability to natural hazards throughout the country.

Mexico's vast landscapes and diverse climatic and meteorological conditions expose the national territory to a wide range of hazardous natural phenomena (hereafter referred to as hazards), including: earthquakes, volcanoes, tsunamis, landslides, floods, hurricanes, torrential rain, forest fires, droughts, heat waves, freezes, etc. Significant segments of the population and key sectors of the economy are highly vulnerable to these hazards. Past disasters have resulted in mass fatalities, devastating damage to public assets and private property and significant diversion of budgetary resources that undermine longer term economic development objectives (Arnold et al., 1999).

Mexico is one of the areas in the world with the most frequent occurrence of both severe earthquakes and tropical storms. There has been a 4-fold increase over the past 40 years in the average annual occurrence of disasters; more than double the OECD average increase (Figure 1.1). Confidence in government can shift sharply depending on the capacity of public services to plan for and handle extreme hazardous events. While the occurrence and magnitude of natural hazards cannot be controlled, public policies can reduce disaster damages and alter the levels of society's vulnerability to them. These two points underscore the capacities of integrated risk management.

Figure 1.1. **Disasters preceded by natural hazards in Mexico and OECD countries (1970-2011)**

A. Number of disasters



B. Number of deaths

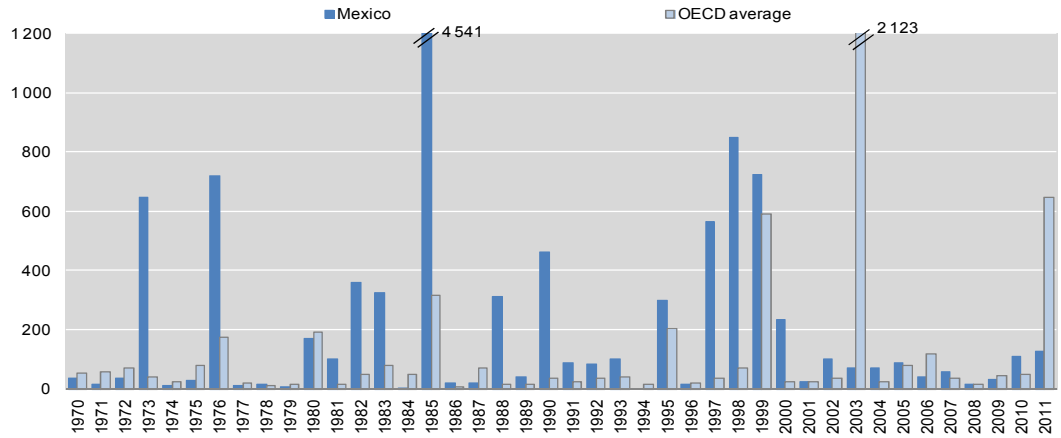
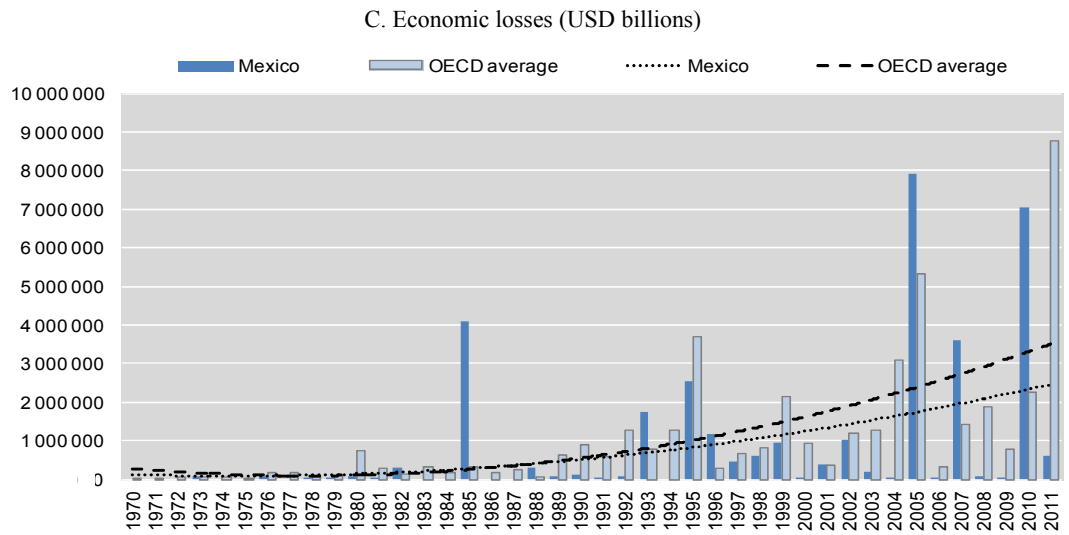


Figure 1.1. **Disasters preceded by natural hazards in Mexico and OECD countries (1970-2011)** (*cont.*)



Source: *International Disaster Database*, Center for Research on the Epidemiology of Disasters (CRED EM-DAT), Université catholique de Louvain, Brussels, *www.emdat.be/database*, accessed on 22 August 2012.

One of the fundamental roles of Mexico's National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) is to build a knowledge base and understanding of exposure to natural hazards and vulnerability factors that underlie disaster risks. SINAPROC has boosted the scientific understanding about the nature and extent of disaster risks in Mexico, which has been usefully applied in many instances to guide public policies to reduce damages as well as better prepare for and recover from them (see Chapters 3 and 4). The National Centre for Prevention of Disasters (*Centro Nacional para la Prevención de Desastres*, CENAPRED) provides the Ministry of Interior (*Secretaría de Gobernación,* SEGOB) with a key interface to the scientific community, a fundamental capacity of a modern civil protection system. Collaboration with universities and research institutes, for example the National Autonomous University of Mexico's Institute of Geophysics and the National Seismological Service have significantly improved knowledge about the nature, location, historical and projected frequency, and severity of disaster risks throughout the national territory. The financial and human resources, monitoring systems and collaborative relationships that made this progress possible need to be preserved and strengthened due to the dynamic character of risks in general and expected changes associated with climate change in particular.

Hazardous natural phenomena in Mexico

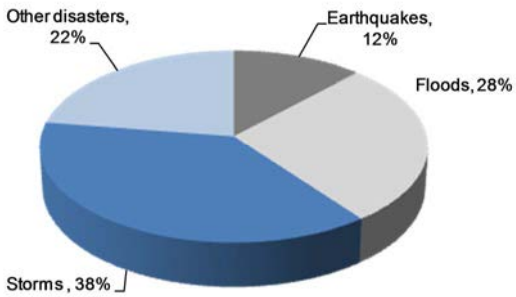
This *Review of the Mexican National Civil Protection System* focuses on earthquakes, hurricanes and floods, which are the most frequent natural hazards in Mexico and result in the highest share of direct damages in terms of human fatalities and economic losses. From 1970 to 2011, these three hazards contributed to 78% of the disasters in Mexico, comprising 89% of the fatalities and 93% of the resulting economic losses (Figure 1.2).

Figure 1.2 presents aggregate data at the national level about the number of disasters, and the resulting deaths and economic losses in Mexico; however, some states are far

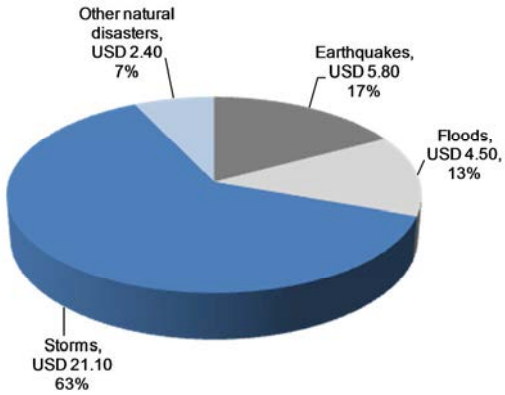
more exposed to losses than others. Between 2001 and 2011, all 31 federal states and the Federal District made emergency declarations. Chiapas, Nuevo Leon and Veracruz each made more than 20 such declarations – most of which related to floods and tropical cyclones – but 11 states made fewer than 5 declarations during this period.[1] With an average of 32 state declarations of emergency per year, different hazardous events may occur simultaneously in the country. The potential for multiple and simultaneous occurrence of hazardous events underlines the benefit of a national co-ordination mechanism in the field of civil protection, since state and municipal civil protection services may not be able to provide assistance to neighbours if they are already occupied with a local emergency.

Figure 1.2. **Disasters preceded by earthquakes, storms, floods and other natural hazards in Mexico (1970-2011)**

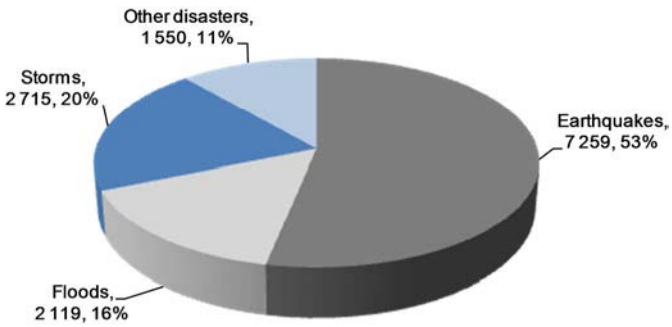
A. Number of disasters



B. Economic losses (USD billions)



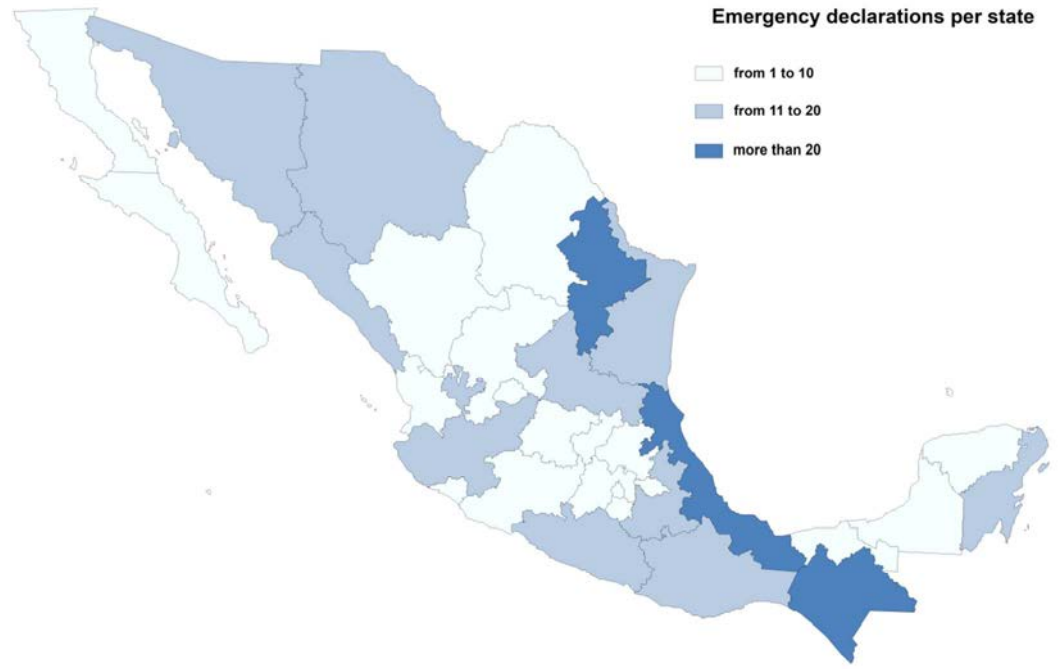
C. Number of deaths



Note: Other disasters include droughts, epidemics, extreme temperatures, insect infestations, mass movement dry, mass movement wet, volcanoes and wildfires. The *EM-DAT international database* is utilised here as it is the most complete cross-country database for disasters and covers the longest time period. The remainder of this report uses information from national databases as well.

Source: *International Disaster Database*, Center for Research on the Epidemiology of Disasters (CRED EM-DAT), Université catholique de Louvain, Brussels, Belgium, *www.emdat.be/database*, accessed on 22 August 2012.

Figure 1.3. **Emergency declarations per state (2001-2011)**



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: CENAPRED (2012), *Atlas Nacional de Riesgos*, CENAPRED, Mexico.

Earthquakes

Mexico's national territory is subject to high seismic activity due to the interaction of five tectonic plates and important regional faults (Figure 1.4). As a result, more than 50% of the national territory is prone to strong earthquakes. Seventy-one earthquakes measuring over 7.0 on the Richter scale occurred in Mexico during the 20th century (CENAPRED, 2008b) mostly along the Pacific coastline (Figure 1.5).

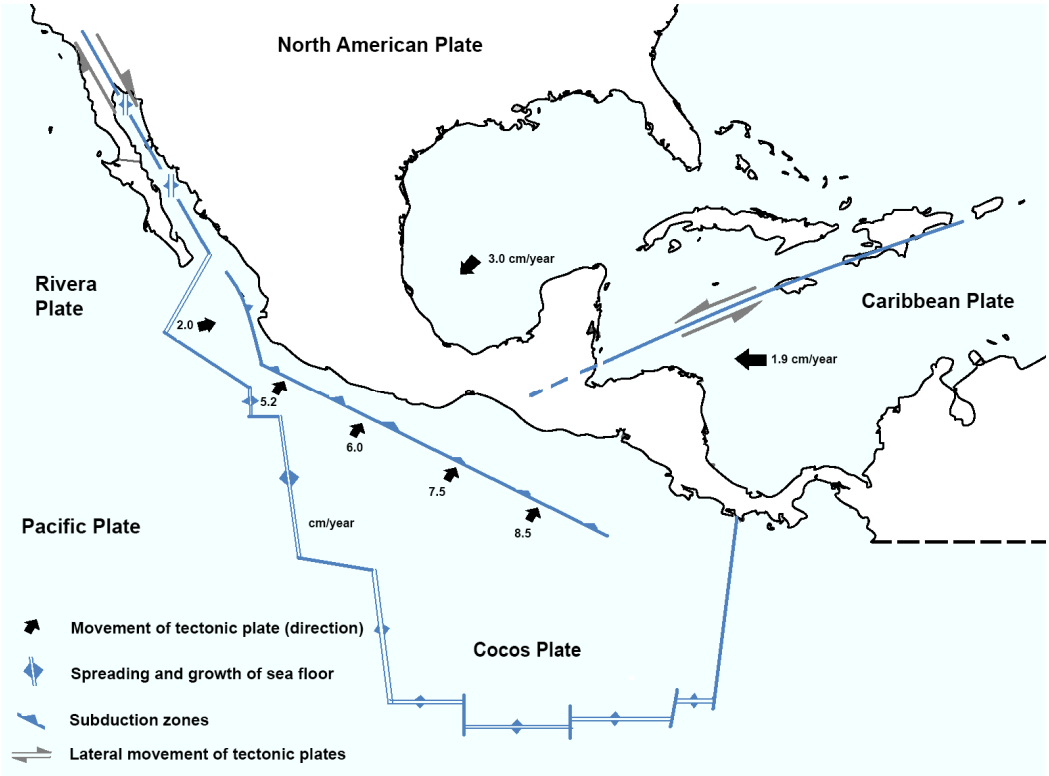
On average, more than 90 earthquakes occur every year with a magnitude ≥ 4.0 on the Richter scale. Probabilistic hazard analysis indicates that Mexico can expect an earthquake measuring ≥ 6.5 every two years, ≥ 7.0 every 10 years, and ≥ 8.0 every 33 years (Carpenter and IIASA, 2000). In addition to major earthquakes, almost the entire national territory experiences minor tremors every year. In 2011, for instance, the National Seismological Service (*Servicio Sismológico Nacional*, SSN) registered 4 168 earthquakes, 88% of which measured ≤ 4.0 on the Richter scale, 11% with a magnitude between 4 and 5, and less than 1% above 7. The marked increase in recorded seismic events over the past 100 years can be attributed in a large part to improvements in the coverage of the national seismic monitoring network. The area with the highest potential for a major seismic event is referred to by seismologists as the "Guerrero Gap". A major earthquake, or several with moderate to great magnitude, could be felt in this area in the near future (Box 1.1).

Table 1.1. **Number of emergency declarations per state, by disaster type (2001-2011)**

	Number of emergency declarations	Due to earthquakes	Due to flooding	Due to tropical storms	Due to other hazards
Aguascalientes	4		2		2
Baja California	6	1	3		2
Baja California Sur	8		1	6	1
Campeche	3		1	2	
Chiapas	26		17	5	4
Chihuahua	11		6		5
Coahuila	6		3	1	2
Colima	5	2		3	
Durango	8		7		2
Federal District	1		1		
Guanajuato	4		2		2
Guerrero	14	5	4	2	3
Hidalgo	5		2	3	
Jalisco	11	1	4	4	2
México	8		7		1
Michoacán	6		4	1	1
Morelos	1		1		
Nayarit	4		3	1	
Nuevo León	22		20	1	1
Oaxaca	19	1	11	2	5
Puebla	14		4	3	7
Querétaro	3		2		1
Quintana Roo	11		5	6	
San Luis Potosí	11		7	1	3
Sinaloa	10		4	2	4
Sonora	10	1	5	3	1
Tabasco	8		7		1
Tamaulipas	11		7	2	2
Tlaxcala	2			1	
Veracruz	55	1	40	5	9
Yucatán	3			3	
Zacatecas	5		3		2
Total	315	12	183	57	63

Source: Based on data provided by the General Directorate of FONDEN.

Figure 1.4. **Tectonic plates in Mexico**

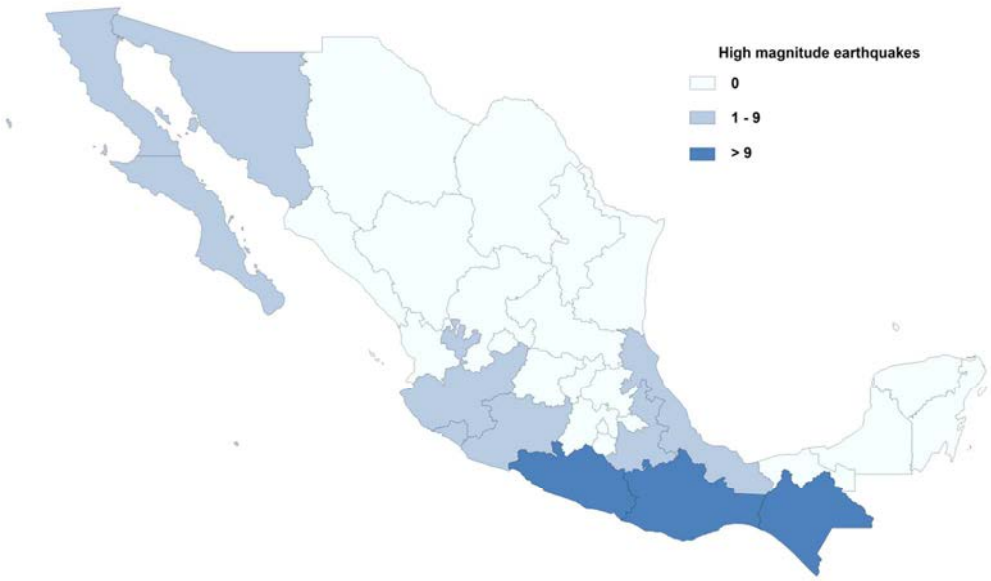


Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: CENAPRED (2008), *Sismos*, Serie Fascículos, CENAPRED, Mexico.

A national seismic map of Mexico classifies the country into four zones according to the degree of seismic hazard exposure (Figure 1.6): Zone A indicates the very low hazard areas where no significant seismic activity has been registered in the last 80 years, and where no ground acceleration higher than 10% of gravity can be expected. It includes 14% of the national population. Zone D is the high hazard area where strong earthquakes and an acceleration of more than 70% of gravity can be expected and includes 10% of the population. Zones C and B are the medium and low hazard areas respectively. Over 40% of Mexico's municipalities comprised of more than 24 million inhabitants are located in Zones C and D. When we include the population of Mexico City, 33% of Mexico's 97.4 million inhabitants are exposed to a high or severe level of seismic hazard (CENAPRED, 2008b).

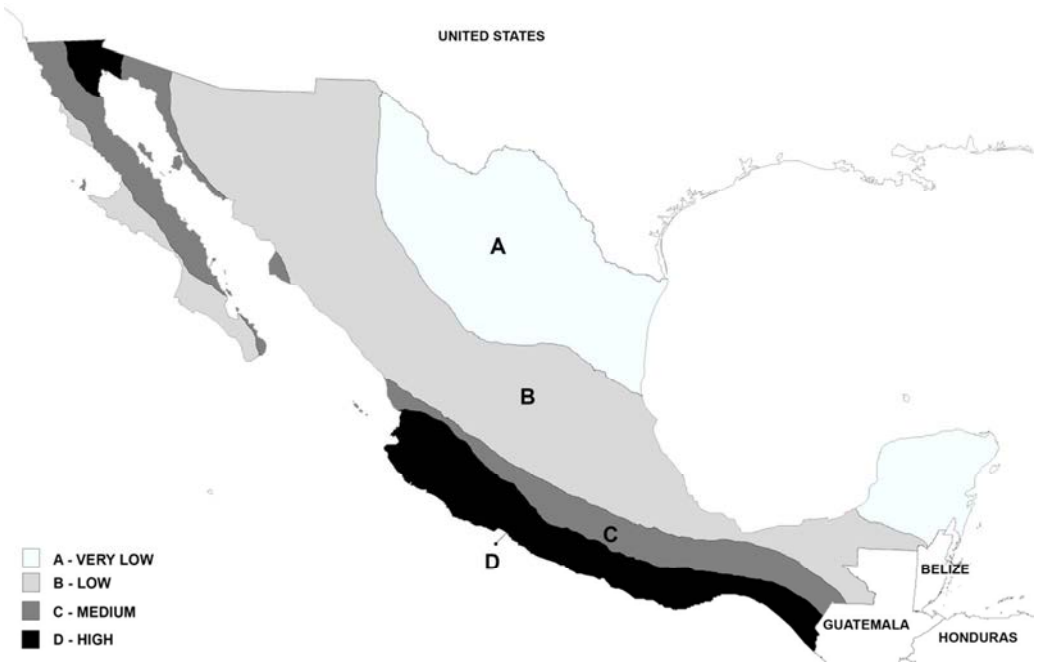
Figure 1.5. **High magnitude earthquakes (>7.0) per state in Mexico (1990-2003)**



Notes: Five earthquakes occurred in Guatemala less than 150 kilometres from Mexico. This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Sources: CENAPRED (2012), *Atlas Nacional de Riesgos*, Ministry of the Interior, Mexico, *www.atlasnacionalderiesgos.gob.mx*; CENAPRED (2008), *Sismos*, Serie Fascículos, CENAPRED, Mexico.

Figure 1.6. **Seismic hazard in Mexico**

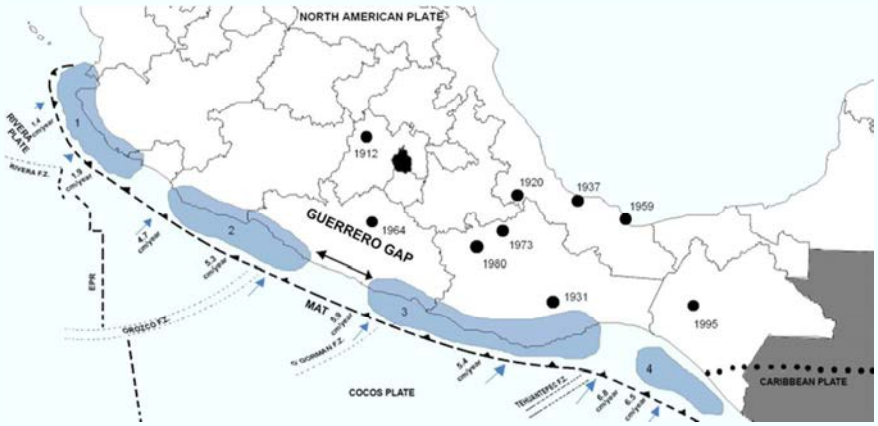


Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Federal Electricity Commission (CFE) (1993), "Manual de Diseño de Obras Civiles: Diseño por Sismo" (Manual on Civil Works Designing: Seismic Design), CFE, Mexico.

Box 1.1. **The Guerrero Seismic Gap: A major risk of high-magnitude earthquake**

The coastal region of the state of Guerrero is marked by a narrow, well-defined seismic gap in which no major earthquake has occurred since 1911 – the so-called "Guerrero Gap". The large tectonic stresses present in this seismic gap caused by subduction are expected to eventually produce a major earthquake (Nishenko and Singh, 1987), which could seriously affect Mexico City. The Guerrero Gap produced earthquakes in excess of 7.5 on the Richter scale in 1845, 1899, 1908, 1909 and 1911. Several planning scenarios consider that a major earthquake of a magnitude 8.0 or higher or several earthquakes with a 7.8 magnitude are highly probable. The National Seismological Service of Mexico estimates there is an 85% probability that such a scenario will occur in the next ten years in this highly populated and developed area. Such a major earthquake could lead to catastrophic damages in Mexico City, which is only 300 kilometres away (Box 1.2), and create a major tsunami impacting Acapulco which is located on the Guerrero coast. A major civil protection initiative called "Plan Sismo" was developed to prepare precisely for such a major earthquake (see Chapter 5).



Seismic events: (1) 1932, 1995 (2) 1976, 1979, 1981, 1985, 1986, 1985, 1997, 1998 (3) 1937, 1957, 1962, 1965, 1968, 1978, 1982, 1989, 1996 (4) 1902, 1903, 1942, 1950, 1993. This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Sources: National Seismological Service (2012), "The National Seismological Service: Past and Present", PowerPoint presentation during the OECD mission to Mexico City in March 2012; CENAPRED (2008), *Sismos* (Earthquakes), Serie Fascículos, CENAPRED, Mexico.

Tropical storms and hurricanes

Mexico is one of the few countries in the world exposed to tropical cyclones[2] originating from two ocean basins: the North Atlantic where the cyclonic season starts on 1 June and ends 30 November, and the North Pacific where the season lasts from 15 May to 30 November. Mexico's national territory can be hit simultaneously by a hurricane from each of these two cyclonic basins. From 1966-2002, an average of 25 tropical storms and hurricanes developed in this inter-tropical convergence zone – 15 originating from the Pacific and 10 from the Gulf of Mexico and the Caribbean sea (CENAPRED, 2003). Nearly half of these were intense hurricanes of Category 3 to 5 as measured on the Saffir-Simpson scale.[3] An average of 4 cyclones come within less than 100 kilometres of the Mexican coastline every year, which can lead to severe damages on the coastal areas and further inland, as an average-sized tropical cyclone has a radius between 300 and 700 kilometres (National Oceanic and Atmospheric Administration, 2010).

Box 1.2. **Mexico's 1985 earthquake**

Mexico City is built on the ancient lake bed sediments of Lake Texcoco, which was drained over many centuries to extend the city and control flooding. Its subterranean soil conditions consist of soft clay with a high water content. In the event of an earthquake, these conditions create a strong amplification known as the "Mexico City site effect". On 19 September 1985, an 8.1 magnitude earthquake occurred with its epicentre located in the Cocos plate subduction zone along the coast of Michoacán, some 400 kilometres from Mexico City. It took two minutes for the seismic waves to reach Mexico City, where the intense ground movement entered into resonance with the buildings of the historic centre (Arnold et al., 1999). It was one of the highest ground acceleration events ever recorded (Risk Management Solutions, 2009). The official estimated loss of lives was 4 541 people according to the Mexican government (Departamento del Distrito Federal, 1988). However, this point remains highly debated in the country, with many contending that the actual number of lives lost was much higher.

Property damage from the 1985 Mexico City earthquake included 258 totally collapsed buildings, 143 partially collapsed buildings and 181 severely damaged structures. In the city overall, 2 831 buildings were damaged and 880 completely ruined (Girty, 2009). The overall economic losses attributed to this disaster have been recently estimated at USD 11.4 billion (in 2011 value) (SHCP in World Bank, 2012a).

Collapsed General Hospital in Mexico City, 1985

Source: United States Geological Survey.

Nuevo León apartment building, 1985

Source: United States Geological Survey.

Source: CENAPRED (2008), *Sismos*, Serie Fascículos, CENAPRED, Mexico.

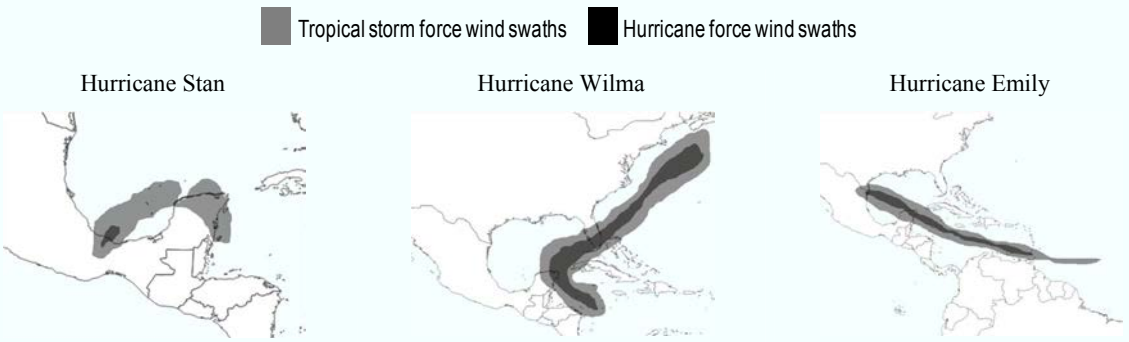
Tropical cyclones, and particularly hurricanes, may produce storm surge linked to high tides and tall waves, which typically disrupt economic activities and damage infrastructure and dwellings in coastal areas. Such meteorological phenomena may produce one or several types of flooding – from torrential floods to riverine and coastal inundation. A hurricane may generate these various hazards over the course of its path, which stretches thousands of kilometres (Box 1.3).

Box 1.3. **Diversity of hurricane hazards in Mexico**

In 1998, Hurricane Gilbert reached the strength of a Category 5 hurricane, with winds over 270 km/h and higher gusts reaching 315 km/h when it approached the Yucatán Peninsula. Waves reaching five meters in height heavily damaged the touristic and harbour infrastructures of the region. The hurricane then continued its path through the Gulf of Mexico and damaged the northern states of Tamaulipas, Nuevo León and Coahuila, flooding almost all of the area up to 300 kilometres inland. Among the 225 lives lost, 200 occurred in the flooding of Río Santa Catarina in Monterrey, 250 kilometres away from the sea. The mountains surrounding the city provoked heavy orographic rainfall in addition to the effects of the hurricane (CENAPRED, 2007).

In 1997, Hurricane Pauline generated in the Pacific basin and had devastating effects as its path moved inland along the coast of the states of Oaxaca and Guerrero. Its rains led to widespread landslides and flooding, and heavily damaged Acapulco due to strong waves. Two hundred twenty-eight people died and 200 000 people were affected by the disaster. In 2005, Mexico was hit by eight tropical cyclones, three of which were hurricanes that hit the south-eastern part of the country successively. Hurricanes Stan (Category 1) and Wilma (Category 4) reached landfall almost at the same time in early October, in areas which were still in the early recovery phase after having been devastated by Hurricane Emily (Category 4) in mid-July. Overall, these three disasters killed 98 people and caused damages estimated at MXN 44 billion.

Area of high wind speeds for Hurricanes Emily, Wilma and Stan in 2005



Note: These maps are for illustrative purposes and are without prejudice to the status of or sovereignty over any territory covered by these maps.

Source: Graphics archive of the NOAA's National Weather Service/National Hurricane Center.

Sources: CENAPRED (2001), *Características del Impacto Socioeconómico de los Principales Desastres Ocurridos en México en el Periodo 1980-99* (Characteristics of the Socio-economic Impact of the Main Disasters that Occurred in Mexico for the 1980-1999 Period), CENAPRED, Mexico; CENAPRED and the Economic Commission for Latin America and the Caribbean (ECLAC) (2006), *Características e Impacto Socioeconómico de los Huracanes "Stan" y "Wilma" en la República Mexicana en 2005* (Characteristics and Socio-economic Impact of Hurricanes Stan and Wilma in Mexico), CENAPRED, Mexico; and, CENAPRED and ECLAC (2006), *Características e Impacto Socioeconómico del Huracán "Emily" en Quintana Roo, Tamaulipas y Nuevo León en Julio de 2005* (Characteristics and Socio-economic Impact of Hurricanes Emily and Wilma in Quintana Roo, Tamaulipas and Nuevo León in July 2005), CENAPRED, Mexico.

Based on data from 1970-2011, 23% of the Mexican territory is exposed to a high or very high risk of being hit by a tropical cyclone (defined by one to three tropical cyclones per year), 17% is at a medium risk (one occurrence of tropical cyclone every two years), and 60% is at a low to very low risk. Most of Mexico's coastal states are highly exposed to the risk of tropical cyclones, where the concentration of population and assets is often very high, particularly in the states of Yucatán, Veracruz, Tamaulipas, Baja California Sur, Michoacán, Guerrero, Sinaloa, Sonora and Jalisco (Figure 1.7).

Figure 1.7. **Landfall of hurricanes in Mexico (1970-2011)**

Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Based on information provided by the National Meteorological Service (May 2012).

Floods

Heavy rains occur at intervals throughout the year in most areas of Mexico, even in the absence of tropical cyclones. On average, 500 floods occur each year in Mexico. The frequency of floods is higher in the tropical southern part of the country during the rainy season (March to November), but they can also occur in the northern arid part of the country. Among Mexico's 338 river basins, there is a high risk of inundation in 17% of them, and a medium risk in another 11% (CENAPRED, 2007).

Mexico's meteorological and topographical characteristics are particularly suited to generating floods. The fragmented relief of its landscapes and its orientation related to the atmospheric circulation generates a strong orographic effect and heavy rainfall locally. In the winter, cold fronts can generate important rains in the north-eastern part of the country in the Gulf of Mexico and in the Yucatán Peninsula. Convective rainfalls can be very intense as well, as is typical in Mexico City. These various types of meteorological phenomena can generate flash floods or more lengthy riverine floods, and more importantly, they can happen simultaneously and interact in a way that increases the level of water overflowing its natural river course. The effects are even more severe when storm surge elevates the level of water at a delta, blocking a river's natural outflow to the sea. Floods may also occur as a result of dam overflow, the mismanagement or even collapse of dams. Many of the country's 4 500 dams were constructed long ago and have not always been properly maintained.

Table 1.2. **Major floods in Mexico and their impacts (1943-2004)**

Year	States	Number of deaths	Cost of total damages (USD millions)
1943	Sinaloa	27	0.14
1949	Sinaloa, Sonora	10	10.2
1955	Quintana Roo, San Luis Potosí, Tamaulipas, Yucatán, Veracruz	110	7.5 (only concern the city of Tampico, Tamaulipas)
1959	Colima, Jalisco	1 500	
1960	Chihuahua, Sinaloa, Sonora,	3	18.82
1967	Baja California, Guerrero, Nayarit, Nuevo León, Tamaulipas, Quintana Roo, Sonora, Yucatán	15	500
1968	Chihuahua, Coahuila, Colima, Durango, Sinaloa, Sonora	10	
1976	Baja California Sur, Chihuahua	600	3.1
1982	Sinaloa	0	114.6
1985	Nayarit	0	16.4
1988	Campeche, Coahuila, Nuevo León, Quintana Roo, Tamaulipas, Yucatán	225	766
1990	Baja California Sur, Chihuahua, Sinaloa, Sonora		50.85
	Hidalgo, Veracruz	139	90.7
1992	Nayarit	64	78
1993	Baja California	33	32
	Baja California Sur	3	63.4
	Hidalgo, San Luis Potosí, Tamaulipas, Veracruz	40	
1995	Baja California Sur, Sinaloa, Sonora	200	418.4
	Campeche, Quintana Roo, Tabasco, Veracruz	23	
	Campeche, Quintana Roo, Tabasco, Veracruz		
1997	Guerrero, Oaxaca	228	447.8
1998	Chiapas	229	603
	Baja California	92	38.78
1999	Hidalgo, Puebla, Tabasco, Veracruz,	387	807.5
2000	Chiapas, Nuevo León, Quintana Roo, Tamaulipas	9	38.78
2001	Baja California Sur, Sonora	9	184.15
	Chiapas, Guerrero, Jalisco, Michoacan, Veracruz	95	42.3
2002	Campeche, Yucatán	4	870.07
	Jalisco, Nayarit	2	122.15
2003	Guanajuato, Jalisco, Michoacán, Nayarit, Zacatecas	14	194.13
2004	Coahuila	38	13.6
Period total		4 109	5 532.7

Source: CENAPRED (2007), *Inundaciones,* Serie Fascículos, CENAPRED, Mexico.

Other natural hazards in Mexico

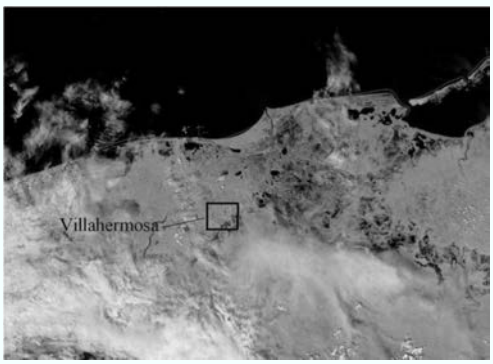
Numerous natural hazards can have significant human and socio-economic impacts in Mexico, including volcanoes, droughts, extreme temperatures, snowfall or forest fires.

Box 1.4. **The diversity of flooding risks**

At the end of October 2007, a low pressure system caused several days of continuous rain in the state of Tabasco, leading to large overflows of the Río Grijalva and the Río Usumacinta in this low-lying state. Eighty percent of the territory remained under water for almost one month, including its capital Villahermosa, where water rose to the second floor in many homes. More than 1 million people were affected in what the President of Mexico called "one of the worst disasters in the history of the country".

Satellite imagery of the 2007 Tabasco floods

Villahermosa City, 18 October 2007 (before)



Villahermosa City, 3 November 2007 (after)

Source: NASA Earth Observatory. NASA images courtesy the MODIS Rapid Response Team at NASA GSFC.

After Hurricane Gilberto in 1988, Hurricane Alex in 2010 again caused heavy orographic rainfall in and around the inland city of Monterrey in the state of Nuevo León. Even though Alex was downgraded to a tropical depression when it reached the city, 616 mm of rainfall were recorded in 60 hours by the National Water Commission (CONAGUA). Torrential flooding in the mountains surrounding the city reached the dry river bed of the Río Santa Catarina around which the heart of the city is built. With river flow recorded at 2 500 m^3/s, the flood killed 15 people and heavily damaged the city, its infrastructures, and significantly disrupted the economy of the city, and the country more broadly, with damages estimated at MXN 21.5 billion (CENAPRED, 2012).

In Mexico City and the surrounding state of Mexico, heavy convective rains cause flooding every year in low-lying areas.

In 2002, two 100-year old dams burst in the central states of Zacatecas and San Luis Potosí due to heavy rainfall, causing 11 deaths (CENAPRED, 2007; Dartmouth Flood Observatory).

Volcanoes

While about 2 000 volcanoes are registered in Mexico, there are currently 14 active ones that have erupted in its modern history (Figure 1.8) and an average of 15 eruptions per century over the last 500 years. In Mexico, volcanoes are located in an east-west belt over 1 200 kilometres long, and between 20 and 150 kilometres wide. The belt crosses the Mexican continental territory from Nayarit on the Pacific coast to Veracruz on the Gulf of Mexico. Moreover, other important tectonic activities take place in the north-west of the country (Baja California, Sonora), in Mexico's Pacific islands and in the southern state of Chiapas. Past volcanic eruptions have had significant consequences (Table 1.3). The eruption of the Chichonal volcano in 1982 is considered as the worst damaging volcano disaster in Mexico's history. It led to 20 fatalities due to the collapse of low-cost ceilings under the weight of accumulated ash, the destruction of the town Francisco León by a pyroclastic flow and the devastation of 150 km² in southern Mexico. In 1994, after almost 70 years of inactivity, the Popocatepetl, close to Mexico City, began to have important activity again. Its eruptions in the same year led to the evacuation of 20 000 persons. This period of activity has not yet stopped.

Figure 1.8. **Main active volcanoes in Mexico**

Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: CENAPRED (2012), *Atlas Nacional de Riesgos*, Ministry of the Interior, Mexico, *www.atlasnacionalderiesgos.gob.mx*, consulted 23 October 2012.

Tsunami

The Pacific coast of Mexico is exposed to two types of tsunamis: remote origin and locally generated (Figure 1.9). The northern part of the Pacific coast, which includes the states of Baja California, Sonora and Sinaloa, is exposed to tsunamis of remote origin. These are considered to be low-risk tsunamis, as their surge does not typically exceed three meters. On the other hand, the central and southern coasts are exposed to high-risk locally generated tsunamis due to seismic activity in the Meso-American trench: the industrial and touristic area spanning over 1 000 kilometres is highly exposed to destructive local-origin tsunamis with surges reaching ten meters in height. The 1925 and 1932 tsunamis in Colima and Guerrero are considered to be the most destructive in Mexico's history. Statistics on tsunamis are quite recent though, as the first tide-gauging network was developed in 1952. Since 1950, 59 remote-origin tsunamis have been registered; they especially affected the coasts of Baja California Sur, Colima and Guerrero while the 37 registered tsunamis of local origin mostly affected the states of Guerrero and Jalisco (Table 1.4). For instance, in 1995, various coastal populations in the states of Colima and Jalisco were affected by a 5.1 meter-high surge tsunami that resulted in significant damages, one fatality and flooded two municipalities in Jalisco.

Table 1.3. **Major active volcanoes and eruption consequences in Mexico since 1980**

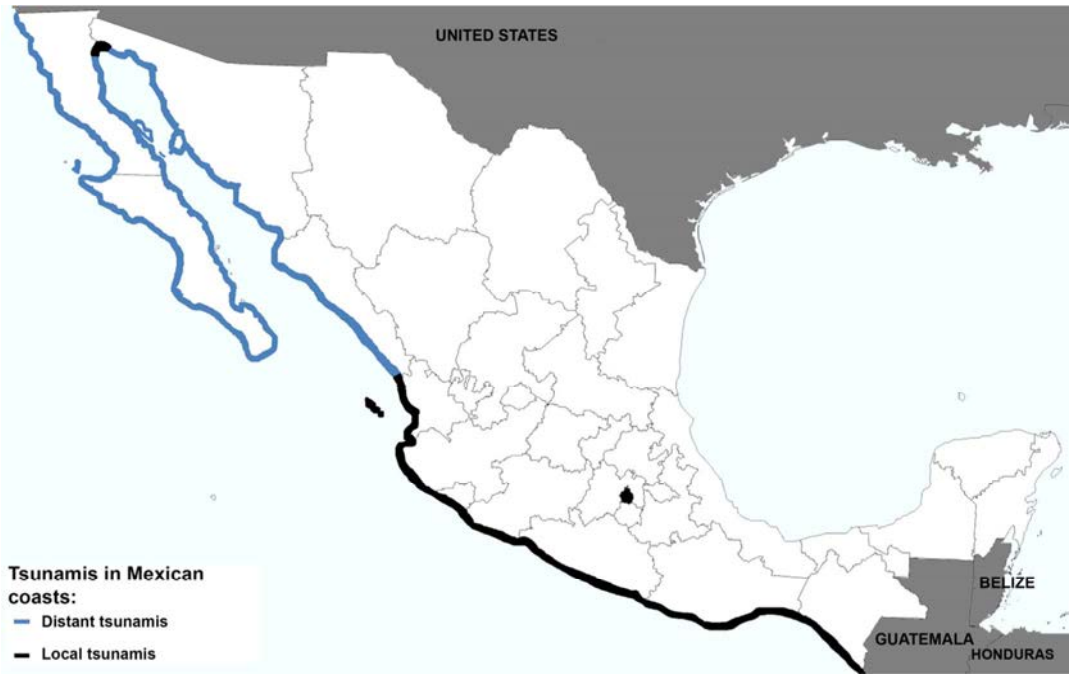
Volcano	Consequences
Fuego, Colima	– Lava flows generated glowing rock avalanches and ash flows
	– Population evacuated four times in 1998 and 1999
	– Lava flows from 1999 to 2001
Popocatepetl, Mexico/Puebla	– 20 000 people evacuated in Puebla – 5 deaths in 1996
	– 1997: ashes reached Mexico City
	– 1998-1999: forest fires because of glowing fragments
	– 2000: preventive evacuation (biggest eruption)
El Chichon, Chiapas	– 1982: various massive explosions
	– 20 victims of collapsing ceilings because of ash accumulation
	– 15 km² of cultivated lands were damaged
	– 20 000 affected people

Source: CENAPRED (2010), *Volcanes*, Serie Fascículos, CENAPRED, Mexico.

Landslides

Although landslides in Mexico generally occur when heavy rains destabilise slopes and hillsides, often where deforestation has loosened the sediment, ground movements might also follow from rock falls, debris flows and slope instability (Figure 1.10). In 1997, after Hurricane Pauline had drenched the state of Guerrero, landslides were registered in the city of Acapulco, leading to numerous rock avalanches. Similar events occurred in October 1999 in the states of Hidalgo, Puebla and Veracruz, when torrential rains led to hundreds of landslides and the deaths of 120 people as well as significant economic damages in Puebla. In 2000 in Tabasco, heavy rains weakened limestone quarries, and sudden collapses killed seven people. Finally, in 2007 one of the largest recorded landslides in Mexico's history occurred in the state of Chiapas, involving the movement of about 55 million m^3 of rock following heavy rains. The tsunami-like wave of 50 metres clogged the Grijalva river (CENAPRED, 2008c).

Figure 1.9. **Tsunami risk in Mexico**



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: CENAPRED (2012), *Atlas Nacional de Riesgos*, Ministry of the Interior, Mexico, *www.atlasnacionalderiesgos.gob.mx*, consulted 23 October 2012.

Table 1.4. **Number of tsunamis registered in Mexico after 1950**

State	Tsunamis of remote origin (including the 1995 regional tsunami)	Tsunamis of local origin
Baja California	7	0
Baja California Sur	11	2
Colima	10	7
Jalisco	2	9
Guerrero	10	12
Michoacán	0	3
Oaxaca	9	3
Sinaloa	7	1
Sonora	3	0

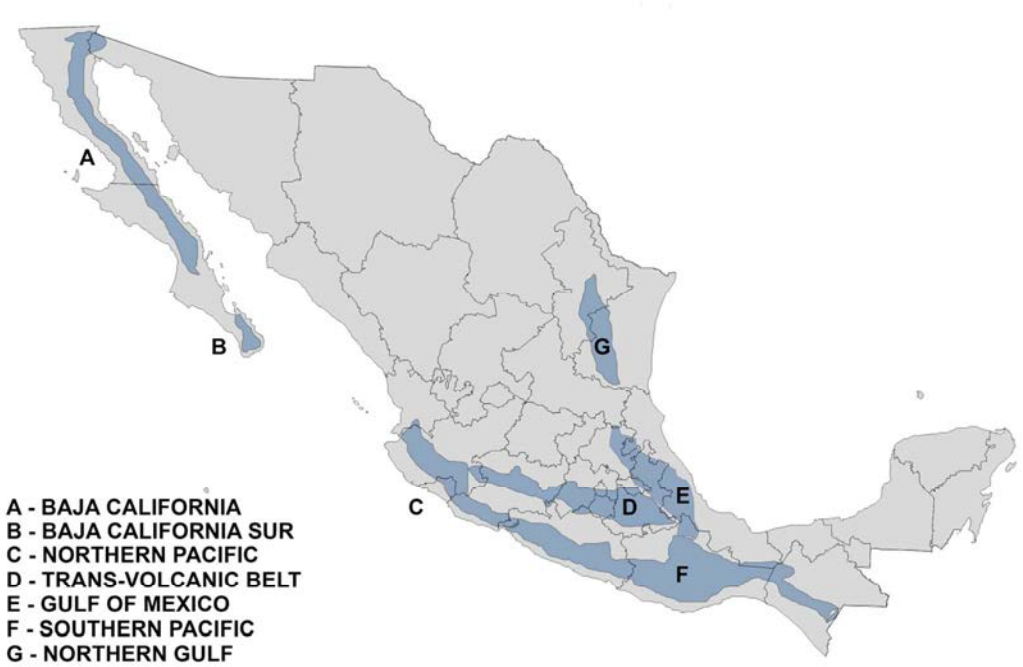
Source: CENAPRED (2005), *Tsunamis*, Serie Fascículos, CENAPRED, Mexico.

Climate-related hazards

Droughts

Drought is a frequent phenomenon in Mexico with around 70% of the national territory (Table 1.5) subject to at least mild, and in some cases extreme, droughts. Droughts usually affect the central and northern parts of the country, and they can have important economic impacts on the agricultural sector. During the 20th century, four major drought periods were registered: 1948-1954, 1960-64; 1970-78 and 1993-96. More recently, more severe droughts have been observed: their duration and severity tend to increase and their spatial expansion is broader than before. An example of drought consequences for the whole territory can be observed during the 1998 drought which affected 23 states (Table 1.6).

Figure 1.10. **Landslide areas in Mexico**



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: CENAPRED (2012), *Atlas Nacional de Riesgos*, Ministry of the Interior, Mexico, *www.atlasnacionalderiesgos.gob.mx*, consulted 23 October 2012.

Table 1.5. **Percentage of Mexican territory affected by droughts**

Type of drought	Number of municipalities	Affected area		Affected population	
		km²	%	Number	%
Extreme	195	573 000	29	9 913 699	10
Moderate	408	712 8000	37	21 478 004	22
Low	572	81 620	4	6 764 556	7

Source: CENAPRED (2002), *Sequías*, Serie Fascículos, CENAPRED, Mexico.

Heat waves and freezes

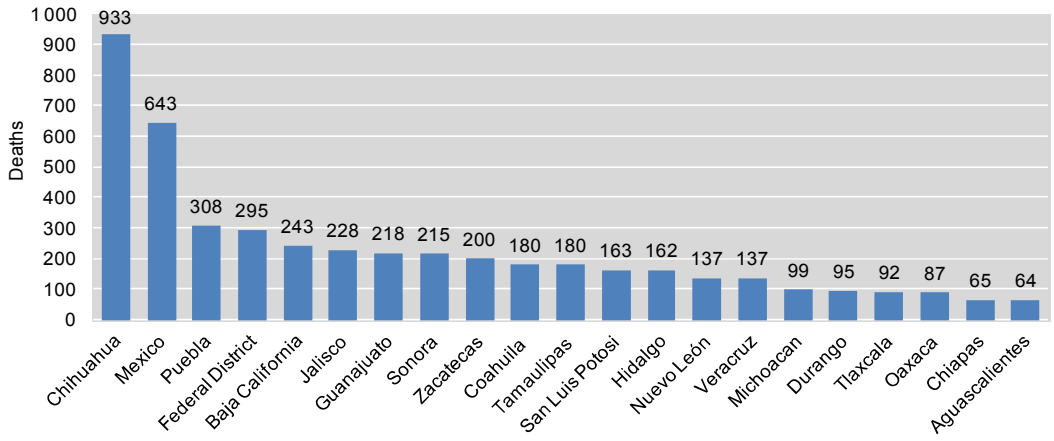
Extreme temperatures, including heat waves and cold fronts, can also lead to loss of lives. For instance, low temperatures in the northern state of Chihuahua between 1985 and 2005 were indirectly related to 933 deaths (Figure 1.11), most of which were caused by carbon monoxide poisoning that occurred due to poorly ventilated home heating systems.

Table 1.6. **Economic and social consequences of the 1998 drought**

Affected areas	Economic and social consequences
North	– 1 million heads of cattle died
	– 40 000 hectares of crop lands damaged (decrease in production by 50%)
	– 32 deaths – migration of 22 000 people towards the United States
North-east	– 415 000 heads of cattle and 13 people dead
	– 7 000 cases of dehydration
	– 300 000 hectares of affected crops – loss of 50% of crops
	– Dams only reached 30% of their capacities
Center	– 600 000 people affected by water shortage in Michoacan
	– Loss of 45% in wheat crop – 300 000 crop hectares
	– Dams only reached 10% of their capacities
	– 330 affected communities by temperature reaching 50°C
	– MXN 1 000 million of economic losses in the countryside
South	– 6 500 families suffering from thirst – 4 dead people
	– 90% of Tabasco basic crop is affected
Yucatán Peninsula	– Worst drought in 20 years
	– 345 000 crop hectares affected

Source: CENAPRED (2002), *Sequías*, Serie Fascículos, CENAPRED, Mexico.

Figure 1.11. **Number of deaths caused by freezes in Mexico (1985-2005)**



Source: CENAPRED (2008), *Heladas*, Serie Fascículos, CENAPRED, Mexico; with data from the Ministry of Health (2007).

Implications of climate change

The effects of climate change have been linked to increased variance of annual precipitation in many OECD countries. While the annual average remains nearly unchanged, precipitation has become more concentrated in shorter periods of time, implying more intense rain and longer dry seasons. Given the frequent occurrence of hydrometeorological hazards, droughts and heat waves in Mexico and their associated damages, SINAPROC pays keen attention to changing climatic patterns and has begun to plan for emerging risks.

According to the Intergovernmental Panel on Climate Change, the observed long-term increases in tropical cyclone activity are robust. It projects tropical cyclones will increase in their severity, with a reduced number of weaker storms in most basins and an increased frequency of stronger storms. Its models project rainfall rates associated with tropical cyclones will increase around the centres of storms by 3% to 37% (Intergovernmental Panel on Climate Change, 2012). Taken together with a projected increase of sea levels, floods associated with tropical cyclones may see their severity increase over the next decades, especially in coastal areas.

Infectious diseases

The first detected cases of the H1N1 virus linked to the 2009 flu pandemic were in Veracruz, which led Mexico to activate its national epidemiological alert. The rapid spread of this outbreak was detected through pro-active surveillance and consequently reported to the Pan-American Health Organisation (PAHO) in accordance with the International Health Regulations (IHR). At the end of April 2009, 1 455 probable cases of influenza including 84 deaths were reported across the country, mostly concentrated in the Federal District and surrounding states. Day-care canters, schools and universities were closed, and social and cultural activities were suspended in Mexico City for a period of ten days (PAHO, 2009). In the meantime, the influenza virus spread rapidly in other countries and the World Health Organisation (WHO) activated its emergency processes including the declaration of a Public Health Emergency of International Concern (PHEIC) on 25 April 2009. The characteristics of the H1N1 virus, its susceptibility to existing anti-viral stockpiles and the ways to develop the appropriate vaccine were rapidly identified and led to an internationally co-ordinated response in what was eventually declared a pandemic by WHO on 11 June 2009. Mexican authorities and its national health system took effective actions in their response to the influenza such as the international sharing of information and containment measures (ECLAC, 2010). Nevertheless, as the outbreak of the pandemic continued, Mexico paid a large price: by August 2010, 1 292 deaths attributed to complications from the virus had been registered in Mexico as WHO announced that the H1N1 influenza event had moved into the post-pandemic period (WHO, 2011). Furthermore, economic impacts linked to business interruption and losses to the tourism sector were significant. The estimated losses linked to H1N1 influenza were MXN 127 billion, or 1% of Mexico's GDP. The tourism sector, trade transport and restaurants and bars were the most affected sectors, and the Federal District and the state of Quintana Roo were the most affected.

Mexico's vulnerabilities to natural hazards

Civil protection strategies include programmes in support of mitigating the physical effects of hazards when possible, i.e. to reduce the probability of an adverse event occurring; to reduce, eliminate or transfer risk impact before an event; to control, contain

and reduce impact during an event; and to restore and recover after the event. In many cases, hazard intensity, frequency or location cannot be modified and disaster damage reduction strategies should focus on reducing vulnerability (see Chapter 4). The frequency of disasters in Mexico from 1970-2011 cannot be attributed solely to a rise in the occurrence of hazards; it is in great part the result of social and economic vulnerability. Urbanisation and the concentration of assets in hazardous zones are driving the increase in financial and economic disaster losses in Mexico as in other OECD countries (Figure 1.1). This includes important economic activities such as oil extraction and coastal tourist resorts, but also the establishment of dwellings and businesses in illegal settlements.

In several parts of Mexico migration from rural areas and Central America has led to illegal settlements in flood zones, hills prone to landslides and building structures unable to withstand a significant earthquake, especially in the states of Mexico and Nuevo León. In addition, illegal settlements often lack access to basic services that would otherwise help their residents cope with extreme hazards, in some cases because they have been deliberately cut-off by public authorities as a disincentive to remain in place. Despite the increase in disaster damages, the average number of fatalities per disaster since 1985 has decreased by well over one half (Figure 1.1b). This may be due to a combination of advances in hydrometeorological forecasting, improved emergency preparedness and response capacities (WMO, 2012) and building to better standards in high seismic risk areas.

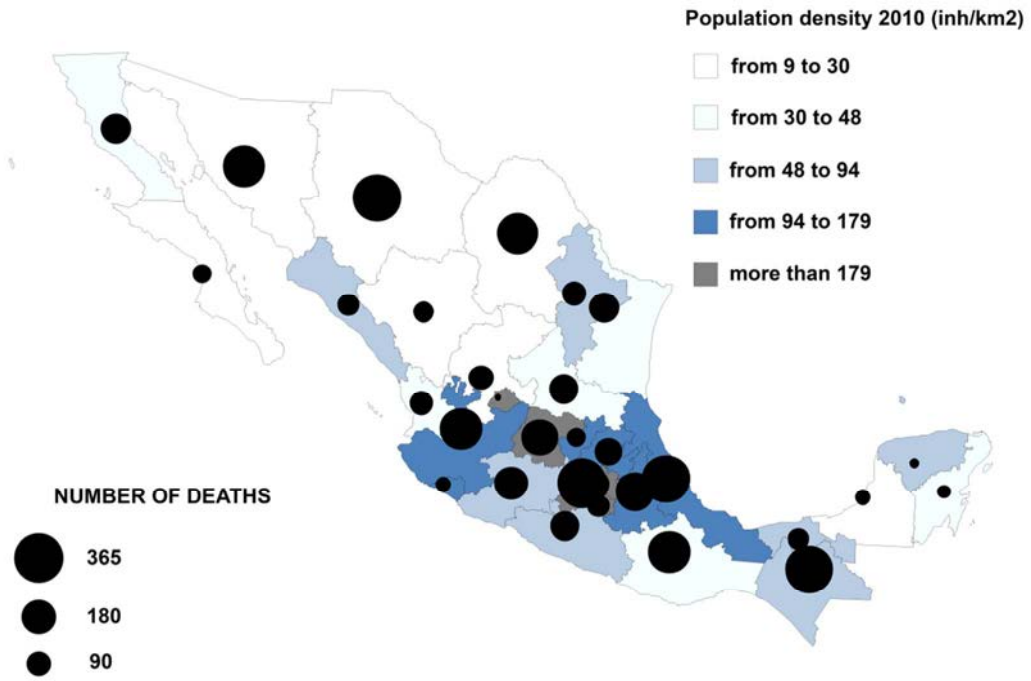
Concentrations of production and population in hazard-prone areas

More than two-thirds of Mexico's population and GDP are exposed to major natural hazards (World Bank, 2012a). Significant population concentrations are especially present across a central stretch of land that covers only 10% of the national territory (Figure 1.12), while comprising more than 50% of the population. This area includes such large cities as Mexico City, Guadalajara, Aguascalientes, Xalapa, Veracruz, Puebla, Cuernavaca and Morelia, and is exposed to tropical storms on its two lateral sides as well as earthquakes and volcanoes on its western half. The population of the Mexico City metropolitan area alone is estimated at 20.1 million inhabitants, with an average population density of 950 persons per km² and reaching as high as 5 397 persons per km² (Burton and Rhoda, 2010). This ranks Mexico City and Guadalajara amongst the highest population densities of major cities in OECD countries (Table 1.7). Other concentrations of population include the north-east economic region organised around the city of Monterrey, which extends to the states of Coahuila and Tamaulipas, and the north of Veracruz and San Luis Potosí, as well as some coastal cities and along the Mexican borders. The desert central north of the country has a very small population and the south-east of Mexico concentrates rural communities.

With two exceptions, the states located across this central band suffer the highest disaster impacts in terms of number of lives lost: casualties are higher as a proportion of population in Chiapas and Oaxaca states where poverty rates are the highest. Over 50% of the area the most prone to earthquakes is located along Mexico's poorest states of Oaxaca, Chiapas and Guerrero. Another exception is the state of Chihuahua, where cold waves have had a huge human impact in recent years. In terms of loss probabilities, the analysis of the *DesInventar database* with the method of the loss exceedance curve indicated that an event has occurred at least once a year with more than 70 deaths, 2 000 injured, 200 displaced, 20 000 evacuated, 90 000 victims and 400 000 affected,

without these effects having necessarily occurred in the same event, and one event with more than 10 000 wounded and 10 000 deaths at least every 40 years (UNISDR, 2011).

Figure 1.12. **Population density and fatalities caused by disasters**



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: Based on information from INEGI and the National Risk Atlas (CENAPRED).

Table 1.7. **Largest cities in OECD countries ranked by population density**

Rank	City/urban area	Country	Population	Land area (km²)	Density (inhabitants/km²)
1	Seoul/Incheon	Korea	17 500 000	1 049	16 700
2	Mexico City1	Mexico	19 650 000[2]	2 072	9 800
3	Santiago	Chile	5 425 000	648	8 400
4	Istanbul	Turkey	9 000 000	1 166	7 700
5	Monterrey	Mexico	3 200 000	479	6 700
6	Osaka/Kobe/Kyoto	Japan	16 425 000	2 564	6 400
7	Guadalajara	Mexico	3 500 000	596	5 900
8	Athens	Greece	3 685 000	684	5 400
9	Ankara	Turkey	3 100 000	583	5 300
10	Madrid	Spain	4 900 000	945	5 200

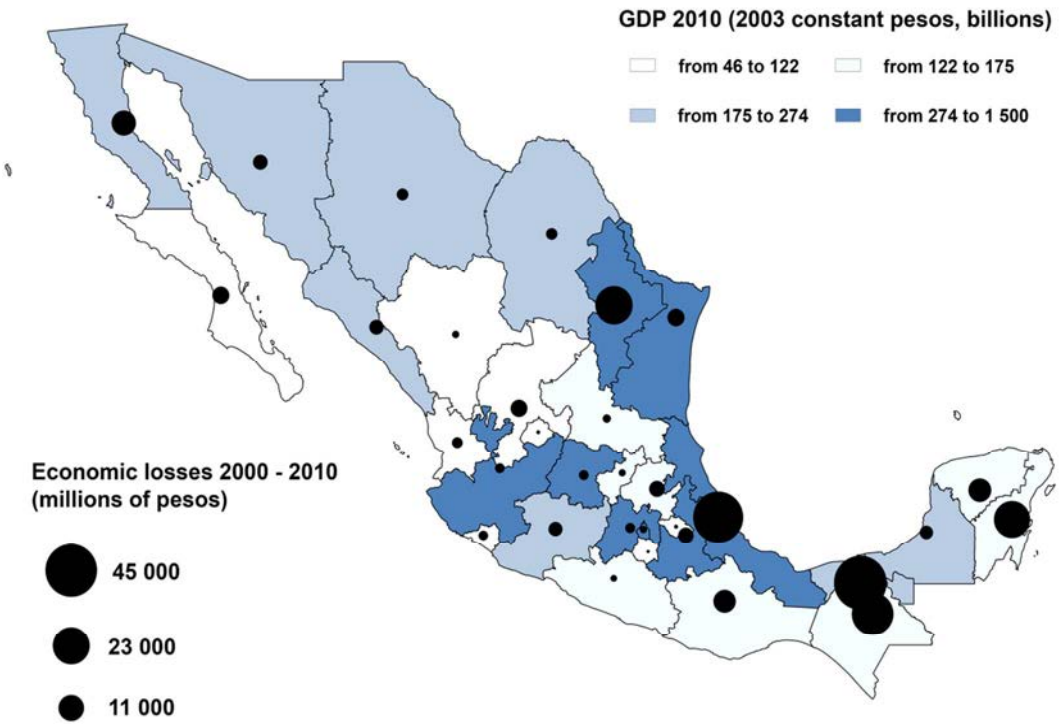
Notes: Population data may reflect metropolitan areas comprising several cities. 1. Data for Mexico City reflects population for the metropolitan area of the Mexico Valley. 2. Data provided by the State of Mexico.

Source: City Mayor Statistics (2007) *www.citymayors.com/,* July 2012.

Disasters can have a noticeable impact on Mexico's GDP: in 1985, the damages caused by the Michoacán earthquake were estimated at USD 4 billion, or the equivalent of 2.2% of GDP.[4] In 2005, the damages from three successive hurricanes (Emily, Stan and Wilma) reached the equivalent of 0.49% of GDP. The 2007 Tabasco floods led to damages in yet another noticeable year in which disaster damages equalled the equivalent of 0.45% of GDP. From 2000-09, the average annual amount of disaster damages only represented the equivalent of 0.16% of GDP, but repairing the damages nevertheless amounted to an important part of the state budget.

The economic impact of disasters on states can be more severe, especially for those with lower per capita income or multi-hazard exposures. In southern states such as Chiapas, Quintana Roo, Yucatán and Oaxaca, disasters have had significant effects on local economies. The hurricane season of 2005 resulted in economic losses amounting to more than 9% of GDP in Chiapas, and more than 14% of GDP in Quintana Roo (CENAPRED, 2006; *OECD Regional Statistics*). In northern states such as Nuevo León, the economic impact of disasters may be significant in nominal terms, but are a much lower percentage of its GDP. In 2010, Hurricane Alex caused USD 1.35 billion damages in Nuevo León, representing 1.8% of GDP and 36% of the state's public budget according to local media. In terms of loss probabilities, it has been estimated that losses equal to or greater than USD 1 million have occurred at least 80 times per year, USD 35 million at least 10 times per year, USD 400 million once per year and USD 1 billion at least once every 3 years (*DesInventar database*, UNISDR, 2011).

Figure 1.13. **GDP and economic losses caused by disasters in Mexico**



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Source: OECD, based on information of the INEGI and information provided by the National Risk Atlas (CENAPRED).

Societal vulnerability to natural hazards

While the impacts of disasters do not usually register significant macroeconomic effects at the national level, the adverse impacts on local livelihoods and living standards perpetuate poverty rates. Exposure of the poor is aggravated by their inability to accumulate savings, which increases their susceptibility to suffer losses from a disaster event (World Bank, 2012a). Disasters can consequently increase the risks of being stuck in a "poverty trap", and particularly when recurrent hazards – such as in the south-east of Mexico – overwhelm the low adaptation capacities of these populations.

Hurricanes Wilma and Stan in 2005 illustrate differences between the resilience and coping capacity of local populations. While the former caused economic losses estimated at USD 1.7 billion mostly in Quintana Roo located in the Yucatán Peninsula, economic losses related to Stan were USD 2 billion in poorer Chiapas. Over 50% of Wilma's impacts in the Yucatán Peninsula were covered by insurance since they were due to damages to touristic infrastructure. On the other hand, recovery from Hurricane Stan in Chiapas was much slower, since it affected uninsured basic goods of a generally poor population living either from subsistence farming in rural areas or in urban peripheries (Saldaña-Zorrilla, 2007).

Two distinct and impoverished populations are particularly vulnerable to hazards in Mexico: the urban poor living in informal settlements or low quality houses in hazard-prone areas, and the rural poor often living in isolated communities exposed to flooding. The urban population increased three-fold between 1970 and 2005, and by 2010 a full 62% of the population lived in the 56 largest metropolitan areas (INEGI, 2010). The urban population in the 358 cities of the "National Urban System" (*Sistema Urbano Nacional*) is projected to grow to 82% of the population by 2030 (Mansilla, 2008). Approximately 200 towns or cities of more than 10 000 inhabitants are located in river basins with high risks of flooding (CENAPRED, 2007).

The trend of rapid and continuous urbanisation observed in Mexico over the last decades was not accompanied by the appropriate development of infrastructure and land-use policies, and has permitted concentrations of rural migrants and poor populations to settle in hazard-prone areas, such as river banks. Hazard-prone areas in Mexico City, for instance, are mostly populated by the poor. The National Institute of Statistics and Geography (INEGI) developed socio-economic maps plotting the wealthiest areas of the nation's capital located on the western side, whereas the poorest areas and the slums are in the east, where risks of floods, landslides and damages from earthquakes are the highest (Saldaña-Zorrilla, 2007).

Mexico's poor rural communities are concentrated in the southern states of Oaxaca, Chiapas and Guerrero, which score very low in most human development indicators – such as income per capita, illiteracy and the number of health facilities (Saldaña-Zorrilla, 2007). In 2010, more than 60% of the population in these states lived in poor conditions. The marginalisation rate of this region is also very high, gathering the most marginalised areas in the country and suffering from high socio-demographic vulnerabilities (CONAPO, 2010). This marginalisation process is linked to rurality; while the rural population accounts for 23% of the Mexican population, it compounds more than 40% of the southern states' communities and reaches 54% in Chiapas and a third in Guerrero and Oaxaca (CONAPO, 2010).

While Mexico has enjoyed impressive economic growth over the past 20 years, remote communities often do not profit from opportunities resulting from development and growth. In Chiapas, population dispersion is an issue as 64% of the communities

within the state have a population below 50 inhabitants. Dispersion, remoteness and a high level of poverty are significantly increasing the social and overall vulnerability to disaster events of these communities, notably because, in addition to their lower adaptation capacities, they have little access to risk information or alert systems and can hardly be reached.

Among these vulnerable rural populations, indigenous communities are even more marginalised and vulnerable. Although they are present in the whole country, they are especially established in the south of Chihuahua, Veracruz, Oaxaca, Chiapas, Guerrero and Tabasco where their human development is generally low and leads to vulnerability clusters. Due to a combination of vulnerability factors, disaster losses in the Mexican countryside can exceed rural coping and adaptive capacity, thus reinforcing the urbanisation trend by triggering migration from rural areas to the already highly vulnerable urban peripheries. Emigration rates in Chiapas are higher in communities where disasters produce recurrent impacts, even compared with poorer communities (Saldaña-Zorrilla, 2006).

Disasters in Central America could also trigger migration to Mexico as has been observed in past events. In 2005, when Hurricane Stan wrought damages both in Chiapas and Guatemala, communities in Guatemala migrated to Chiapas just as the population of affected areas in Chiapas migrated to other areas of Mexico. In 2000 and 2005, just after Hurricanes Mitch (1998) and Stan (2005), international migration levels in Chiapas showed important increases of 109% and 45.71% respectively (INEGI, 2012).

Key economic sectors vulnerable to natural hazards

Four key economic sectors have shown vulnerability to natural hazards: transport, agriculture, energy and tourism.

Transport

Transport infrastructures such as roads, bridges and tunnels suffer high damages every year due to disasters. In 2011, 65% of the total post-disaster reconstruction funds, equalling USD 588 million (FONDEN statistics, 2011), were spent to restore rural and state roadways. Disruptions to road, air and sea transport (in the case of a hurricane) can interrupt business several days and sometimes weeks at the local level. Disruptions to transport infrastructure also impede the delivery of disaster relief aid and rebuilding supplies. Following Hurricane Alex, tens of thousands of trailers were unable to deliver imported medicine, equipment and building materials to industries in Nuevo León, Tamaulipas and Coahuila, due to flooded roads. Damages to transport infrastructure can also lead to important indirect damages such as productivity losses. Manufacturing in the Monterrey metropolitan area was severely interrupted during and following Hurricane Alex, when employees were unable to travel from their homes to their jobs. More than 3 700 companies were affected, including many *maquiladoras,* which are an important source of Mexico's exports to its primary trading partner.

Energy

The energy sector plays a fundamental part in Mexico's economy. Oil accounts for about 5-6% of GDP, 10-15% of exports and 30-40% of fiscal revenues (OECD, 2009) and more than 40% of the foreign currency (OECD, 2011b). Off-shore oil production areas are highly exposed to tropical cyclones and hurricanes in the Gulf of Mexico

(Figure 1.14). Tropical storms may require the evacuation of hundreds of oil platforms, while refineries and pipelines may be damaged or flooded.

Natural hazards also threaten Mexico's electricity infrastructure. Between 1996-2006 natural hazards caused four times as many high-tension power lines to fall compared to the period 1985-1995. This increase reflects the installation of new electricity infrastructure in hazard-prone areas. As of December 2009, 30% of the national electricity network was located in or close to coastal hazard zones, such as the Yucatán and Baja California peninsulas (Federal Electricity Commission, 2010).

Box 1.5. **Impacts of Hurricane Emily on oil production in Mexico**

In 2005, Hurricane Emily had significant impacts on Mexico's coastal states; however, the combined damages to the states of Yucatán, Quintana Roo, Tamaulipas and Nuevo León (MXN 4.39 billion) were less than the economic losses of MXN 4.48 billion to Mexican Petroleum (PEMEX). Evacuation of off-shore platforms in Yucatán and Campeche interrupted oil extraction for 10 days in 23 wells that had been producing 2.95 million barrels of crude oil and 1 600 million cubic feet of gas daily. Oil exports of 1.87 million barrels per day also had to be interrupted. In addition, sea conditions during tropical cyclones can threaten the navigation systems of tankers transporting crude through the Gulf of Mexico's trade routes and result in oil spills (CENAPRED, 2006).

Figure 1.14. **Location of the major oil and gas infrastructures in Mexico**

Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

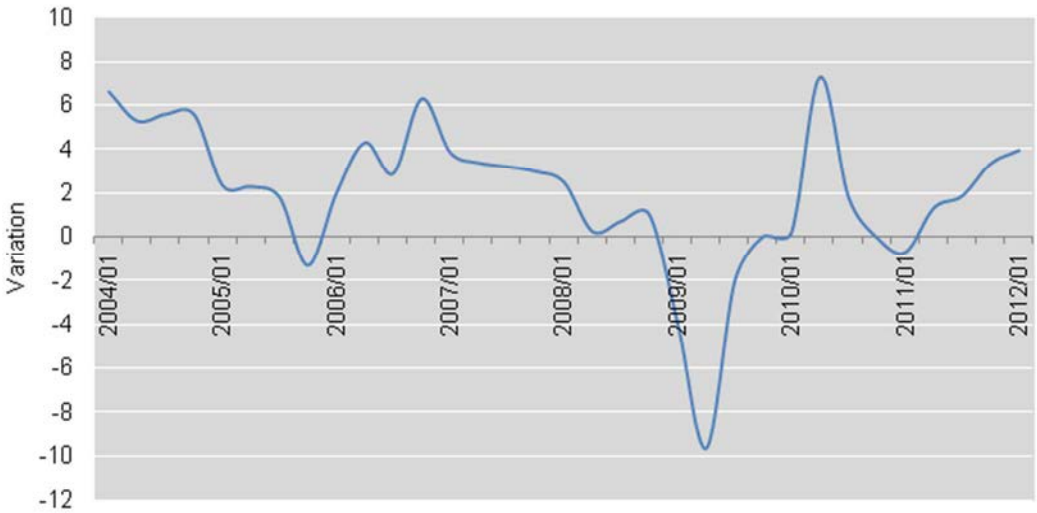
Sources: OECD based on information provided by PEMEX.

Tourism

In 2010, over 22 million tourists visited Mexico, making it the 10th most visited country in the world (WTO, 2012). With a share of 7-9% of the country's GDP, tourism is the fourth source of foreign currency and employs 7% of the labour force (INEGI, 2012). The main touristic destinations in Mexico are located in areas highly exposed to natural hazards, from Mexico City (earthquakes) to the Pacific coast and Yucatán Peninsula resorts where hurricanes and floods frequently occur (Propin Frejomil and Sanchez Crispin, 2007). Catastrophic events can have an important impact on the revenues of communities that depend on the tourism sector. In 2009, the H1N1 influenza pandemic led to a nearly 10% drop in tourism's contribution to GDP (Figure 1.15). In 2005, three major hurricanes (Emily, Wilma and Stan) resulted in significant damages to the tourist infrastructure of the Yucatán Peninsula; 1% of the tourism GDP was lost in the 3rd quarter, whereas a 2-4% increase was expected.

Disasters not only affect Mexico's tourist economy and infrastructure, they can directly threaten the tourist population, which may be more vulnerable due to poor risk awareness, a language barrier or lack of vigilance while on holiday. Managing the specific vulnerabilities of tourists may involve international relations and diplomacy with countries whose citizens find themselves without resources and in need of assistance for basic needs. In addition to the short-term economic impacts linked to the cancellation of planned trips or direct damages linked to a disaster, ineffective emergency response for the tourist population could lead to significant long-term economic impacts, such as damage to Mexico's reputation as a desirable tourist destination.

Figure 1.15. **Tourism GDP: Quarterly percentage variation**



Source: OECD based on information from the INEGI.

Agriculture

The agriculture sector only contributed 3.7% of Mexico's GDP in 2010; however, it employed 13.3% of the country's labour force (OECD, 2011b). In addition, the agro-industry has a major influence on Mexico's economy, representing 9% of GDP (FAO, 2012). Every year hurricanes and floods and other hydrometeorological hazards destroy crops, resulting in an estimated USD 32 billion in losses between 1980 and 2006

(Mansilla, 2008). Several states with more than 1.2 million hectares of croplands are highly exposed to natural hazards, such as Chiapas, Sinaloa, Veracruz, Tamaulipas and Jalisco (INEGI, 2012).

Conclusion

Overall, Mexico's territory is highly exposed to tropical cyclones (41% of the territory and 23% of its population), earthquakes (27% of its territory and 33% of its population) and all types of flooding across almost all of its territory. These three most significant hazards hold the greatest potential for becoming large-scale disasters in the country. Many seismic areas of Mexico are also exposed to major hydrometeorological hazards, the severity of which may increase in the future due to climate change. This overall picture underscores the need for Mexico to ensure that civil protection is a policy priority. The characterisation of hazards is the first step of any risk management policy, and the significant amount of available scientific information demonstrates the efforts Mexico has undertaken in this area.

This translates into significant social vulnerability. With a high concentration of its population and assets in areas highly exposed to natural hazards, Mexico's risk profile has been, and is projected to remain, one of the highest among OECD countries. Urbanisation trends and peri-urban poverty tend to increase its social vulnerability and major economic sectors of the country are also highly exposed. Higher levels of societal vulnerability among the poor have meant that disasters occurring between 2000 and 2005 increased poverty in Mexico by 3.7% (World Bank and United Nations, 2010). While past disasters have undermined longer term economic development objectives to some extent, this high level of vulnerability is a strong argument for a risk management policy that would not only address emergency response and recovery, but also risk prevention and vulnerability reduction. As the linkages between development, poverty reduction and risk management have been recognised by the Mexican government, and in particular in its 2008-2012 National Programme for Civil Protection, public policies have developed in Mexico to seize the opportunities for net economic gains through poverty reduction.

From a policy perspective, the 1985 Michoacán earthquake was a turning point in the development of civil protection, and resulted in the formal establishment of the National Civil Protection System (SINAPROC) to better plan and co-ordinate risk management policies and programmes. Mexico's national territory has been exposed to natural hazards for centuries, but the heavy human and economic tolls of recent decades are the result of development that could be better planned. Mexico will continue to be subject to high-magnitude earthquakes in the future, some of which will impact upon highly populated and vulnerable areas with major effects on the nation's economy. Major hurricanes will regularly reach the coasts of the country and flooding will happen every year. The evolution of SINAPROC as a network of institutions will be needed to limit the loss of lives, damages to infrastructures and buildings, and disruption of business activities. The challenges facing civil protection cannot be addressed by one institution or stakeholder alone, and will require policy-oriented measures to strengthen risk assessment, prevention, preparedness and response-oriented capabilities. Chapters 2-7 of this peer review examine various components and functions of SINAPROC, including policies and programmes in support of risk assessment, disaster risk prevention, emergency preparedness and response, reconstruction and recovery, and international co-operation. Progress made in each of these areas since 1986 is identified, and opportunities for improvement are defined in policy level recommendations for action.

Notes

1. A declaration of emergency is not the same as a declaration of natural disaster. A declaration of emergency is issued by the Ministry of the Interior upon the request of affected states so that they can obtain emergency support from the FONDEN federal emergency fund. A declaration of natural disaster is issued by the Ministry of the Interior upon the request of affected states so they can obtain reconstruction support from the FONDEN reconstruction fund. Both declarations are based on scientific and technical advice from dedicated committees.
2. Tropical cyclones are classified into three main groups, based on intensity: tropical depressions, tropical storms and a third group of more intense storms, whose name depends on the region. These are called hurricanes in the North Atlantic and North Pacific basins.
3. The Saffir–Simpson Hurricane Scale classifies hurricanes of the North Atlantic and North-Western Pacific cyclonic basins according to the strength of their sustained winds. It distinguishes five categories of hurricanes: Category 1 hurricanes are tropical cyclones with maximum sustained wind speed starting at 120 km/h, Category 5 hurricanes are tropical cyclones with maximum sustained wind speed starting at 251 km/h. This categorisation does not indicate the physical size of the storm nor the intensity of precipitation.
4. This percentage has been calculated using EM-DAT data on economic losses for 1985 in Mexico. GDP is in current dollars from the World Bank.

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Chapter 2

Legal and institutional framework for risk management

Mexico's National Civil Protection System relies upon a comprehensive legal and regulatory framework. This chapter will discuss key examples of the progress made, highlighting the major achievements that underpin operational and strategic strengths of the system today, while also identifying opportunities for improvement. It discusses the challenges of co-ordination across the three levels of government as well as the institutional frameworks at local level. Finally, it analyses the opportunities offered by the new 2012 General Law for Civil Protection, as well as its implications in terms of challenges for implementation.

Introduction

A core responsibility of public authorities is to ensure the safety and security of citizens, property and environmental resources throughout the national territory. In Mexico, this responsibility takes on added significance and requires capacities to manage large-scale risks due to the confluence of extreme natural hazards and vulnerable populations in some parts of the country (see Chapter 1). This underscores the importance of the National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) and its integrated approach to risk management as government capacities to foster the sustainability of economic and social development.

The experience in OECD countries shows that disaster management requires the co-ordination of organisations and resources from several levels of government, industry and social organisations that typically only work with each other under relatively rare, dangerous and often chaotic conditions. An effective civil protection system should incorporate capacities to co-ordinate every phase of the risk management cycle, including those which come to bear before, during and after a disastrous event, namely: risk assessment, risk reduction, emergency preparedness and response, recovery and reconstruction. In every phase of this cycle policies, tools and procedures are delivered by various lead ministries, agencies, and public and private sector entities, at the national, as well as at the local level. Therefore, a clear institutional and legal framework is necessary to support a co-ordinated and comprehensive approach, to clearly define the roles and responsibilities for each phase of disaster risk management.

As a result, civil protection systems need a clear statement of duties and obligations, backed by appropriate incentives and sanctions, in order to function to effectively protect citizens, assets and the economy and to help maintain trust in government. The criteria for evaluating civil protection institutional capacities are the coherence of mandates and legislation with a national disaster management strategy that enjoys broad input and support, as well as the effective co-ordination and mobilisation of operational capacities. This includes both vertical coherence between federal, state and local levels and horizontal coherence across government departments to efficiently distribute roles and responsibilities in a manner that limits duplicative efforts and fosters synergies. In summary, good practice in civil protection, therefore, entails a clear institutional and legal framework in which the mandates, roles and responsibilities of all stakeholders are defined from local to national levels, in a manner that is compatible with a country's constitution and national traditions.

Mexico is a large federal country and its Constitution grants broad autonomy to the two local levels of government – municipalities and states. Organising a national civil protection system with responsibilities for risk management entails governance challenges. The Ministry of the Interior (*Secretaría de Gobernación*, SEGOB) leads these efforts using the tools available to it to achieve national objectives horizontally across the federal government, and vertically with local levels.

Since the establishment of SINAPROC in 1986, Mexico has made impressive progress through iterative changes to its legal and institutional framework for civil protection. The evolution of civil protection in Mexico reflects policy developments in many OECD countries, where legislation and institutions are often reformed in the aftermath of major disasters. The 1985 Michoacán earthquake led to sweeping changes to the organisation of civil protection, as the devastating impacts revealed weaknesses in the

institutional framework for co-ordinating emergency response, which led to the creation of SINAPROC.

The concept of SINAPROC is an integrated system of functional parts that can draw resources from its constituent members. This framework was issued in an era of positive and dynamic change, both at the national and at the state levels. Over a ten year period (1992-2001), the 31 Mexican states and the Federal District developed their own civil protection legislation, and civil protection institutions were established at the federal and local level.

The core institutional framework of SINAPROC has not significantly changed since its creation. It comprises public, private and social sector organisations, with the three levels of government represented in the public sector, important industrial organisations such as Mexican Petroleum (*Petróleos Mexicanos*, PEMEX), and non-governmental organisations such as the Red Cross. SEGOB is responsible for co-ordinating from the federal level, and vertical integration of functions reflects the principle of subsidiarity. Municipalities can request assistance from states when their own emergency management capacities are exceeded, and states can call for the support of federal resources under the same conditions. This principle underpins the approach towards disaster risk management in other federal countries, such as Australia and the United States, where states and local communities have to provide first response capabilities for emergencies and where additional capacity can be marshalled and co-ordinated from the federal level to organise major efforts and provide assistance in the event of large-scale disasters.

The system received a legal underpinning with the first federal law on civil protection (General Law for Civil Protection 2000, GLCP), which integrated concepts previously conceived at the federal level into actions at state and local level This reflects the gradual strengthening of SINAPROC, which has gradually evolved from a disaster response-oriented system towards a more holistic and proactive approach, integrating disaster risk prevention, early warning and foresight. This effort is continuous and is expected to be strengthened by the revised 2012 GLCP, which is an acknowledgment of this change of mentality and shows that SINAPROC's missions have been officially recognised.

Towards the development of a harmonised nationwide emergency response approach

The situation before 1985

Since the creation of the first Fire Brigade in Mexico in 1871, civil protection and its governance has gradually evolved over the years, most often with a reactive approach following the occurrence of a major disaster. The creation of the Mexican Red Cross in 1910, for instance, followed a series of major earthquakes in the Guerrero Gap between 1900 and 1910.

Initially, civil protection was mostly considered a local issue under the responsibility of the municipalities and the states. After the Mexican Revolution, the Constitution of 1917 restructured the Mexican federation and defined the roles and responsibilities of the different levels of government. Public safety became a responsibility of the 2 440 municipalities, with the support of the 31 states when needed. Concerning the Federal District (*Distrito Federal*, DF), the Constitution specifically mentions civil protection as an area that the DF Legislative Assembly can regulate. Consequently, following the 1957 earthquake, which caused significant damages in Mexico City with

more than 1 000 damaged buildings and USD 25 million in estimated losses, the Federal District developed and adopted the first building codes that took seismicity into account.

The federal government became involved in civil protection in the 1960s with the creation of the National Council for Accident Prevention, and more importantly with the development of the federal Army emergency plan, the DN-III. Again, this followed the occurrence of a major disaster, the 1966 large-scale flooding of the Pánuco River in the states of Veracruz and Tamaulipas. The lack of a strong institutional framework focused on civil protection or of a body dedicated to the immediate assistance of the population, led to the establishment of the "Plan of Aid for Civil Population", commonly known as the DN-III Plan, created, managed and implemented by the Ministry of National Defence. The DN-III Plan is still one of the most important emergency response mechanisms in Mexico (Chapter 5). At the same time, the introduction of the General Law of Population and the Law of Civil Responsibility for Nuclear Damages in 1974 laid out the early responsibilities for SEGOB, and mostly focused on its role for co-ordinating disaster response (see Annex C). But what really provoked a full revision of the national approach for civil protection and the involvement of the federal government in this area was the 1985 Michoacán earthquake, which caused major damages in Mexico City.

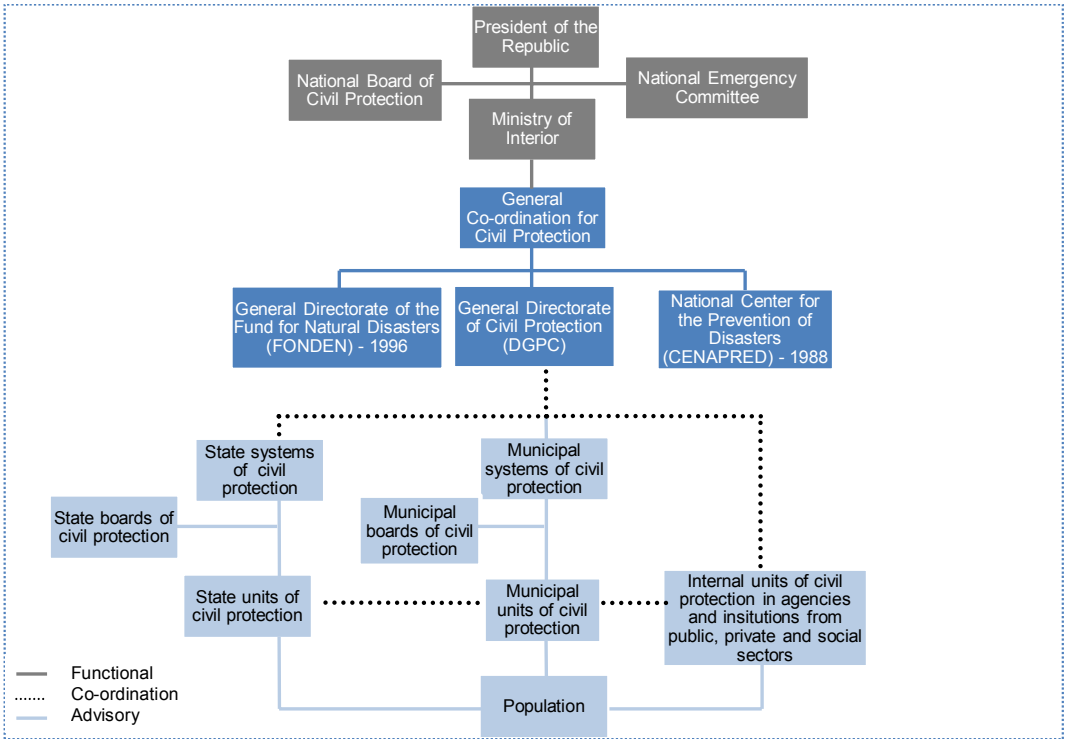
The creation of the National System for Civil Protection

The devastating earthquake of 19 September 1985 was a turning point in the history of civil protection in Mexico. Rescue, relief and early recovery operations were mostly handled by the civil society, as the government's preparedness and response was largely insufficient to respond to the needs of the affected population. The earthquake drew attention to the crucial need to set up a harmonised emergency response approach to deal with large-scale disasters nationwide.

The National Commission for Reconstruction was created in October 1985, with representatives from the federal and state governments as well as from civil society, academia and the private sector. Its mission was to tackle the issue of recovery and reconstruction after the earthquake, as well as to reorganise the whole risk management approach in Mexico. Its work led to the establishment of SINAPROC and the National Program of Civil Protection, through a decree issued on 6 May 1986. As SINAPROC was created to address the deficiencies highlighted during the crisis response, it was initially designed with a focus on emergency response. The decree mandated SEGOB to co-ordinate SINAPROC at the federal level, and states and municipalities to create respectively state and municipal civil protection systems harmonised with SINAPROC.

Over the following years, the core bodies and structures of SINAPROC were created. Figure 2.1 presents its overall structure, which has mostly remained the same over the years. At the federal level, the National Board of Civil Protection (*Consejo Nacional de Protección Civil*, NBCP) is responsible for strategic co-ordination and the National Emergencies Committee (*Comité Nacional de Emergencias*, CNE) for emergency co-ordination, while, within SEGOB, the General Co-ordination of Civil Protection (*Coordinación General de Protección Civil*, CGPC) is responsible for policy and the General Directorate of Civil Protection (*Dirección General de Protección Civil*, DGPC) for implementing emergency actions. These bodies are replicated at the state and municipal levels.

Figure 2.1. National Civil Protection System **(SINAPROC)**



Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf.*

The NBCP is supposed to meet once a year to set the guidelines for the implementation of civil protection policies in Mexico and, by law, the Board should integrate the President, acting as the chair, the heads of federal ministries, the 31 state governors and the head of government of the Federal District. However, since it was decided to include the states and the Federal District in the Board, holding regular meetings including all the stakeholders involved in the NBCP has been challenging, thus affecting the co-ordination capacities of the system. The Minister of the Interior is in charge of the secretariat. The creation of the NBCP as a high-level strategic body laid the foundation of the horizontal and vertical co-ordination arrangements on which the system performs. The NBCP defines the cross-cutting policies and programmes for civil protection in Mexico and ensures dialogue among all civil protection stakeholders. During an emergency, the NBCP is supported by the CNE, led SEGOB, to establish the co-ordination mechanisms for emergency and disaster response activities among the federal agencies and with the affected states (see Chapter 5 for a more detailed discussion).

The CGPC co-ordinates the implementation of SINAPROC's policies and programmes. It is in charge of the executive co-ordination of the system, proposing national civil protection policies and strategies to be followed by the three levels of government. While a light structure, its leadership is crucial to ensure the action and co-ordination of the wide array of stakeholders. The CGPC oversees the DGPC, which is in charge of vertical integration with the states' civil protection councils and units. It is the CGPC's contact point with SINAPROC stakeholders, working closely with them to promote and support the improvement of their civil protection plans, programmes and activities. The DGPC is also in charge of operating the National Communications Centre

(*Centro Nacional de Comunicaciones*, CENACOM). This national centre centralises and distributes information related to SINAPROC emergency preparedness and response operations, issuing bulletins to civil protection authorities across the country on potential risks.

The CGPC is integrated by two other core components of SINAPROC which were later created: the National Centre for Prevention of Disasters (*Centro Nacional de Prevención de Desastres*, CENAPRED) created in 1988 and the General Directorate of the Fund for Natural Disasters (*Dirección General del Fondo de Desastres Naturales,* DGFONDEN) created in 1996, which represent respectively the scientific and technical knowledge and the financial resources mechanisms of the CGPC. Chapters 3 and 4 discuss in more detail CENAPRED's key role in prevention while Chapter 6 focuses on the FONDEN Reconstruction Fund.

Building disaster management capacity across levels of government

Many disasters begin as local events, therefore local governments have a crucial role to play in terms of disaster management, which calls for the appropriate knowledge, needs and capacities. This has been fully recognised in Mexico, which is a large federation with 31 autonomous states plus its capital, the Federal District. Each state is divided into municipalities – or boroughs for the Federal District – for a total of 2 441. The states, the Federal District and the municipalities all have autonomous governments, creating a vertical structure for the implementation of national public policies and programmes, including at the local level. Policies defined at the central level must respect local autonomy and co-ordinate with all 32 federal entities and municipalities, facing a large and diverse audience with varying driving forces. These driving forces all have specific economic or technological capabilities, diverse population groups, levels of urbanisation, education and income, etc.

Following the creation of SINAPROC and the establishment of its co-ordination structure at the federal level, other levels of governments established their own civil protection systems. Between 1992 and 2001, all states issued a State Law for Civil Protection. Civil protection councils and units were also created in many states and municipalities. The Constitution defines public safety as a responsibility of the municipalities, with the support of the states when needed. The first state laws on civil protection were originally passed in the different Mexican states between 1991 and 2002. As the 2000 General Law was mostly intended to harmonise the system at the federal level, there were not any significant gaps between the legal frameworks of these two levels of government, which would have required changes to the state legislation. Consequently, only a few amendments were required. Generally, the state laws were designed to establish civil protection units and councils at state level. They also instituted the role of the municipalities as first responders and the principle of emergency declaration to call for federal support. These laws also recognised voluntary groups and the priority of developing a culture of civil protection among the society.

As SINAPROC's approach was gradually moving towards more prevention, some states also started to design and implement prevention policies, following the guidelines provided by the National Program for Civil Protection. This was also acknowledged by a new series of state laws developed at the end of the 2000s. Table 2.1 shows the growing importance of some of the issues related to risk prevention in states' legislation: risk atlases; record of disaster losses; insurance mechanisms in states like Chiapas, the Federal District, Tabasco or Colima. The state of Mexico defined the use of risk maps as a tool for development planning. Moreover, the state of Tamaulipas modified its Penal Code in

order to penalise people encouraging the establishment of illegal settlements in high-risk areas, among others. This movement towards more prevention at the state level shows the efficiency of the co-ordination mechanisms established nationwide. The NBCP plays a major role as a co-ordination forum allowing the governments of the states and the Federal District to participate in the decision-making process. Similarly, the CGPC encourages the support, co-ordination and willingness of the local level by involving it in meetings with the governments of the states and the Federal District, during the National Conference of Governors (*Conferencia Nacional de Gobernadores,* CONAGO), for instance.

However, a decentralised approach, in a rather heterogeneous setting, also involves a risk of fragmentation and dispersion, as all efforts may not point in the same direction. This is the challenge for co-ordination mechanisms to operate, particularly in the area of risk prevention. They indeed require the political willingness and support at the state and municipal levels, as very few mandatory regulations or control and sanction mechanisms exist, when the autonomy of the states and the municipalities remains a core principle. Key areas of risk prevention fall under the responsibility of the municipalities, as guaranteed by the federal Constitution: land-use planning and permits as well as building codes regulation, for instance. Municipalities and states demonstrate different levels of political will and a wide variety of capabilities, which can create bottlenecks for the implementation of ambitious federal policies.

Table 2.1. **States' civil protection laws**

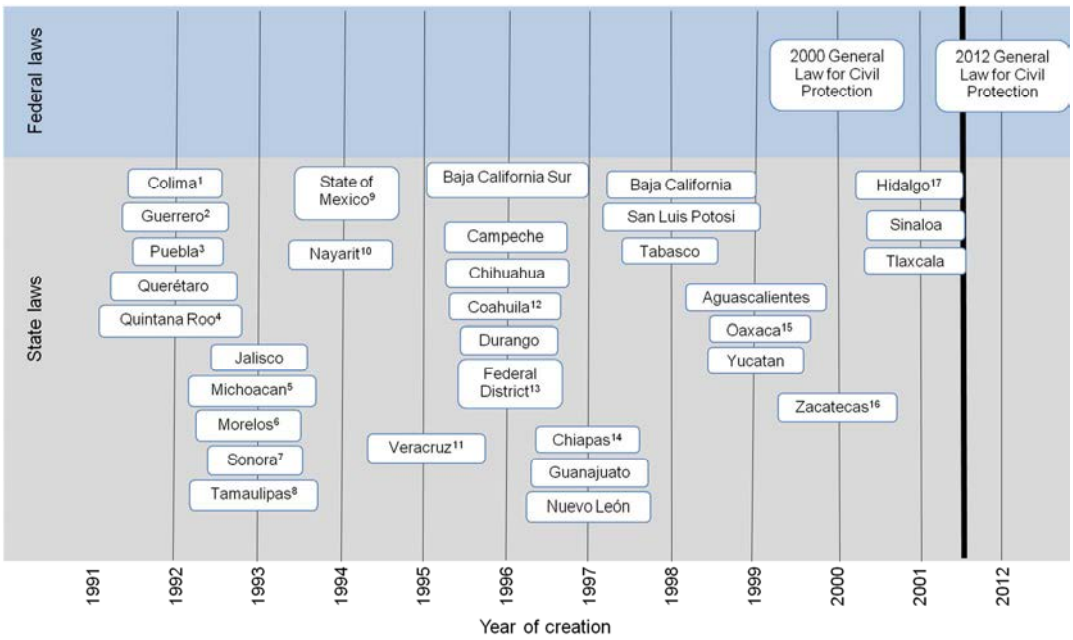
State*	Chiapas	Colima	Federal District	Jalisco	State of Mexico	Nuevo León	Tabasco	Tamaulipas
Entry into force	2011	2011	2011	1993[1]	2001[2]	1997[3]	1998[4]	1997[5]
Municipality as first responsible institution	●	●	● * boroughs	●				
Co-ordination of international support	●	●	●	●		●		●
Mention of early warning systems			●				●	
Special civil protection plans for specific populations	●	●	●	●				
Mention of municipal risk atlas	●	●	●		●	●	●	●
Mention of the use of a risk atlas	●		●	●	●		●	
Obligation of the media to disseminate civil protection information	●	●	●	●			●	●
Compulsory insurance policy for disasters	●		●		●		●	
Regional centres of civil protection	●	●	●	●		●		●
States' civil protection schools	●		●					
Records of past disasters		●	●			●	●	●

Notes: The table includes states visited on the OECD peer review missions to Mexico in 2012. 1. Last update: 2006. 2. Last update: 2010. The state of Mexico's original legal framework was issued in 1994. However, this table considers the new legal framework that entered into force in 2001. 3. Last update: 2 April 2012. 4. Last update: 1999. 5. Last update: 2010.

Source: State civil protection laws.

Specifically at the municipal level, the mandates of municipal boards are limited to a three-year period, which can result in short-term planning and human capital losses, and can affect the continuity of policies. In addition, the current lack of compliance and enforcement with regulations and the lack of sanctions at the local level are identified as important issues by SINAPROC stakeholders.

Figure 2.2. **Timeline of civil protection laws in Mexico**



Notes: The figure shows the year that the first civil protection laws entered into force in the states. Numbered laws have been abrogated by the entry into force of new civil protection laws in the state.

Date of entry into force of new laws: 1. 29 December 2011. 2. 25 June 2002. 3. 29 September 2003. 4. 1 June 2009. 5. 28 December 2011. 6. 26 August 2010. 7. 3 October 2005. 8. 22 January 1997. 9. 6 November 2010. 10. 23 July 2003. 11. 1 February 2008. 12. 14 May 2010. 13. 8 July 2011. 14. 30 March 2011. 15. 14 September 2009. 16. 21 August 2011. 17. 5 December 2011.

Source: Based on information provided by SEGOB (2012) and state's civil protection laws.

Towards greater co-ordination

With the expansion of the SINAPROC at federal and local level, the need for co-ordination increased. SEGOB concluded agreements with many federal agencies and other stakeholders from the academic and private sector to integrate them into SINAPROC. The purpose of these agreements was to define the co-ordination linkages to ensure the operability of the system. From 1989 to 2000, more than 20 such agreements were signed. The FONDEN Reconstruction Fund was created in 1996 under the responsibility of SEGOB.

The need surfaced for a clear legal structure to harmonise all of these different initiatives. The complexity of and number of stakeholders involved in SINAPROC activities required a legal framework to clarify their mandates and co-ordinate their actions. Likewise, the issuance of regulations in the states and municipalities required federal guidance to ensure the efficient functioning of the overall system. The federal government thus made the creation of a federal civil protection law a priority of the

National Program of Civil Protection (*Programa Nacional de Protección Civil*, NPCP) for the period 1995-2000. In 1999, an amendment to the federal Constitution granted the Mexican Congress the power to legislate on civil protection, providing legal support and setting the foundation for the creation of the General Law of Civil Protection (*Ley General de Protección Civil*, GLCP) which entered into force in 2000. From its creation in 1986 through its evolution until 2000, SINAPROC has progressively resulted in a harmonised nationwide emergency response which was consolidated by the adoption of the first GLCP in 2000.

The 2000 GLCP focused on emergency response. It acknowledged, for the first time, the multiple roles of the federal government in civil protection:

- to develop general guidelines for civil protection in Mexico;
- to earmark a budget for civil protection and in particular the Reconstruction Fund in the federal budget;
- to issue disaster and emergency declarations.

This law laid out the roles and responsibilities of the different bodies engaged in SINAPROC. It acknowledged the need to develop a multi-year civil protection programme as part of the national planning to fix objectives and tasks. The principle of subsidiarity was enacted in law to clarify how the federal government could support civil protection emergency response at the local level, along with the process for declaring emergencies and disasters, which is necessary for states to be able to trigger this support and to access the federal Reconstruction Fund FONDEN. In addition, the law included specific chapters regulating the participation of voluntary groups in the response phase, as well as the articulation of the emergency forces from municipal, state and federal levels (Army and Navy). As a general law, it was mandatory for states to transcribe it in their legislation.

The adoption of the 2000 General Law modified the organisation of powers between the three levels of government, allowing the federal government to initiate and implement policies in the domain of civil protection. As the balance of power and the autonomy of the states and municipalities *vis-à-vis* the federal government are sensitive issues in Mexico, the law did not impose significant changes to be implemented but rather provided a homogenised framework for the development and implementation of civil protection activities. Apart from creating local units of civil protection, it did not establish specific obligations for states and municipalities. It was for this reason the law did not particularly innovate and focused mostly on a traditional approach to risk management based on emergency response. Most of the key elements of the law were indeed related to emergency response: the principle of subsidiarity, the disaster/emergency declaration, the Reconstruction Fund, volunteer and emergency forces. Few elements of risk prevention were present, with a clear priority on education on risk and civil protection – a rather consensual topic – the foundation for the creation of a federal prevention fund and the need to develop a risk atlas. It was only in the following decade that risk prevention gradually became a priority of SINAPROC.

A gradual move towards more emphasis on preventive approaches

Once the 2000 General Law was passed, the then well-established federal institutions co-ordinating SINAPROC gradually started putting emphasis on risk prevention, which appeared more clearly in federal programming: the 2001-06 National Development Plan and the 2001-06 National Programme of Civil Protection clearly shifted SINAPROC's strategy from a reactive to a preventive one. This paradigm shift was aligned with work carried out at the international level during the United Nations International Decade for Natural Disaster Reduction 1990-99, promoting the importance of prevention and mitigation policies which served as a reference in Mexico. Many of the policies related to prevention elaborated during this period, including the work on risk atlases and the creation of the federal prevention fund (*Fondo para la Prevención de Desastres*, FOPREDEN) in 2003, are further analysed in Chapters 3 and 4.

Under this new approach, the need to precisely allocate roles and responsibilities for all stakeholders became crucial. It led to the publication of the *Organization and Operations Manual of the National Civil Protection System* in 2006 (the "Manual"), which defined for the first time each stakeholder's mandate in the three key areas of risk management: prevention, response and recovery. While SINAPROC's overall organisation and bodies remained the same, for the first time stakeholders' functions and responsibilities were defined in detail. While SINAPROC stakeholders mainly include federal ministries and agencies, the private sector and civil society organisations such as the Red Cross, the media and chemical industry professional organisations are also involved (Box 2.1).

Box. 2.1. **Key federal agencies of SINAPROC**

In addition to SEGOB's key co-ordinating role with its CGPC and its three key directions – the DGPC, DGFONDEN and CENAPRED – the other key federal agencies involved in SINAPROC include:

- The Ministry of National Defence (*Secretaría de la Defensa Nacional*, SEDENA) is in charge of providing emergency support to the population, which constitutes one of its three key missions. Through the implementation of its emergency plan "DN-III Plan", the Army constitutes the main federal emergency force, active in response and early recovery.
- The Ministry of Navy (*Secretaría de Marina*, SEMAR), as SEDENA, is involved in the response and early recovery phase, mainly through the implementation of its emergency response "Navy Plan". SEMAR is also involved in meteorological monitoring, forecasting and warning in case of tropical cyclones, as well as in early warnings for tsunamis.
- The National Water Commission (*Comisión Nacional del Agua*, CONAGUA) is in charge of water resources management within the Mexican territory. Within SINAPROC, CONAGUA is active in all phases of the risk management cycle. In terms of prevention, CONAGUA is in charge of flood risk mapping, has the authority on land use along river beds exposed to flooding and builds flood protection infrastructure such as dams and dikes. In emergency preparedness and response, CONAGUA operates the National Meteorological Service (*Servicio Meteorológico Nacional*, SMN) and flood early warning systems, it manages the operations of dams and regulates river flows and ensures water supply to affected population. In recovery and reconstruction, CONAGUA participates in water service and infrastructure damage assessment, business continuity and reconstruction.

Box. 2.1. **Key federal agencies of SINAPROC** (*cont.*)

- The Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE) is in charge of electric production and distribution. One of its main functions within SINAPROC is to ensure the safety of its facilities and, in case of emergency, to ensure the fast restoration of electric power supply in the affected areas. As CONAGUA, CFE operates dams for hydroelectricity purposes, and consequently has developed hydrometeorological monitoring and early warning capacities that allow it to take preventive or emergency response measures in order to ensure uninterrupted electric power supply, or fast restoration, as well as the safety of its employees and the population.
- The Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*, SCT) is responsible for ensuring and providing the necessary infrastructure for communication services and transport across the Mexican territory. As a major infrastructure developer, The SCT plays a key role in construction norms to ensure buildings' resistance to earthquakes. In SINAPROC, the SCT is also in charge of infrastructure damage assessment and reconstruction, as well as ensuring access to emergency areas by quickly repairing affected roads. It is also in charge of airports and navigation at sea and thus implements specific plans for operations during emergencies.
- The Ministry of Social Development (*Secretaría de Desarollo Social*, SEDESOL) is in charge of poverty reduction and development policies. While the majority of its programmes aim at fostering social inclusion and welfare, it also takes part in risk prevention, through its Programme of Risk Reduction in Human Settlements which finances municipal risk atlases and prevention activities at the local level. In early recovery and reconstruction, SEDESOL provides emergency supplies to the affected population, participates in shelter management and in the reconstruction of affected settlements for poor households.
- Mexican Petroleum (*Petróleos Mexicanos*, PEMEX) is the state-owned company in charge of managing oil resources. Its revenues constitute one of the main sources of financial resources for the federal budget. PEMEX is in charge of oil platforms, pipelines and refineries located on continental land and overseas. Its main objective within SINAPROC is to ensure safety within its facilities and continually review its internal and external emergency plans. As CFE and CONAGUA, PEMEX has a hurricane early warning system. During an emergency, PEMEX works in co-ordination with its local representations through a well-established line of command ensuring uniterrupted supply of fuel for the continuity of economic activity.

Note: Annex D provides more detailed information on the role of key government institutions involved in SINAPROC.

Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, SEGOB, Mexico DF.

The Manual was instrumental in mobilising all of the federal institutions and making risk management a priority. With 38 organisations in the field of prevention, 34 in the emergency phase and 18 in the recovery and reconstruction process, co-ordination is fundamental. While the Manual defines different roles in each of these domains – executive co-ordination, technical co-ordination, technical support and co-responsibility – SEGOB always remains the executive co-ordinator and the states and municipalities technical co-ordinators, with a few exceptions. This Manual clearly clarifies the roles and responsibilities of each individual stakeholder but with the exception of the previously

existing National Board for Civil Protection and the National Committee for Emergencies, does not further define the co-ordination mechanisms.

Box 2.2. **Sharing common values all along a diversified network of risk management stakeholders: Examples from France, the Netherlands and the United States**

The French White Paper on Defense and National Security (2008), the Netherlands National Risk Assessment (NRA) and the United States National Response Framework have all set up objectives and common values to be shared along an extensive inter-agency response network.

The French White Paper of Defense and National Security underlined the importance of new technologies and efficient communication providing that management planning has to strengthen communication as an operational dimension of emergency response. It promoted the creation of a crisis inter-ministries network to facilitate joint management and inter-operability. In this spirit, the Netherlands also adopted a bottom-up, whole-of-government process underlining interconnections between risks and promoting security on the agenda of public and private actors. For instance, regarding prevention, common spirit among diverse actors lies in boards such as the Cyber Security Board which allows different perspectives (government, business, science) to be considered to independently advise the government. Finally, the United States' approach favours various scales of response through close collaboration with the private and non-profit sectors. This whole community approach permits to build relationships and learn about the complexity of the community to reveal inter-dependencies. The final developed scheme is a diversified response network which is flexible and adaptable under a unified command system and shared common strategies.

Source: Ministry of Security and Justice, the Netherlands; Dutch Ministry of Interior and Kingdom Relations (2009), "Working with Scenarios, Risk Assessment and Capabilities in the National Safety and Security Strategy of the Netherlands", Directorate-General for Public Safety and Security; Présidence de la République Française and Mallet, J.C. (2008), *Défense et Sécurité Nationale: Le Livre Blanc*, Éditions Odile Jacob and La Documentation Française, Paris; US Department of Homeland Security (2011), "Risk Management Fundamentals, Homeland Security Risk Management Doctrine", US Department of Homeland Security, Washington, DC.

This holistic approach for risk management was redefined by the NPCP 2008-12, which promoted the concept of integrated risk management. The NPCP 2008-12 focused on modernising the Mexican civil protection system by strengthening its technical and scientific capacities as well as its legal basis in order to allow it to implement its new integrated risk management approach. It recognised the link between disasters and development and the relationship between vulnerability and poverty levels. To ensure its success, the DGPC monitors the implementation of the policies defined by the NPCP and proposes modifications if needed. The NPCP 2008-12 was a continuum of the NPCP 2001-06 in order to foster a stronger preventive approach.

This shift towards prevention benefited from a strong impetus from the federal government, and particularly from the institutions in charge of civil protection. This demonstrated a strong political will to strengthen the risk management policies and practices in Mexico, aligning them with international standards. However, while emergency response operational procedures are fitted to the principle of subsidiarity, prevention issues are not: lower levels of government will not ask for support from a higher level to implement prevention policies in the same way. In addition, as risk prevention deals with issues that are the responsibility of the municipalities (guaranteed by the federal Constitution), such as land use or building codes, the articulation of the roles of the three levels of government needs to be carefully thought out on these issues.

Meanwhile, while horizontal co-ordination is guaranteed during emergency phases through the National Emergencies Committee and at the strategic level through the National Board of Civil Protection, more mechanisms are required for co-ordinating the activities of the major governmental agencies (such as CONAGUA, CFE, the SCT, SEDESOL) for the implementation of long-term prevention policies.

Towards integrated risk management: The new 2012 General Law for Civil Protection and its implementation challenges

The new GLCP entered into force on 7 June 2012 and represents the achievement of more than a decade of progressive consolidation. This involved five years of preparation with intensive consultations with all SINAPROC stakeholders from the national to the local level. The law consolidates the new preventive and integrated approaches to civil protection in Mexico. It recognises integrated risk management as the key governing principle of SINAPROC, consecrating risk prevention and mitigation based on risk knowledge and identification as the best way to increase society's resilience to disasters. The GLCP also insisted on the key challenge of co-ordination by creating the guidelines, parameters and the responsibilities necessary for the co-ordination that was set out by the 2000 General Law and the 2006 Manual. While the 2000 law defined the importance of carrying out co-ordinated and concerted activities among SINAPROC stakeholders, the 2012 law has made this co-ordination mandatory.

This represents a significant milestone, after several decades of gradual progress. In 1986, SINAPROC started by establishing a light co-ordination mechanism between the three levels of government, which mostly focused on emergency response. It then harmonised the approaches adopted at the local level through a bottom-up approach which led to the first 2000 General Law on Civil Protection. The federal level clearly showed its leadership in facilitating the evolution of the system towards an integrated risk management approach with a stronger emphasis on prevention. CENAPRED was instrumental in the development of risk assessment efforts and early warnings. FONDEN led initiatives to develop and strengthen risk financing instruments. The DGPC pushed for more co-ordination in emergency preparedness and response. The strengthening of the risk management legal framework at the federal level became crucial to further diffuse this approach and help address the implementation challenges at the state and municipal levels.

Table 2.2 shows the extent to which the stronger emphasis the 2012 law gives to prevention is presently reflected at the state level. The 2012 General Law emphasises the importance to create, improve and use prevention tools. For instance, the national and local risk maps have to be the reference framework for risk management decisions and policy making. The use of risk assessments is now mandatory for the construction of infrastructure or dwellings, and its absence is now considered an offense of the law. Mitigation actions are also mandatory when a risk has been identified. Public servants issuing land-use permits without the authority to do so are considered to be violators. The law was also instrumental in providing legal support to initiatives such as the creation of a National School for Civil Protection and the prevention programmes Safe Hospitals and Safe Municipalities. It also created five regions for civil protection. It equally created the National Centre for Civil Protection's Communication and Operation to facilitate the co-ordination between the states and the federal level during emergencies. This centre is managed by the DGPC, integrating capacities of the National Communications Centre (*Centro Nacional de Comunicaciones*, CENACOM), the National Operations Centre (*Centro Nacional de Operaciones*, CNO) (Chapter 5) and additional documental

information. In addition, the 2012 General Law recognises all of the financial mechanisms related to risk management (see Annex H for wider information on the main provisions of the 2012 GLCP).

Table 2.2. **Comparison of the 2000 and 2012 General Laws for Civil Protection**

		2000 law	2012 law
Financial mechanisms	Fund for Natural Disasters (FONDEN)	●	●
	Fund for Natural Disasters Prevention (FOPREDEN)	●	●
	Mandatory use of risk transfer mechanisms on the local level		●
	Special Funds for Rural Sector		●
	Creation of the Local Civil Protection Funds (FOPROCI) (mandatory for states)		●
Guidelines	National Development Plan as the framework for the National Program of Civil Protection		●
	National Program of Civil Protection	●	●
	Holistic risk management		●
	Special programmes of civil protection	●	●
	Establishment of inter-institutional committees and scientific advisory committees		●
	Mandatory co-ordination		●
	Technical information sharing (mandatory)		●
	Climate change		●
	Institutional co-ordination agreements	●	●
	Certification of competences by the National School of Civil Protection		●
Risk assessments	National Risk Atlas	●	●
	Local risk maps		●
	Use of risk maps for decision making		●
	Mandatory risk assessments for construction areas (law offense)		●
	Mitigation works in risk areas		●
	Relocation and mitigation works in risk areas		●
	Issuance of land-use permits by public servants (law offense)		●
Education and capabilities	Improved conceptualisation of civil protection culture		●
	Self-protection culture	●	●
	Certification and authorisation of training providers by civil protection authorities	●	●
	Risk knowledge as a right of the population		●
	National School of Civil Protection		●
	Civil protection included in educational curricula		●
Risk communication	Co-ordination with the media	●	●
	Use of official media times		●
Emergency preparedness	Internal programmes of civil protection	●	●
	Internal units of civil protection		●
	Safe Hospital Program		●
	Hazardous materials		●
	National Centre for Civil Protection's Communication and Operation		●
	Volunteers: National Network of Communitarian Brigades		●
Emergency response	International co-operation	●	●
	Guidelines related to emergency or disaster declarations	●	●
Recovery	Donations management		●
	Operations continuity		●
	Resilient communities		●

Source: 2000 and 2012 General Laws for Civil Protection.

The 2012 General Law makes it mandatory for state governments to adapt their state laws to the General Law. National authorities are committed to continuing to improve the preventive and mitigating capabilities of the system. However, significant challenges remain in terms of implementation at the local level in order to fully adapt local regulations and capacities. The new responsibilities established by the GLCP have created a gap between the federal and the current local legislation, creating new challenges from a multi-level governance approach (Table 2.3). In particular, issues related to land use, financial issues such as the allocation of funds at the state level for risk prevention purposes, or the development of risk transfer instruments may be challenging for some states and municipalities. The success of the new risk management approach promoted by the federal government will depend on the implementation of this new law at the local level. This will require that local legal frameworks be adapted according to the new regulations established by the General Law, and that local stakeholders be aware of it. However, this process is not easy as it depends on local support and political willingness, requiring a strong federal leadership. For the first time, sanction and control mechanisms have been established. Will they be effective? Will local governments accept the greater requirements imposed by the federal law? These are questions for the years to come. The law may also require the federal level to adapt SINAPROC to ensure that the currently light co-ordination structure is adapted to implement not only an emergency response approach, but a larger one as well encompassing all components of the risk management cycle. The new version of the SINAPROC Manual currently being developed by the CGPC will be a crucial instrument to further establish co-ordination mechanisms, especially in the area of prevention.

Table 2.3. **Integration of the 2012 General Law concepts into state laws for civil protection**

	Integrated risk management	Compulsory risk transfer mechanisms	National School of Civil Protection	Use of risk atlas
Chiapas	●	●	⦿*	●1
Colima	●	○	○	–
Federal District	–	●	⦿*	●2
Jalisco	–	–	○	●3
State of Mexico	–	●	○	●4
Nuevo León	–	–	○	–
Tabasco	–	●	○	●5
Tamaulipas	–	–	○	–

(–) Not mentioned
● Yes
○ No

Notes: * The state of Chiapas and the Federal District have their own state civil protection schools. 1. Municipal urban plans must comply with risk atlas parameters. 2. Creation and update of the Federal District's and boroughs' civil protection programmes. Integration of regional operational centres, identification of uninhabitable areas. 3. Reference for urban, touristic and industrial planning and urban growth. 4. Tool for development planning. 5. Considered as an operational civil protection instrument.

Source: 2012 General Law and state laws for civil protection.

Conclusion

Risk management in Mexico has evolved significantly since SINAPROC was created in the aftermath of the devastating 1985 earthquake. In a federal country, the articulation of mandates and responsibilities between the various levels of government touches upon sensitive issues related to states' and municipalities' autonomy as guaranteed by the Constitution. While SINAPROC was initially created to strengthen and harmonise Mexico's emergency response and capacities based on the principle of subsidiarity – bottom-up – it gradually evolved to include more prevention, driven by the federal government – reaffirming the national level's steering function. The two-phase development of the legislation related to civil protection, with the 2000 law harmonising emergency response and the 2012 one mainstreaming prevention, is a clear reflection of this trend. Meanwhile, SINAPROC's institutional structure has not significantly evolved, apart from the creation of new bodies, such as CENAPRED and FONDEN, and specific instruments. A question then remains: how can a structure that was designed for emergency response and to apply the principle of subsidiarity be appropriate for ensuring prevention policies are developed and implemented throughout the country, particularly at the local level?

Over the past two and a half decades, SINAPROC has achieved incremental improvements, notably in its planning, response and recovery capacities. Similar to many OECD countries, however, there is a need to shift the focus toward risk prevention capacities. This forward-looking approach aims to stop or reduce damages before they occur, and is consistent with placing climate change adaptation at the core of the country's strategic vision for development. These improvements have enjoyed strong political support at the federal level and buy in from most of SINAPROC's stakeholders. It is necessary for them to be continued to foster resilience and keep pace with increasing vulnerabilities.

Mexico's federal and state civil protection laws are milestones in the incremental process to establish a national system of integrated risk management. They provide a legal basis to move beyond the traditional focus of emergency preparedness, response and recovery, calling for disaster risk reduction actions and prevention based on common guidelines for risk assessments. Implementation of the 2012 General Law on Civil Protection provides an opportunity to strengthen co-operation in these respects and fix priorities to better align sub-national programmes with federal policies.

Recommendations

- Seize the opportunity of the 2012 General Law for Civil Protection to set priorities for integrated risk management through multi-level stakeholder consultations.
- Follow-up implementation of the 2012 General Law at state level with a dedicated monitoring mechanism and programme to establish benchmarks.
- Design the next National Programme for Civil Protection to leverage momentum created by the 2012 General Law.
- Include civil protection as a priority in the National Development Plan.

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Chapter 3

Risk assessment in the National Civil Protection System

This chapter analyses the progress that has been made since 1986 to produce reliable and scalable risk assessments for the most serious risks facing Mexico – including efforts to produce a geographic information system-based mapping of earthquake, hurricane and flood hazards with overlays of the population and infrastructure assets that are exposed to these hazards. Responsibility for risk assessment in civil protection policy planning and implementation is often spread across different bodies and levels of government. This chapter, therefore, also examines how the National Civil Protection System supports the development and use of consistent risk assessment methods to ensure comparable results across different levels of government.

Introduction

Civil protection stakeholders at central and decentralised levels of government should conduct risk assessments to guide the optimal allocation of the limited resources destined for the various phases of disaster risk management. Risk assessment is a methodical determination of the nature and extent of risk to assets of value. It analyses the potential magnitude and likelihood of hazards, and evaluates the vulnerability of assets that could be exposed to such hazards. Without a systematic approach grounded in the best available scientific understanding of hazards, planning and investment in the disaster risk management cycle is arbitrary, more susceptible to uninformed demands and often leads to wasteful, overprotective measures or dangerous neglect of the assets that civil protection is meant to protect: people, property, livelihoods and the environmental resources on which they depend.

Figure 3.1. **Risk assessment**

Risk assessment is the starting point of integrated risk management; its results are used across all phases of the risk management cycle: prevention and mitigation, planning and response, recovery and reconstruction.

This chapter examines how Mexico's National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) supports efforts to produce a systematic and consistent approach to hazard and vulnerability analysis. It also considers whether SINAPROC has made progress in using the knowledge generated by risk assessments toward such key purposes as:

1. guiding disaster risk reduction measures such as land-use and urban development plans in the designation of high, medium and low risk construction zones (see Chapter 4);
2. raising the population's awareness and informing them of the potential risks confronting them at the national and local levels (see Chapter 4);
3. developing appropriate emergency response plans (see Chapter 5); and
4. estimating disasters damages to ensure financial strategies are implemented that are suitable in light of national risk-bearing capacity and tolerance levels (see Chapter 6).

From risk atlases to multi-sectoral and multi-level risk assessment

Risk identification and analysis are considered to be the key elements underpinning the transition to integrated risk management. After the devastating Mexico City earthquakes of 1985, the momentum to strengthen civil protection capacities led to the development of the first "National Risk Atlas". This collective effort was co-ordinated by

the Ministry of the Interior and involved various sectoral ministries (Water, Industry, Infrastructures, Urban Development, Health, Agriculture) and academic expertise from the National Autonomous University of Mexico (*Universidad Nacional Autónoma de México*, UNAM). This risk atlas, however, was mostly a hazard inventory for the national territory. The National Centre for Prevention of Disasters (*Centro Nacional para la Prevención de Desastres*, CENAPRED) published an updated version in 2001, which focused not only on hazard analysis and identification, but also on providing information about disaster risks and past disaster impacts and losses (CENAPRED, 2001).

Toward a multi-sectoral, multi-level risk assessment process

The updated version of the National Risk Atlas was followed by concerted efforts to promote the development and use of risk assessment. For example, the General Law for Civil Protection (*Ley General de Protección Civil*, GLCP) of 2000 and its follow-up policies and plans emphasised the need to expand the use of risk assessment across federal, state and municipal levels of government, as well as horizontally with the various economic and social sectors. An objective of the National Development Plan for 2001-06 was to shift the focus of civil protection from emergency response capabilities toward a more prevention-oriented approach. In particular, it provided for the need to identify and increase knowledge about threats and risks at the community level. Accordingly, the National Programme for Civil Protection 2001-06 acknowledged the risk assessment work that had been conducted previously, and in particular the National Risk Atlas. It also called for its continuous improvement as a geographic information system (GIS) based tool, to be further developed in co-operation between the three levels of governments, and with the social and private sectors.

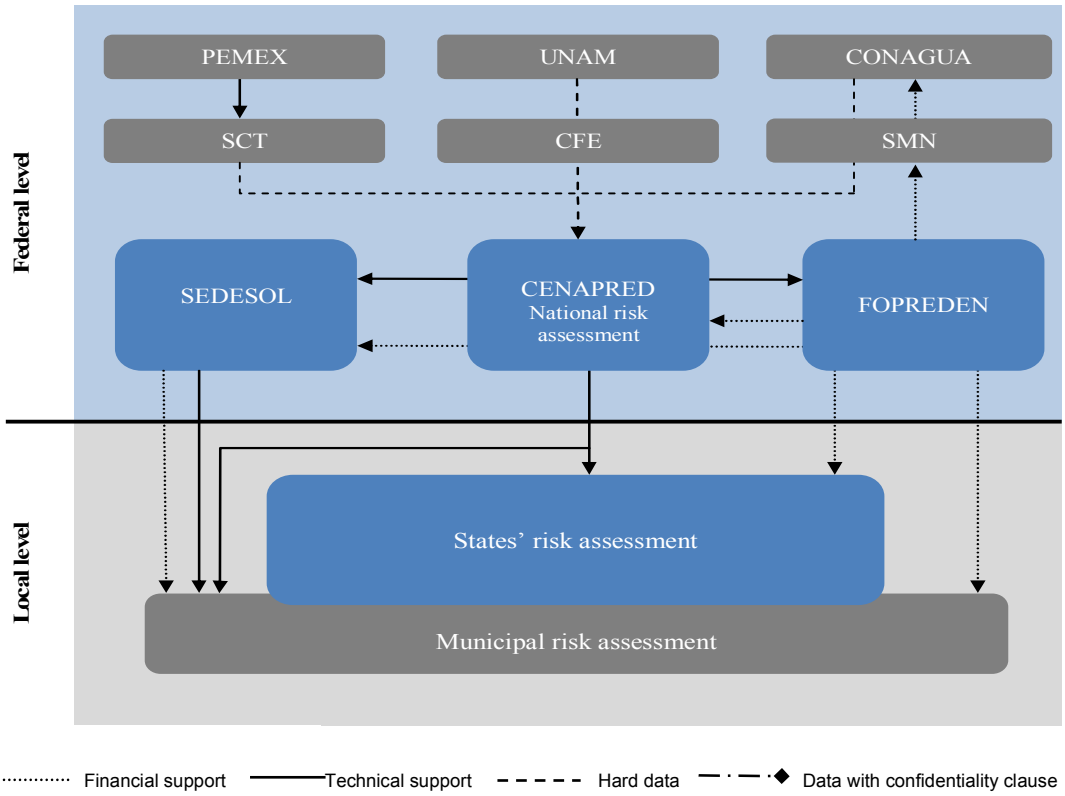
In 2004, CENAPRED began the development of a third-generation National Risk Atlas. It evaluated hazards, risks and damages linked to disasters, integrated this data into a GIS-based tool, and thereby increased risk knowledge in co-ordination with many contributing organisations. In parallel, the Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL) started to support the development of risk atlases in urban areas in 2004 and published a methodological guide for developing them through its "Habitat" programme. It also launched a GIS tool for risk identification.

In 2006, the SINAPROC Manual clearly laid out the roles of all federal entities in the various areas of risk management (see Annexes E and F). Regarding hazard data collection, mapping and the development of risk information, CENAPRED has the overarching role of supporting the technical development of such information and ensuring it is integrated appropriately into the National Risk Atlas. The various sectoral ministries and organisations, as well as the state and municipal governments, each have a key role to play in their specific areas (Figure 3.2).

Following this clarification of roles and responsibilities for risk assessment, CENAPRED published a full list of guidelines and manuals for the development of risk atlases with the appropriate concepts corresponding to the three levels of government. The benefit of these publications was to highlight how few states and municipalities had developed a risk atlas that met the minimum standards of quality. One of the key priorities of the National Programme of Civil Protection for the period 2008-2012 was to increase the number of states with a state level risk atlas conform to the established guidelines. With significant technical and financial support over this period, the number of completed state risk atlases increased from 6 to 28. Progress at all levels can be

expected to continue as promoting risk assessment is one of the seven stated priorities of the 2012 GLCP.

Figure 3.2. **Roles and responsibilities for risk assessment in Mexico**



Notes: * In addition to the UNAM, other national or local universities could be involved in this process.

CONAGUA: National Water Commission; SMN: National Meteorological Service; UNAM: National Autonomous University of Mexico; CFE: Federal Electricity Commission; SCT: Ministry of Communication and Transport.

Source: OECD based on information from SINAPROC.

An evolving process consecrated by the adoption of the 2012 General Law for Civil Protection

From the early stages of the first National Risk Atlas, which was basically a document about hazards, to the development of an online digital tool, Mexico has made clear progress. One of its main achievements is the design and launch of the National Risk Atlas: the result of a holistic, multi-stakeholder and multi-level process, set up to foster analyses of hazards and vulnerabilities from the local to the national level. The various sectoral ministries integrate hazard and vulnerability databases with GIS, risk scenario simulations, disaster loss estimates and updates underlying variables to inform civil protection policies and programmes.

Line ministries and local governments now have the duty to gather data for all hazards databases and information contributing to risks for the development of risk atlases at federal, state and municipal levels. An important development under the 2012 General Law for Civil Protection is that local risk atlases will form part of the legal basis

for decisions to issue or deny building permits, and also provide the basis for tools to raise the public's awareness of exposure to risks.

The multi-layered risk atlas process is designed to support the major uses of modern risk assessment: it uses a GIS-based common platform, integrates data from local to national levels, receives multi-stakeholder input and can be regularly updated. CENAPRED has demonstrated leadership in the field of risk assessment both in terms of promoting modern concepts and providing tools and methodologies to SINAPROC stakeholders with direct responsibility for applying them. It provides an effective bridge between the policy, operational and academic research capacities though its resources are quite limited for its wide range of responsibilities, which also include training, the provision of operational and policy advice and scientific research, and monitoring hazards.

Box 3.1. Scientific advisory committees

The importance of creating linkages between the scientific community, academia and policy makers is an internationally recognised good practice in the field of disaster risk management. Civil protection decision making based on the best available scientific knowledge supports government's capacity to establish the most adequate measures for risk management. These connections are particularly important at the risk identification and risk assessment stages, which require technical knowledge.

SINAPROC recognised the importance of including specialised knowledge in civil protection decisions and planning early on, and in 1995 a federal decree created the scientific advisory committees. These committees comprise technical and scientific experts in various fields of natural and social sciences and engineering who provide advice to civil protection authorities. Committees chaired by CENAPRED have been established for geological, hydrometeorological and chemical hazards along with a Technical Advisory Committee for the Popocatépetl volcano with researchers from UNAM's Institute of Geophysics.

At the local level, linkages between local governments and the scientific community are now also well developed, although this was not always the case. The National Development Plan 2001-06 identified the lack of linkages between specialised knowledge and decision making as an opportunity area within SINAPROC. Since then, civil protection authorities in Chiapas, Colima and Jalisco have integrated scientific advisory bodies to advise on risk management matters. The state of Nuevo León also created a specific committee devoted to hydrometeorological phenomena with the participation of the National Water Commission, CONAGUA (Comisión Nacional del Agua). The state of Tamaulipas created a Board for Hurricane Risk Prevention to improve its monitoring capacities.

Source: Agreement creating Scientific Advisory Committees of the National Civil Protection System as Technical Advisory Bodies for the Prevention of Disasters caused by Geological, Hydrometeorologial, Chemical and Socio-organizational phenomena, *Diario Oficial de la Federación*, 6 June 1995; and Mexico's National Development Plan 2001-06.

Gathering the empirical evidence for risk assessment

Setting forth institutional mandates and defining roles and responsibilities are important governance features of the risk assessment process. Actually developing risk assessments, however, combines the difficult task of collecting hazard and exposure data and integrating it with the results of vulnerability analysis. Data collection requires adequate hazard monitoring networks to produce and process it in an appropriate format, and the development of databases for hazard events (e.g. hydrometeorological and

seismological data) and socio-economic features (e.g. demographics, assets at risk, social vulnerability).

Hazard data availability and analysis

Meteorological monitoring,

The National Meteorological Service of Mexico (*Servicio* Meteorológico Nacional, SMN) is responsible for weather monitoring and forecasts. In addition to weather and meteorological hazard prediction and warnings (see Chapter 5), it collects meteorological data and has kept a national database of climatic data (temperatures and precipitations) since 1941. The monitoring of meteorological phenomena is assured by a network of 212 meteorological stations, 133 of which are automated, 15 upper-air radiosonde stations and 13 radars. The capacity of this network to produce and gather data could be further improved, as only 6 of the 13 radars were functioning in 2009.

The SMN is part of CONAGUA and has partial access to hydrometeorological data generated by the network of its Directorate of Surface Waters and River Engineering (see next section). In addition, several institutions have their own meteorological networks, both at the federal and state levels. The Navy (*Secretaría de Marina*, SEMAR) has its own atmospheric monitoring system composed of 35 automatic weather stations (AWS) and there is a forecasting centre at PEMEX and the Federal Electricity Commission (*Comisión Federal de Electricidad,* CFE) as well. At the state level, the Ministry of Public Security of Chiapas maintains 13 AWS, the river basin authority of the Mexico valley has 25, the North Gulf basin 26 and the state of Guerrero 36. These multiple networks are not fully operational and/or maintained and they only partially transfer their data to the national level (10% in some cases). Some states and universities, such as the University of Guadalajara, have also invested in weather radars. This scattered landscape for meteorological observation and services in Mexico was evaluated in 2010 by the World Meteorological Organisation (WMO). The results were used for a project financed (61%) by the World Bank in 2012 for the "Modernization of the National Meteorological Service for Improved Climate Adaptation".

The SMN has a historical database specifically for tropical cyclones that make landfall in Mexico, and has mapped out their entry points. However, this database contains little information about the dates, wind strength or states impacted by specific events. In this respect, it is not as complete as the WMO Regional Specialised Meteorological Center (RSMC) in Miami – US-NOAA National Hurricane Center. The RSMC monitors tropical cyclones that generate in the North Atlantic and the North East Pacific. It also maintains a freely accessible database of tropical cyclones dating back to 1958, including all of the meteorological and oceanographic parameters. In 2002, CENAPRED and the Mexican Institute for Water Technology used this database to develop the Climatic Atlas of Tropical Cyclones in Mexico. This atlas contains detailed maps and geospatial analysis of tropical cyclone tracks, their pressure and wind speed. It is publicly available and can be utilised to support the development of risk assessments.

Integrating forward-looking hazard analysis is fundamental in the arena of meteorology. Due to climate change, hazards from the past may not be representative of what will occur in the future. In this respect, research and investments in better understanding the potential impact of climate change on hazard patterns, their intensity and/or their frequency is a key domain for risk assessment. It is also in this context that Mexico developed a project for modernising the SMN, which includes a strong

component on climate modelling. The strengthening of the meteorological and climatological capacities of the country was part of the National Special Climate Change Programme 2009-2012, as was the development of a National Atlas on climate change impacts and vulnerability. The development of this atlas, on the model of other atlases in Mexico, should be made a priority so that these data and information are available for forward-looking risk assessment.

Hydrological monitoring

CONAGUA is the federal agency responsible for the entire water cycle, from resource management to water supply and sanitation, irrigation and other water uses. It plays a key role in SINAPROC, from flood risk management to providing drinking water during and after different kinds of disasters. CONAGUA, through its 37 hydrological regions that regroup 728 hydrological basins, monitors water levels and discharge with its dense hydrological network of 499 hydrometric stations, covering most of the 50 major rivers, though not every basin. The network was developed primarily for water resource management: irrigation, urban water supply and energy production – i.e. for water uses, not to counter flood risk. For instance, although rainfall from hurricanes Gilbert and Alex led to devastating floods of the Río Santa Catarina riverbed, there is no regular hydrological monitoring of it, because it is otherwise entirely dried out.

CONAGUA also manages a network of 1 000 reference climatologic stations, which produce precipitation data for the development of hydrological modelling. CFE has its own hydrological monitoring network for managing many of Mexico's major hydroelectric dams. In addition, cross-border exchanges about hydrometeorological conditions and data are established to monitor cross-boundary watershed: the Río Bravo and Colorado rivers cross the Mexico-United States border, while rivers also flow from Guatemala into the hydrological regions of Costa de Chiapas, Grijalva-Usumacinta and Yucatán Este (see Chapter 7).

While national maps of rainfall distribution, with different return periods, are easily available from CENAPRED's website and its publications, hydrological information does not appear to be as accessible. CONAGUA has a geo-database containing information on water tables in the country; however, series of river discharge are not part of this database, which concentrates more on describing water resources and their uses. Nevertheless, a national map ranking the various river basins has been developed by CENAPRED, and CONAGUA's analysis of flooding events provides some information on the hydrological characteristics of the floods occurring in Mexico as well as their extension. These two institutions are currently collaborating to develop the National Flood Atlas, together with the Mexican Institute of Water Technology (*Instituto Mexicano de Tecnología del Agua*, IMTA) and UNAM. This work will gather all hydrometeorological information together and make it available for the development of flood risk assessment at the local level. It is hoped that this ambitious work will result in gathering hydrological information and making a sufficient amount of it available so that flood risk assessment can be developed at a large scale.

Seismological monitoring

The National Seismological Service (*Sistema Sismológico Nacional*, SSN), founded in 1910 and part of UNAM, operates Mexico's national seismological network, which comprises 36 broadband stations covering the country and 19 stations in the Valley of Mexico. Several institutions at the state level also have their own networks, such as

universities (Colima), research centres (Sinaloa, Veracruz), civil protection (Chiapas) or even NGOs or private institutions (CIRES in Guerrero, Oaxaca – see Chapter 5). Considering the lack of coverage, co-ordination and data exchange between these networks, along with the ageing of the infrastructure (20% of the stations have exceeded their life cycle), the seismic network in Mexico does not seem to be aligned with the level of seismic risk in the country.

The situation is quite similar regarding the network of accelerometric stations. These stations measure soil acceleration, which is the main cause of damage, whereas the seismographic network registers the seismic waves. The Institute of Engineering of UNAM in charge of this accelerometric network is also working with an ageing and fragmented network, which does not fully cover the country and its high risk areas.

A proposal for modernising the network has been developed by UNAM and includes: *i)* the establishment of 1 seismic station in each of the 8 states that do not yet have one; *ii)* 1 seismic and at least 1 accelerometric station in each of the 22 cities with more than 300 000 inhabitants that are not yet equipped with such stations; *iii)* the creation of 3 sub-networks in the earthquake-prone states of Jalisco, Michoacán and Colima; and *iv)* the strengthening of the accelerometric network around Mexico City. It is important to bear in mind that the seismic network, as the hydrometeorological network, is not only crucial for risk assessment, which is mostly a medium to long-term planning tool – even though it is becoming more and more dynamic. This network is also fundamental for real time monitoring, early warning and emergency preparedness and response, and is essential for saving lives (see Chapter 4).

The SSN has recorded more than 100 years of seismic data and a very high-quality database with seismic data since 1958, the *Base Mexicana de Datos de Sismos Fuertes*, which contains more than 14 000 entries generated by 1 500 earthquakes. This key historical data set could be copied and stored on servers in a seismically safe location. The SSN has analysed the data and mapped out epicentres of every earthquake that has taken place over the past 100+ years. It has also produced analysis and maps of earthquake intensities based on the Mercalli scale as well as the return period. All of these hazard data, information and analysis are available on CENAPRED's website and in its publications.

CFE developed a map of seismic hazards in Mexico in the second edition of the volume for Seismic Design included in its Manual on Civil Works Designing published in 1993. This map, based on the database of major earthquakes, divides the country into four seismic zones (Figure 1.6 on Chapter 1), depending on both the seismicity and the expected ground accelerations, the main cause of damages to buildings and infrastructures. The Manual was updated in 2008 with more precise acceleration maps for various return periods, which is still the reference today. It is available in the public domain and widely utilised in the country. The joint UNAM-CFE-CENAPRED programme on seismic risk in Mexico also developed precise acceleration maps with various return periods in 1996, available in CENAPRED publications.

Exposure and vulnerability analysis

Once natural hazards have been characterised, analysed and mapped, the information can be cross-referenced with information on population and asset exposure, and their vulnerability. Providing this information for risk assessment in a standard format across regions is a common challenge for civil protection services in OECD countries, as it requires combining multiple geographic and socio-economic datasets.

The National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía*, INEGI) is the official provider of geo-referenced information from the national to local levels. INEGI regularly conducts census and population surveys, and provides data and information about land use, population, demographic trends, household incomes, etc. Its system for state and municipal databases (*Sistema Estatal y Municipal de Bases de Datos*, SIMBAD) provides detailed statistical information through an online portal. Furthermore, the National Population Council (*Consejo Nacional de Población*, CONAPO) has compiled many of these socio-economic data at the neighbourhood level of all municipalities to develop the "Marginalisation Index",[1] which may serve as a proxy for social vulnerability. Maps of the Marginalisation Index are available for all of the municipalities on the CONAPO website.

CENAPRED has also developed and mapped a specific "Index of Social Vulnerability" combining INEGI socio-economic information with results from household surveys related to risk knowledge. The survey gathers information from households across the country at the municipal level with questions about their perceptions of risks and their knowledge of prevention and institutional capacities.

Sectoral agencies and ministries at the federal level map the vulnerabilities of infrastructure under their authority and provide this information for the development of risk assessment. Following earthquakes of a magnitude of 5.0 or higher on the Richter scale, CONAGUA and CFE conduct inspections of dams located close to the epicentre to look for structural damages. Maps of the location of the major dams in the country are made available by CONAGUA, as well as their date of construction – which is a good indicator as ageing infrastructures are more vulnerable. Data on the actual condition of these infrastructures, however, appears to be missing, whereas some countries have begun to make it available for free online.

The Ministry of Communication and Transport (*Secretaría de Comunicaciones y Transportes*, SCT) provides statistics about transport infrastructures, including roads, bridges and harbours, and has developed an atlas for the sector. The SCT has a specific strategy for mapping development at the national level with the objective of making maps of infrastructures in the country available on a public GIS, but this has not yet been implemented. Again, bridges and roads are frequently inspected by the SCT, but information on their vulnerability status is not available. In addition, many of these infrastructures are in the hands of the states, which have their own statistics and databases regarding their infrastructures.

PEMEX has developed a sophisticated database called @ditpemex as well as an Atlas of Strategic Infrastructures (AIE-PEMEX), which includes detailed information on the location of oil sector infrastructure, exposure to natural hazards and vulnerability. The PEMEX Control and Data Acquisition System allows it to monitor pipeline operations throughout the country. This information is not available to the general public, however, as it is classified for reasons of national security. PEMEX can share some of the information with state governments through specific confidentiality agreements as well as with state institutions, although there is not currently such a confidentiality agreement with CENAPRED that would enable it to be used for the National Risk Atlas.

The Ministry of Public Education has developed a publicly available online platform called GEO-SEP, which categorises educational facilities according to level of instruction and physical location – both for public and private educational facilities. A strength of this system is that it provides information about schools located in hazardous zone for the System for the Analysis and Visualization of Risk Scenarios (*Sistema de Análisis y*

Visualización de Escenarios de Riesgo, SAVER) (Box 3.3). The information was gathered through an Educational Infrastructure Survey issued to school principals at national and local institutions of education in 2007.

Finally, a recent initiative from FONDEN could facilitate the development and availability of data on infrastructure exposure and vulnerability. One of FONDEN's strategic objectives is to develop the insurance coverage for state and federal infrastructure (see Chapter 6). To this end, it started to finance the development of infrastructure inventories at the state level in 2010, as these are useful for obtaining insurance coverage. For instance, in 2011 it financed an analysis of the inventory of infrastructures in the state of Sonora and their vulnerability, covering the sectors of transport, water, health and urban areas.

Gathering data on disaster losses is also necessary to develop risk assessment, and especially for conducting probabilistic modelling of potential future losses based on hazard frequency. While the number of deaths due to an event is often available, other measures such as the number of affected people, the number of injured or the number of displaced people are not. For economic losses, this is even more challenging, as there are direct and indirect losses. Direct losses refer to damages to buildings, infrastructure, natural resources and services and other assets. Indirect losses are linked to foregone business activity or supply chain interruption, for example. In Mexico, efforts have been made to gather losses data through the yearly publication of the socio-economic impacts of disasters performed by CENAPRED since 2001. While this publication presents a consistent methodology for calculating direct and indirect losses, it does not receive sufficient data about the latter to publish verifiable statistics.

Risk assessment tools and methodologies

CENAPRED is the lead governmental agency for the development of disaster risk assessment. It has published clear methodological guidelines for developing risk assessments at state and municipal level, and more specifically on how to produce risk atlases. These guidelines provide concrete instructions about the information needed to conduct risk assessment, such as the type of data to use, where to find it and what tools are appropriate to use for mapping (Table 3.1). Furthermore, CENAPRED makes all of its data for the development of risk assessment available and also provides technical support to institutions that are required to conduct one.

Table 3.1. **List of CENAPRED guides for the design of state and municipal risk atlases (2006)**

Basic Guide for the Creation of State and Municipal Hazard and Risk Atlases (Basic Concepts on Dangers, Risks and Their Geographic Representation)
Basic Guide for the Creation of State and Municipal Hazard and Risk Atlases (Geological Phenomena)
Basic Guide for the Creation of State and Municipal Hazard and Risk Atlases (Hydrometeorological Phenomena)
Basic Guide for the Creation of State and Municipal Hazard and Risk Atlases (Chemical Phenomena)
Practical Guide on Chemical Risks (Food)
Practical Guide on Chemical Risks (Pollution)
Practical Guide on Chemical Risks (Epidemics)
Practical Guide on Chemical Risks (Plague)
Basic Guide for the Creation of State and Municipal Hazard and Risk Atlases (Assessment of Physical and Social Vulnerability)

Source: CENAPRED website, *www.cenapred.unam.mx/es*, last consulted in September 2012.

Development of a national risk atlas

Since the publication of the first National Risk Atlas in 1991, and the updated version in 2001, major progress has been made in the development of risk assessment in Mexico. The National Risk Atlas of Mexico, available online at *www.atlasnacionalderiesgos.gob.mx*, is in fact a portal that includes all available risk information on the country: from hazard analysis to vulnerability mapping, all the various national maps are available for a series of hazards on an evolving GIS-based platform. It includes information on economic and human losses and metadata describing the assets at risk. The development of this innovative tool has stimulated the risk assessment process countrywide, as its objective is to gather all of the risk atlases that are developed at state and municipal levels. The integration of atlases from different levels has not yet reached the point, however, where the local level automatically informs the next level above. The key to attaining this objective is to ensure that all entities providing input, from federal to state and municipal levels, use the same methodology and data standards. This requires multi-disciplinary collaborations among many scientific communities and organisations. CENAPRED, as well as the scientific advisory committees (Box. 3.1), could be inspired by international examples where multi-disciplinary data and expertise is combined together in a flexible partnership to support risk assessment (Box.3.2).

Box. 3.2. **Leveraging scientific collaborations: The Natural Hazards Partnership in the United Kingdom**

In the United Kingdom, the Natural Hazards Partnership (NHP) provides information, research and analysis on natural hazards for the development of more effective policies, communications and services for response to civil contingencies, government planners and the first responder community across the United Kingdom. It focuses on natural hazards that disrupt the normal activities of the country's communities or damage its environmental services. The NHP also provides the international community with a model for cross-government hazard management based on a platform of world-class environmental sciences.

The NHP brings together expertise from across leading public sector agencies including: the Environment Agency, Flood Forecasting Centre, Health Protection Agency, Health & Safety Laboratory, Met Office, Natural Environment Research Council, British Geological Survey, Centre for Ecology and Hydrology, National Centre for Atmospheric Science, National Oceanography Centre, Ordnance Survey, Scottish Environment Protection Agency, and the UK Space Agency.

The NHP also contributes towards the Hazard Impact Model (HIM), which combines data and expertise from partners to identify areas and assets which are most vulnerable to a particular hazard. This is intended to help prioritise where to deploy "responder" services, as well as to identify when and where to issue hazard alert warnings.

The NHP also contributes to the National Risk Assessment (NRA) process by providing recommendations on: scientific overview for natural hazards and advising on any new risks that may need inclusion, supplementing current advice on scenarios for existing risks identifying NRA risks that could be linked and could occur concurrently.

Source: OECD (2012), "Disaster Risk Assessment and Risk Financing, A G20/OECD Methodological Framework", OECD, Paris, *www.oecd.org/finance/insurance/G20disasterriskmanagement.pdf*.

SAVER is another tool developed by CENAPRED which is password protected and available to civil protection stakeholders (Box 3.3). It combines information from several sources into one single map with different layers, including all of the critical infrastructures of the country – with the exception of PEMEX. It can provide decision

makers with a clear view of the people and resources that could suffer damage when a hazardous event occurs.

Box 3.3. **The SAVER system**

The System for the Analysis and Visualisation of Risk Scenarios (SAVER) is a tool that civil protection authorities in Mexico use to include information from risk scenarios in policy making. CENAPRED created the system to comprise strategic risk information and data from several sources. SAVER integrates risk maps and geo-referenced information on the vulnerability of hospitals, schools, public infrastructure and population into one single database. Currently, its capacity to create risk scenarios is one of its most important characteristics.

SAVER is the result of a horizontal and vertical effort across organisations throughout the country. Ministries such as Social Development, Communications and Transport, and Public Education provided valuable data and information on their infrastructure in order to feed the system's database. Currently, the system comprises 700 hazard layers and socio-economic and vulnerability data. In 2011, the development of SAVER 2.0 increased its capacities allowing the database to be fed online.

The system provides public entities in charge of social, territorial and human development with information about potential damages and affected populations based on historical occurrence records. SAVER 3.0 will integrate data from all 32 state risk atlases. Currently, states such as Jalisco and Chiapas have already provided their databases in support of the system.

Source: Information provided by CENAPRED and the CGPC.

The National Risk Atlas, however, is not conceived as the national risk assessments developed by many OECD countries in which major hazard and threat scenarios are assessed according to common criteria (in terms of their likelihood and impact) to rank them for the purpose of informing decisions about investments in capabilities planning (Box 3.4).

Box. 3.4. **The National Risk Assessment of the Netherlands**

Since 2007, the Netherlands National Safety and Security Strategy has put in put in place an holistic approach to risk management based on preserving five vital interests for the country: territorial, physical, economic and ecological safety, and social and political stability. The main objective of the Netherlands National Risk Assessment (NRA) is to prioritise risks that the Netherlands should prepare for, and develop capabilities to handle civil contingencies accordingly.

The NRA consists of two parts: risk analysis and capabilities analysis. Risk analysis is managed by a network of independent experts who operate under the leadership of the steering committee of the National Security Committee (drawn from ministries, businesses and intelligence services). The experts develop risk scenarios and assign scores for their likelihood and impact according to ten criteria related to vital safety and security interests. Initial ranking results are given according to low and high estimates. The impact assessment is used to analyse the capabilities needed to prevent and/or mitigate each type of risk. The time horizon for NRA scenarios is five years; however, analyses and the corresponding capabilities needed can be reassessed frequently by the expert groups according to new information or changing conditions. A report summarising the results of the NRA is sent each year to Parliament; it is also published on official websites and sent to relevant stakeholders.

Source: Dutch Ministry of Interior and Kingdom Relations (2009), "Working with Scenarios, Risk Assessment and Capabilities in the National Safety and Security Strategy of the Netherlands", Directorate-General for Public Safety and Security.

Risk atlas initiatives at local levels

Risk assessment at the state level

The federal government has placed a high priority on the need for states and municipalities to develop risk atlases so that they can be incorporated into the National Risk Atlas. Considering the important disparities in terms of human and economic resources at the local level, federal entities play a major role homogenising and encouraging the development of states' risk atlases. The federal entities' main challenge is to help states move from atlases that were merely an inventory of hazards to including a dimension of vulnerabilities and hazard exposure. For this purpose, the federal government has put two major mechanisms in place: *i)* strong technical support from CENAPRED; and *ii)* solid economic support from FOPREDEN.

CENAPRED, in addition to its guidelines, provides various forms of technical assistance for the development of risk assessment: from training inspectors to verification of GIS. FOPREDEN constitutes the most important financing mechanism for the elaboration of risk atlases at the state level. Since 2004, FOPREDEN has financed 23 projects related to the elaboration, extension or updating of risk atlases for a total of USD 11 million (FOPREDEN data, 2011). Since 2011, with the introduction new operational rules at FOPREDEN, states must first possess a risk atlas (or be in the process of developing one) to be eligible for funding for disaster risk prevention projects. If a state does not have a risk atlas, FOPREDEN can finance up to 90% of its development cost as its first project. FOPREDEN and CENAPRED reflect a well-articulated system of inter-institutional co-operation through which 21 of the 32 states have received federal technical assistance for the development of risk atlases.

Between 1993 and 2004, only 9 out of 32 states (including the Federal District) had developed a risk atlas, but from 2004 (the effective year of creation of FOPREDEN) to 2009, 17 states developed risk atlases, which shows the high level of efficiency of the federal incentives to support the development of risk atlases. Civil protection stakeholders have a heightened awareness of the importance and utility of risk assessment, and a better understanding of the difference between hazard analysis and risk assessment. Notwithstanding this awareness, civil protection stakeholders at the state and municipal levels require federal resources to support the costs of producing high-quality risk atlases.

In addition to the tools developed at the federal level, some states have developed their own risk information systems. The state of Tabasco developed a System of Geographic Information (SIGET) which allows the population to access the local risk map, among other data. The state of Jalisco has developed a similar tool, the Online System of State Territorial Information (SITEL), which enables users to access risk information at the state or municipality level. The risk maps available show layers of information, such as flood zones layered over infrastructure. Both the SIGET and the SITEL are open information sources available to the public. In the state of Chiapas, the Integrated System of Civil Protection provides statistics and information to the units of civil protection of the state, but this platform is not open to the public. The state of Tamaulipas is in the process of developing these same capacities.

Table 3.2. **Risk atlases by state**

State	Risk Atlas	Year of creation	% of municipalities included	Type of risks			Federal financing	Federal technical support	Public access	Updated
				Earthquake	Hurricane	Flood				
Aguascalientes	Yes	1993	91-100%	●	X	●●	10%	No	No	Yes
Baja California	Yes	2005	91-100%	●●●	●	●●●	70%	No	No	Yes
Baja California Sur	No									
Campeche	Yes	2004	91-100%	●	●	●	10%	Yes	No	No
Chiapas	Yes	2007	10%	●●●	●●●	●●●	61-70%	Yes	Yes	Yes
Chihuahua	Yes	2006	10%	●	●	●	10%	Yes	No	Yes
Coahuila	Yes	N/A	91-100%	●	●	●	21-30%	Yes	No	Yes
Colima	Yes	2008	91-100%	X	●●	●	10%	No	No	N/A
Federal District	Yes	2007	91-100%	●●●	X	●●●	81-90%	No	No	Yes (2008)
Durango	In progress									
Guanajuato	Yes	1994	91-100%	●	●	●	71-80%	Yes	Yes	Yes (2006)
Guerrero	Yes	2006	91-100%	●	●●	●	11-20%	Yes	No	No
Hidalgo	Yes	2008	91-100%	●●●	X	●●●	51-60%	Yes	No	No
Jalisco	Yes	2007	91-100%	●●●	●●●	●●●	90-100%	Yes	Yes	Yes
Mexico[1]	Yes	1994	81-90%	●●	●	●●●	No	Yes	Yes	Yes (2012)
Michoacán	Yes	2004	91-100%	●	●	●●	51-60%	Yes	Yes	Yes
Morelos	Yes	2008	91-100%	●●	X	●●	61-70%	Yes	Yes	No
Nayarit	Yes	2009	91-100%	●	●	●	90%	Yes	No	Yes
Nuevo León	Yes	1999	10%	●	●●	X	10%	No	Yes	Yes (2001)
Oaxaca	Yes	2002	91-100%	●	●	●	31-40%	Yes	Yes	No
Puebla	Yes	1999	91-100%	●	●	●	21-30%	No	No	Yes (2005)
Querétaro	Yes	2008	91-100%	●●●	X	●●●	81-90%	Yes	No	Yes
Quintana Roo	In progress	N/A	10%	X	X	X	10%	No	No	No
San Luis Potosí	Yes	2005	91-100%	●●	●●●	●●●	81-90%	Yes	Yes	Yes
Sinaloa	In progress									
Sonora	Yes	2007	91-100%	●●	●	●	91-100%	Yes	Yes	Yes
Tabasco	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	In progress
Tamaulipas	Yes	2001	81-90%	●●	●●●	●●●	71-80%	Yes	Yes	Yes
Tlaxcala	Yes	2005	91-100%	●	X	X	41-50%	Yes	Yes	Yes (2008)
Veracruz	Yes	2000	91-100%	●●	●●●	●●●	81-90%	Yes	Yes	Yes
Yucatán	Yes	2003	91-100%	●	●●	●	21-30%	Yes	No	No
Zacatecas	Yes	2008	91-100%	X	X	●	10%	Yes	No	Yes

●●● Advanced

●● Medium

● Basic

X Not included

Note: 1. Information updated by the state of Mexico.

Source: Based on CENAPRED's National Risk Atlas, *www.atlasnacionalderiesgos.gob.mx*, accessed in May 2012.

Rapid changes to populations and industrial development imply the need for periodic updates to risk atlases, otherwise inaccuracies could mislead policy decisions. To Mexico's credit, the frequency of updates to risk atlases has accelerated and has been facilitated by the elaboration of CENAPRED's guidelines, which have become an accepted standard for quality assurance. Despite this, disparities in quality persist between different state risk atlases, mainly due to the capability of states to finance updates. Several states such as Mexico, Aguascalientes and Guanajuato created their risk atlases in 1993-94, and only updated them more than 12 years later, illustrating the difficulty to regularly update such a sophisticated technical tool. In general, risk atlases have been updated once every eight years, and usually with the support of a federal subsidy to defray costs. Finally, public access to the risk atlases remains a challenge for many states. Nearly half the federal states' risk atlases are not accessible via the Internet, which undermines one of their main uses – to inform the public and businesses about risks to which they are exposed.

Risk atlases at the municipal level

While the uptake of risk atlases amongst states has grown rapidly with support from FOPREDEN, the geographic scale is too broad to accurately incorporate risks at the municipal level. Municipalities are among the main potential end users of risk atlases. First, risk atlases can aid local civil protection services to design emergency plans. Moreover, since municipalities in Mexico have competence for establishing building codes and land-use zoning plans, risk atlases could be leveraged to ensure these essential tools are based on a scientific understanding of risks in specific locations. The development of risk atlases at the municipal level, however, has been slow across Mexico. Many of the 2 440 municipalities do not give priority to the development of a risk atlas, due to the time and cost of producing a high-quality product. A view often expressed by municipal civil protection stakeholders is that mayors (who are limited to one, non-renewable term in Mexico), prefer to focus on projects that can be accomplished within their three-year term in office. Projects such as building infrastructure, for example, leave a more visible impact in the eyes of the electorate than a risk atlas.

To address these obstacles, the federal government has put in place specific programmes designed to subsidise the cost of developing risk atlases in the most vulnerable municipalities. SEDESOL plays a significant role in encouraging municipalities to develop prevention strategies, especially through the elaboration of risk atlases. In 2011, it launched the Risk Prevention for Human Settlements programme (PRAH, see Chapter 5), which focuses on risk reduction through discouraging the use of land in high risk areas. Eligibility is conditioned on the existence of a risk atlas, which is why the first PRAH projects at the municipal level support the development of risk atlases. The cost sharing between federal and municipal levels is 65-35%, which still represents an important investment for the budget of some municipalities. Federal government support is limited to MXN 3.5 million per atlas, covering such expenses as research, elaboration and updates.

The PRAH programme classifies municipalities into high or very high risk zones. To date, 322 municipalities have been classified as high risk and 295 as very high risk (SEDESOL, 2012b). Based on this classification, priorities are established to finance prevention measures. Only 85 municipal risk atlases have been developed under this programme in high and very high risk municipalities, however, of which just 30 are publicly available (including Mexicali, Cancun, Cozumel, etc.).

While the quantity of municipal risk atlases elaborated is quite low, the risk atlases publicly available financed by SEDESOL in the last years are high-quality products, with a risk dimension (hazard, exposure and vulnerability) and well-developed methodology based on CENAPRED's guidelines. Nevertheless, making them publicly accessible via the Internet is highly problematic, since the file size is not suitable for an ordinary Internet connection, and the full version is only available in PDF format.

Even though SEDESOL aimed to accelerate the programme with the intention to finance 125 municipal risk atlases per year, the budget of its PRAH programme was reduced by 75% in 2012 compared to 2011, thus calling for other federal policies to support the development of risk assessment at the municipal level.

Conclusion

SINAPROC demonstrates a strong commitment to evidence-based risk management policies and has undertaken multiple efforts at every level to gain a better scientific understanding of natural hazards, to map the exposure of populations and valuable assets to those hazards, and to model their vulnerability.

Continued efforts are needed to integrate risk assessment across levels of government. The SAVER tool is an appropriate approach to strengthening these capacities, and justifies a continual effort from the ministries and institutions of the three levels of government to keep the underlying databases up-to-date. Together with different tools being developed by the federal government, SAVER has been able to support the integrated risk management approach in Mexico. Its continual development needs to be perceived as a joint effort with common benefits, focusing on ensuring the safety and resilience of the population and infrastructure.

Linkages need to be reinforced between the innovative tools developed throughout SINAPROC (risk atlases, SAVER, etc.) and disaster risk reduction measures such as land use, urban development plans and risk mitigation infrastructures. This should take top priority as states begin to implement the 2012 General Law for Civil Protection, which requires the development of risk atlases to inform land-use plans.

Recommendations

- Facilitate linkages across risk atlases at all levels, and develop synergies between SAVER and R-FONDEN.
- Harmonise federal support for the development of risk atlases at sub-national levels.
- Strengthen financial and technical support of municipal risk atlases.
- Take stronger account of potential tsunamis in risk atlases.
- Develop the National Atlas on Climate Change Impacts and Vulnerability.
- Reinforce engagement of the private sector in risk assessment processes at all levels.

Note

1. The Marginalisation Index is a composite index integrating the illiteracy rate, education, access to sanitation, water and electricity, number of people per household, quality of housing and access to a refrigerator.

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Chapter 4

Disaster risk prevention and mitigation

This chapter analyses disaster risk prevention and mitigation activities, including structural measures (such as dams and levees) and non-structural measures (such as land-use planning, building codes, population relocation, building public awareness of risks and early warning systems). These measures are considered in terms of their importance to achieve Mexico's civil protection goal of reducing disaster damages over the long term. It examines underlying governance challenges to the effective implementation of key disaster risk reduction measures, and the need to base risk prevention policies upon accurate and regularly updated risk identification and risk assessment.

This chapter analyses disaster risk prevention and mitigation activities. This includes structural measures (such as dams and levees) and non-structural measures (such as land-use planning, building codes, relocation, raising public awareness of risks and alerting the population and emergency responders through early warning systems) designed to impede interactions between hazards and the built environment or reduce the intensity-frequency and/or impacts of hazards. The aim is not to analyse the cost-effectiveness of these initiatives, but rather to consider whether an effective mix of federal government support and incentives for individuals to self-protect are in place, and to evaluate their coherence with the roles and objectives SINAPROC sets for itself. The chapter also analyses the linkages between prevention programmes and different phases of the disaster risk management cycle, such as risk identification and risk assessment.

Risk prevention: A SINAPROC priority

Investments in structural measures to prevent or mitigate disaster damages often do not pay-off in the short term. In many countries, both developing and industrialised, there is evidence of under-investment in disaster risk prevention due to competing demands on public resources such as education, health and defence. Investments to protect or reduce the effects of extreme events often fail to garner support over immediate concerns or continuous financing through several electoral cycles.

In Mexico, several policy documents and legal instruments indicate strategic vision, commitment and leadership – the institutional qualities it takes to pursue projects with pay-offs over the long term. While the primary aim of the 2000 General Law on Civil Protection (GLCP) was to establish a legal framework for harmonising civil protection from the national to local levels (see Chapter 2), it also reflected disaster prevention as a key component of Mexico's overall civil protection strategy. In particular, the 2000 General Law:

- raised the need to promote public awareness about natural and man-made risks;
- established the legal basis for what would become FOPREDEN – a specific fund managed by the federal government to finance disaster prevention projects implemented by federal, state and municipal government stakeholders;
- asked the Ministry of Interior (*Secretaría de Gobernación,* SEGOB) to develop and update the National Risk Atlas (see Chapter 3).

The 2001-06 National Programme for Civil Protection placed emphasis on strengthening SINAPROC's role in disaster prevention. It included a Special Programme on Disaster Risk Prevention and Mitigation comprising a list of 60 prevention-oriented projects developed by the National Centre for Prevention of Disasters (*Centro Nacional de Prevención de Desastres*, CENAPRED) from the development of risk atlases to early warning systems (EWSs) and from developing public awareness to the reduction of vulnerability. Although the implementation of this programme was stronger in some areas than others – with for instance only 3 of the 32 projects related to seismic risks implemented due to a lack of financial resources (ECLAC, 2006) – the development of risk atlases, as well as the creation of FOPREDEN, were significant first steps laying the foundation for future disaster prevention.

The *SINAPROC Manual*, published in 2006, re-emphasised the need to address all aspects of the risk management cycle, including not only emergency preparedness, response and reconstruction, but also prevention (see Annex E). The 2008-2012 National

Programme for Civil Protection placed an even heavier focus on disaster prevention in SINAPROC and clearly states it as the new paradigm for integrated risk management, aligned with the National Development Plan. Its specific strategies related to civil protection, territorial development and climate change all insist on the need to reduce the vulnerability of the Mexican territory through prevention measures, such as land-use policies and adaptation to climate change. Finally, the new 2012 General Law states that risk atlases at the national, state and municipal levels will be the legal basis for disaster risk prevention, as well as for land use and building permits.

Reducing physical exposure and vulnerability

Risk prevention policies aim to reduce one of a risk's core components: exposure to hazards and/or vulnerability. Reducing exposure to natural hazards may seek to diminish the frequency or intensity of such phenomena and/or avoid their coincidence in time and space with an asset of value. Depending on the hazard in question, this is more or less feasible and costly. For example, control measures can be put in place to change the width, depth, flow rate and direction of a watercourse, whereas seismic waves may be resisted, but not channelled.

Reducing the vulnerability of assets of value is essentially a matter of enhancing the internal capacity to resist or adapt when exposure is unavoidable. Policies designed to reduce the vulnerability of populations are rather more complex than for material assets, as the underlying variables relate to socio-economic characteristics such as: initial well-being, self-protection, livelihood resilience and social capital, which together characterise a continuum of susceptibility to resilience.

In the course of this review, stakeholders presented several examples of measures to reduce physical exposure to natural hazards. Among the structural measures to reduce flood and tropical cyclone hazards are rainfall storage dams to diminish the peak flows of rivers and dikes to channel water flows to act on the hazard itself. Non-structural measures, such as land use and urban planning or building codes, can reduce exposure and vulnerability.

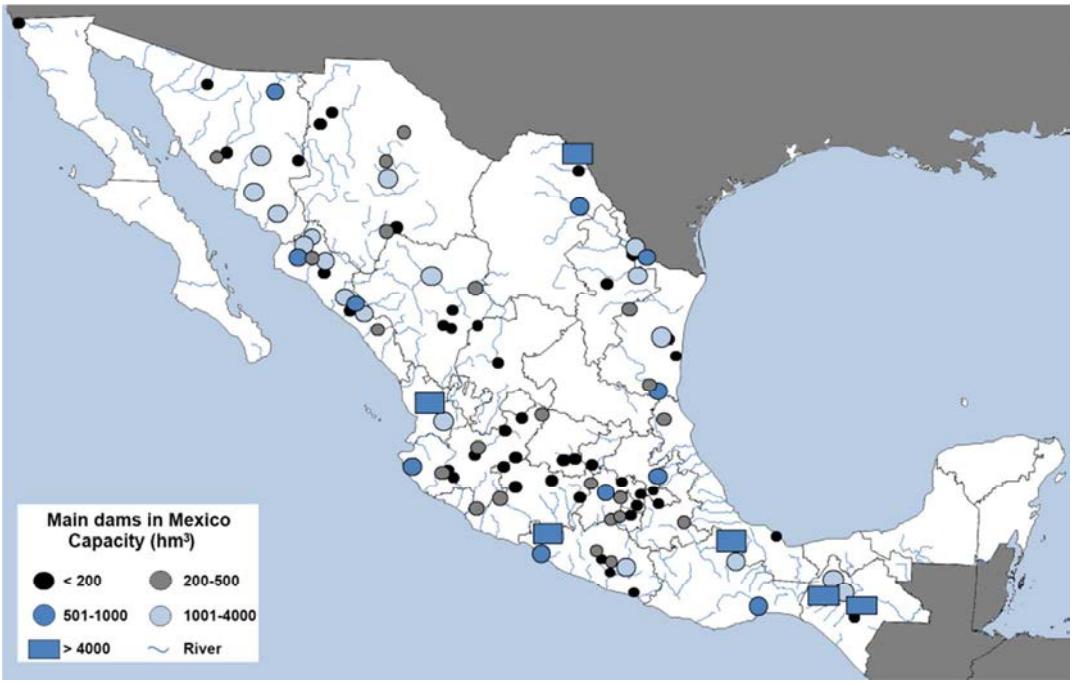
Structural measures to reduce disaster risk

Most of the hydraulic infrastructure in Mexico has been developed by the National Water Commission (*Comisión Nacional del Agua*, CONAGUA), which leads efforts to mitigate hydrometeorological risks such as flooding and tropical cyclones. Mexico has developed a large hydraulic infrastructure network to store water: approximately 4 000 dams, of which 667 are large ones (CONAGUA, 2010a). The purpose of the dams is principally for irrigation, but some also serve to produce electricity, supply drinking water and regulate water flow for flood control.

CONAGUA is also currently implementing two major projects in large flood-prone areas in the country: the Integrated Hydraulic Plan of Tabasco (*Plan Hidrico Integral de Tabasco*, PHIT) and the Hydraulic Sustainability Programme of the Mexico Valley. The PHIT was initiated after the devastating flood in 2007 in the state of Tabasco with the aim to protect all of the state's population centres with the construction of embankments, dikes and protection walls; river drainage; flood control infrastructures and other structural work. It has cost MXN 9.4 billion over the past five years, with the technical support of the National Autonomous University of Mexico (*Universidad Nacional Autónoma de México,* UNAM). Still, this remains a challenging task. According to an

ongoing audit of the Federal Superior Auditor, the plan was not sufficiently detailed technically, the expected objectives were lacking, the cost-benefit analysis was limited and the consultation with UNAM insufficient (Federal Superior Auditor, 2011).

Figure 4.1. **Major dams in Mexico**



Source: CONAGUA (2010), *Atlas digital del agua México 2010* (Mexico 2010 Digital Water Atlas), CONAGUA, Mexico City, *www.conagua.gob.mx/atlas/#.*

CONAGUA also administers an important flood protection project in the Valley of Mexico. The Hydraulic Sustainability Programme of the Mexico Valley (*Programa de Sustentabilidad Hídrica del Valle de México*) is a major hydraulic project integrating all water-related issues, from water supply to wastewater treatment and groundwater over-exploitation. One of its objectives is to reduce the flood risk in Mexico City. As the city was built on an ancient lake, there is no natural way to drain water out of the valley. In the 19th century, a drainage system was built and has been expanded over the years. The current project involves the construction of a tunnel 62 kilometres long and 7 metres wide that would add a new drainage branch to the existing hydraulic system of the Mexico Valley for an estimated cost of MXN 13 billion (CONAGUA, 2010b). It also plans to reduce subsidence in the Mexico Valley, which is a major cause of increased vulnerability of buildings to earthquakes, through the reduction of the overexploited aquifer.

Implementation and maintenance of flood risk infrastructure is a challenge. Such major projects entail environmental costs – for example, ecosystem degradation and erosion – as well as governance challenges related to relocation and the impact on human activities, and may require specific provisions to ensure integrity in the disbursement of public funds. Non-structural measures, such as land-use restrictions and urban development plans to reduce the exposure and vulnerability of human settlements, in conjunction with enhanced risk awareness and better emergency preparedness, may offer a cost-effective alternative. In addition, poorly maintained hydraulic infrastructures have

led to emergencies that require the intervention of civil protection services. These options should be taken into consideration when planning such major investments.

Box 4.1. **Assessing the risk of flood defence failures in the United States**

In periods of extremely high precipitation, the flood scenarios that pose the greatest level of risk to populations and economic activity involve a failure of flood control assets, such as dikes, levies and floodwalls. Risk analysis (hazard, exposure and vulnerability) should therefore take into account the possibility of such failures, but modelling failure requires accurate information about the condition and maintenance of flood defence assets. Most countries, however, do not keep complete and accurate inventories of these assets, much less databases that provide up-to-date and publicly available information about their condition and maintenance. Countries such as the United States (National Levee Database), France (BARDIGUES), and the United Kingdom have made progress in this direction.

In the United States, the Army Corps of Engineers launched the National Levee Database in 2011. It currently includes information on 92% of federal levee systems and plans are to expand the database to include other flood protection systems and to reflect new inspections as reports become available. In addition to physical data points such as location and length of the system, the public can view when the last inspection was performed and a qualitative rating such as acceptable, minimally acceptable and unacceptable, which could help decision makers target limited resources for maintenance. Among the database's impressive features is a mapping tool, which uses Google Earth to enable users to see component parts of a levee system and overlay federal data sets for flood insurance rate maps, data from the U.S. Geological Survey, real-time weather conditions and forecast water levels. In addition to facilitating risk assessments, these tools link activities, such as flood risk communication, levee system evaluation for the NFIP, and flood plain management. Among the parties that could benefit from these features are flood plain managers; levee and drainage district officials; private users, such as property owners protected by a levee; and purchasers or lessees performing real estate due diligence.

Lessons learnt from this experience include a need for building and continuously updating and improving databases of flood defences and their condition to help target investment more precisely to where it is most needed. Currently, significant variability exists between countries with regard to the completeness of such databases, their openness to the public and transparency about the evaluations conducted of the protective assets covered. One challenge to building and maintaining these data sets is cost, but the benefit would be to motivate exposed communities to support their continuance.

Source: National Levee Database website, *http://nld.usace.army.mil/egis/f?p=471:1:1983829781918781*.

In this respect, the development of CONAGUA's 2030 National Water Agenda published in 2011 might indicate a shift in CONAGUA's approach to flood risk reduction. On the one hand, one of the four challenges it identified relates to reducing flood disaster risk, and all of the identified initiatives are non-structural with a strong focus on land use and territorial planning (Table 4.1). On the other hand, an investment programme of MXN 107 billion is targeted at drainage and river control (SEMARNAT, 2011). In the recent OECD Study on Water: *Making Water Reform Happen in Mexico* (2013), it was recommended that Mexico should pay more attention to the cost-effectiveness of water-related spending and decisions (Box 4.2).

Table 4.1. **Initiatives related to flood risk reduction in the CONAGUA 2030 Water Agenda**

CONAGUA: Water Agenda 2030 – initiatives and actions for the development of safe settlements for catastrophic floods	
Initiative 1	Create a Ministry of Territorial Development for the establishment of a long-term urban development policy.
Initiative 2	Create and gradually implement a mandatory programme for territorial ecological development in all Mexican municipalities, expanding its impact to urban areas.
Initiative 3	Create a National Observatory for Sustainable Territorial Development.
Initiative 4	Include the preventive evacuation of population under imminent risk in the DN-III emergency plan of the Ministry of National Defence.
Initiative 5	Increase investment focused on the development of risk maps of floods; definition of riverbeds, federal areas and flood areas; construction of protection infrastructure and maintenance of current hydraulic infrastructure.
Initiative 6	Strengthen the civil protection capacities of the municipalities.
Initiative 7	Consolidate the national and regional hydrological services.
Initiative 8	Speed-up the updating programme of the National Meteorological Service.
Initiative 9	Increase the sanctions applied to public servants who allow the non-compliance of urban development plans.

Source: SEMARNAT (2011), 2030 National Water Agenda, SEMARNAT, Mexico City, *www.conagua.gob.mx/CONAGUA07/Temas/AgendadelAgua2030.pdf*.

Box 4.2. **OECD review on water policies in Mexico**

The OECD/Mexico policy dialogue carried out in 2012 focused on four key areas identified as essential drivers for water reform: multi-level governance, river basin governance, economic efficiency and financial sustainability of water policies, and regulation of water supply and sanitation provision. The OECD review provided the following messages:

- Mexico has the opportunity to invent its own model for water governance. As a federal country, with large regional socio-economic and environmental disparities, Mexico would benefit from place-based responses to water challenges.
- Mexico needs to bring more flexibility into its water policies to ensure they can meet future challenges. Given climate change impacts and uncertainties about future water availability and demand, managing risks and trade-offs requires flexible, smart and green water policies to avoid being locked into sub-optimal options.
- Mexico needs to set incentives for policy coherence in support of inclusive, sustainable and efficient water policy. This implies, for example, removing harmful energy subsidies that work against water policy objectives, increase costs and put water security at risk in several basins. Pilot programmes that work well on the ground need to be scaled-up.
- Mexico needs to pay more attention to the cost-effectiveness of water-related spending and decisions. Well-targeted and cost-effective public expenditures and investments require co-ordination between departments and levels of government, access to other potential sources of financing and further incentives for efficient water use.
- Mexico needs to improve regulatory frameworks for better access to and the quality of water and sanitation services. Regulatory functions need to be properly designed and allocated across actors and places, and major gaps still need to be identified and bridged.

Meeting the water reform challenge in Mexico requires action on several fronts. Making Water Reform Happen in Mexico (OECD, 2013) highlights a number of levers that a new administration may wish to consider for setting up a cohesive and cost-effective water policy framework in Mexico.

Source: OECD (2013), *Making Water Reform Happen in Mexico*, OECD Publishing, doi: *10.1787/9789264187894-en*.

Land use and urban development

According to most SINAPROC stakeholders from federal, state and municipal levels, land use and urban planning is the most pressing challenge Mexico needs to face to reduce risks. As mentioned in Chapter 1, Mexico's rapid and continuous urbanisation linked to migration, both to metropolitan areas as well as to small and medium cities, tends to increase its exposure and vulnerability to disasters. Indeed, as this urban development was not planned nor accompanied with appropriate land-use policies or the development of infrastructures and basic services, some cities in Mexico have grown by the extension of informal settlements in hazard-prone areas. These "*colonias populares*" gradually received attention from the local and federal authorities through social programmes such as Programme HABITAT of the Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL), but they still concentrate most of the vulnerabilities in the country and cities are still expanding with new informal settlements in always more vulnerable and hazard-prone areas, such as river banks or unstable hills.

As in many OECD countries, changes to land-use policy require strong political will to reconcile vested interests. Competence for land use and planning is determined by Mexico's federal Constitution, specifically Article 27, which specifies the role of the federal government in land management, and Article 115.V, which entitles municipalities to manage land-use policies and building permits in their jurisdictions. Still, the federal government is responsible for managing 40% of the national territory: the Ministry of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*, SEMARNAT) regulates the natural resources, the seas and the beaches; CONAGUA the riverbeds and their banks; the National Forest Commission (*Comisión Nacional Forestal*, CONAFOR) the forests; the Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*, SCT) the federal roads, etc. This fragmented landscape of federal competence overlaps with those of the states and municipalities, which has in some cases meant that regulations are not enforced (Box 4.3).

Box 4.3. **Informal settlements along the Río Santa Catarina in the Monterrey metropolitan area**

Informal settlements on the embankments of the Río Santa Catarina in the metropolitan area of Monterrey are located both on CONAGUA federal property and within the territorial jurisdiction of some municipalities. Before Hurricane Alex, CONAGUA had leased land to the municipality of Monterrey inside the river bed, where the city granted commercial concessions for an open market and other activities.

Neither federal nor local governments made an effort to remove the population from these informal dwellings, which had been illegally established in hazardous zones. While cities and towns in the metropolitan area of Monterrey are in charge of their urban development plans, their responsibility does not extend to federal lands. The municipalities, therefore, did not see themselves as competent to take enforcement actions on federal land; CONAGUA did not see its mandate as exercising police power to forcefully remove a population from dwellings.

Both Hurricanes Alex and Gilbert flooded the Río Santa Catarina, causing massive damages to these settlements. The responsibility to rescue this population fell directly to municipal and state civil protection services, which created an incentive for them to prevent the repopulation of these areas after the disaster. However, many invasive settlements were rebuilt along the river bank and are occupied as highly vulnerable shanty dwellings. The collective inaction is indicative of a clear governance deficit that could be rectified.

Source: Interviews with stakeholders.

Municipalities are mandated by the Constitution to develop their own urban development plans. Making vulnerability reduction a priority of these plans requires, first, to develop risk assessment at the municipal scale to map high risk zones, then to develop construction rules in these zones and/or other measures to reduce the exposure and vulnerability of existing construction and housing, such as retrofitting and possibly relocation. As municipal governments are elected for a single, non-renewable three-year term of office and their technical and financial capacities to develop plans taking such criteria into account are often limited, various incentives and support mechanisms have been established by the federal and state governments to support this process.

SEDESOL is the key federal ministry with regard to urban development issues in Mexico. Specific national urban development and territorial planning programmes were designed by SEDESOL in 1995-2001 and in 2001-06, and had among their objectives to foster better urban planning and reduce hazard vulnerabilities. The implementation and impacts of these regulations and strategies were limited. No such national programme was developed for 2007-2012 but these objectives were still included in SEDESOL's sectoral programme based on the National Development Plan. In 2011, SEDESOL initiated its Programme of Risk Prevention for Human Settlements (*Programa de Prevención de Riesgos en los Asentamientos Humanos*, PRAH), which provides studies and advice to reduce exposure and vulnerability in "high risk" and "very high risk" municipalities. In addition to the development of risk atlases (Chapter 3), the PRAH can finance studies for relocating settlements located in hazard-prone areas up to MXN 1 million. While the PRAH budget reached MXN 190 million in 2011, it was reduced by 75% in 2012 due to budget reallocation within SEDESOL social programmes. Another important programme managed by SEDESOL is HABITAT, which supplies basic services to poor settlements such as water, energy and sewage. Established in 2003 as the key federal programme to reduce poverty, HABITAT has reduced the informality of many *colonias populares* by investing in water supply and sanitation, electricity, public infrastructures and other services with annual resources close to MXN 3 billion. In doing so, it has participated in settling communities in hazard-prone areas, despite the fact it specifically included risk reduction as one of its objectives before PRAH was created.

SEMARNAT, through the General Law for Ecological Equilibrium and Environmental Protection (revised in 2012) (see Annex C), has been mandated to regulate land use. Through this law, SEMARNAT can deny a construction permit based on criteria that take into account natural hazards. Furthermore, its environmental attorney agency can close buildings and impose fines if the limits within the permit are not respected. However, this instrument, which can only be utilised on federally regulated land, is not fully implemented and is often challenged at the local level. In addition, this law regulates the environmental plans to be developed at national, regional and local levels as well as for maritime areas. In the development of these environmental plans, SEMARNAT provides technical support at the local level, but as the states and municipalities are responsible for issuing the plan, SEMARNAT's recommendations are not always taken into account. For example, during the development of the environmental land-use plan of the city of La Paz in Baja California, a large participatory process involving the municipalities, SEMARNAT, academics, the private sector and civil society was established. When SEMARNAT initiated discussions about limiting coastal construction, consensus could no longer be reached. The plan was finally adopted by the municipality without these specific rules.

Box 4.4. Land-use practices at the local level: Tabasco and Tamaulipas

Tabasco

The state of Tabasco revealed the need to review the boundaries of zones exposed to flood hazard and to implement land-use policies as disaster prevention measures. After the 2007 floods, a major surveying project was undertaken to update flood hazard zones. To discourage new construction in these areas, these zones were designated as hazardous areas in the Public Registry of Property (a cadastre for the registration of private real estate) so that any future potential buyers of the land could be informed.

Tamaulipas

Informal settlements in hazardous zones create the conditions for large-scale emergencies and constitute a significant challenge for civil protection services. Some individuals encourage people to build or squat dwellings in such areas with a view to pressure local governments to eventually legalise these illegal dwellings, possibly obtaining an economical benefit from them. The state of Tamaulipas has addressed this problem by penalising persons who encourage the population to build in such areas. These penalties are extended to owners who may permit illegal dwellings on their properties without informing the corresponding authorities. The law also penalises public servants who issue permits to build or use land in restricted areas. The state government has perceived a decrease in the quantity of illegal dwellings in Tamaulipas and a reduction of the negative externalities that they produce, which it attributes to these measures.

Source: Meetings held with the states of Tabasco and Tamaulipas during the OECD mission (May 2012).

The federal government has some limited leeway through various agencies and incentive instruments to influence local planning, but the federal Constitution primarily reserves competence in this area for the municipalities. SEDESOL has been active in this area in its programmes to fight poverty in municipalities, but results are limited, as informal settlements continue to increase: more than 250 000 were built illegally every year between 2000 and 2007. In 2008, this represented 60% of the new settlements built (Rodríguez-Oreggia et al., 2008). The environmental approach promoted and managed by SEMARNAT is a new tool for incentivising municipalities and claims to address this challenge, even though it has limited power. Many stakeholders consider the effects of these incentives to be too weak to ensure that local development planning properly takes vulnerability reduction into account.

The current institutional setting makes it difficult to build a joint approach to reduce the exposure of informal settlements. This requires appropriate instruments to strengthen the capacities of the 2 440 Mexican municipalities. CONAGUA made a proposal to create a dedicated Ministry for Territorial Planning in its 2030 National Water Agenda, and to strengthen the capacities of the municipalities. Different SINAPROC stakeholders suggest amending the federal Constitution and the balance of power between the three levels of government with respect to land use. The recently adopted 2012 General Law for Civil Protection states that risk atlases will now be binding instruments for the development of land-use plans at the municipal and state level. As these tools are in the process of being developed, territorial planning will remain on the front line of the policy agenda in the coming years. Ultimately, significant efforts would need to be made to prevent any increases to the already substantive population in highly exposed areas; reducing this number would also need to give support for moving people out of highly exposed areas.

Building codes and retrofitting

Improvements to building codes that enable new buildings to better resist earthquakes or enhance protection against floods, are an effective way to reduce two of the main vulnerabilities in Mexico to large-scale disasters. The building code of Mexico City was revised after 1985 based on an updated seismic risk analysis and updated again in 2004. Building regulations in the Federal District take into account the different sub-soil conditions and acceleration rates to define what types of constructions may be built in different areas of the city. As a consequence, buildings constructed post-1985 should be safer than those built prior to it. A large-scale project to retrofit schools, financed by a World Bank reconstruction loan, was undertaken to comply with the new standards. Between 1986 and 1991, 2 400 educational facilities were rehabilitated. Over the past two decades, CENAPRED has participated in the development and updating of construction regulations, conducting experimental research and convening specialists in technical committees to improve the seismic safety of structures against phenomena such as earthquakes, high winds, flooding or other forces that may arise during a building's foreseeable period of use.

The building stock still includes many older constructions, however, retrofitting them to comply with the new building codes comes at a high cost. There is no specific funding mechanism to support the retrofitting of private property, nor are tax deductions made available as an incentive for making such capital investments. In 1998, the Federal District required private buildings that conduct economic activity to be capable of withstanding an 8.0 magnitude earthquake to validate their internal civil protection programme, but did not offer any specific financial support to this end. The Federal District, through its Institute for Housing, can support poor households for seismic retrofitting, but apparently this programme is far from being fully implemented. There is also a specific programme for seismic retrofitting of hospitals called Safe Hospital (see Box 4.6).

Mexico City, with its high exposure to earthquakes and living memory of the 1985 events, has the most advanced building code in Mexico. Outside of the Federal District, building codes are, in theory, defined at the municipal level, but many municipalities do not have sufficient resources to create such codes. The building codes of many municipalities have not been revised for years, if not decades, and thus do not incorporate seismic codes, which means construction is unregulated for seismic risks in many areas. Some municipalities, such as Tuxla Gutiérrez in Chiapas, have adopted another municipality's code, in particular the one for the Federal District, which is not appropriate for their level of risk.

This reflects a challenge in terms of capacity at the local level, which although not specific to Mexico, is compounded by the size of the country and the diversity and the level of risks faced in various areas. In some cases, legislation has been passed at the local level to encourage the development of building codes. For instance, in 2009, the Urban Development Code of the state of Jalisco made it mandatory for municipalities to create their own building codes. SEDESOL's risk prevention programme PRAH can finance the development of building codes at the municipal level. However, the cost-sharing burden for municipalities (35% minimum) may still be too high for municipal budgets. In Chiapas, the seismic micro-zoning financed at the state level is a good practice that could be replicated in other states to inform the development of adapted building codes (Box 4.5). The role of the Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE) also has to be highlighted, as its *Manual on Civil Works*

serves as a reference nationwide for the construction of earthquake- and wind-resistant infrastructures and buildings; it has been updated several times (most recently in 2008). In addition, the "SCT Regulations" set out homogenised guidelines for the construction of highways across Mexico. Finally, CENAPRED also plays an important role in this area, through its specific laboratory that tests structures' resistance to earthquakes; initially financed through Japanese co-operation after the 1985 earthquake, it is the technical basis for the improvement or creation of building codes.

Box 4.5. **Chiapas: Seismic micro-zoning to support building codes at municipal level**

One-third of earthquakes in Mexico have their epicentre in Chiapas. That is why the state of Chiapas has decided to strengthen its building codes and construction regulations. The objective is to create and implement a new seismic micro-zoning system. With support from the UNDP, the UNAM's Geophysics Institute and the National Seismological Service (SSN), the state is developing a micro-zoning system for its two largest cities: Tuxtla Gutierrez and Tapachula. The project includes the installation of seismographs in all government buildings and infrastructure and is intended to be developed in other municipalities within the state as well.

Currently, the Chiapas Civil Protection Institute for the Integral Disaster Risk Management (IPC) has started to develop this zoning in the state's capital, Tuxtla Gutiérrez. A high-technology laboratory will be created with seismic radars and accelerographs. The data thus obtained will be analysed to determine risk zones and update risk maps. In addition, the project aims to update the city's building regulations in order to define criteria to build earthquake-resilient infrastructures.

A seismic micro-zoning project is also being developed in Tapachula with the support of the Autonomous University of Chiapas (Universidad Autónoma de Chiapas, UNACH), the Tapachula Technological Institute (Instituto Tecnológico de Tapachula) and UNAM. One of its main objectives is to develop technical construction norms for the city. The first part of the project was developed in 2011 to measure the dynamic characteristics of earthquakes. The project also includes the establishment of a laboratory for the identification, mapping and monitoring of natural phenomena, including the activity of the Tacaná Volcano and seismic activity.

Source: Based on information provided by the Civil Protection Institute of the state of Chiapas.

Building codes can also be used to reduce vulnerability to floods, hurricanes and tsunamis, but it appears that, in Mexico, they are mostly focused on the risk of earthquakes. Recent disaster events such as the January 2010 earthquake in Chile and the 2011 Great East Japan Earthquake both triggered major tsunamis, which were the source of most of the damages to lives, livelihoods and infrastructures associated with these events.

With the adoption of the 2012 General Law for Civil Protection, which considers risk atlases as the reference for the construction of new buildings, the design of appropriate building codes at municipal level is a key challenge in the years to come. Developing such instruments requires specific technical knowledge, which presents some municipalities a challenging task.

Box 4.6. **Safe Hospital and Safe School programmes in Mexico**

Following a resolution of the Pan-American Health Organization (PAHO), in 2006 Mexico created the Safe Hospital Programme (Programa Hospital Seguro), co-ordinated by SEGOB and the Ministry of Health. Its objectives are included in the Action Framework of Safe Hospitals 2010-15 of the PAHO and give priority to the assessment, classification and certification of hospitals according to indicators aimed at measuring their level of safety in case of disaster. Hospitals are assessed to identify their level of exposure to risks according to an index of hospital safety designed by the PAHO (145 item checklist). A plan of actions is then developed to reduce the hospital's vulnerability, as well as to ensure that it can appropriately evacuate its patients, maintain critical operations and provide medical care to an important number of victims in case of a disaster. According to these criteria, 200 hospitals in Mexico have been classified as safe and prepared for disaster.

Regarding schools, two complementary programmes aim at reducing the vulnerability to disasters of the 246 000 schools in Mexico. On one side, an internal programme of school safety (Programa Internal de Escuela Segura, PISE) must be elaborated in each school according to the guidelines set out by the Ministry of Education and SINAPROC, which are aligned with the United Nations International Strategy for Disaster Reduction (UNISDR) programme "Disaster Prevention Begins at School" (2006). Internal programmes of school safety are organised around six main areas targeting the entire risk cycle: i) the creation of a committee of health and school safety as well as emergency brigades; ii) internal and external risk assessment (including a vulnerabilities approach); iii) training; iv) civil protection equipment (including signposting, warnings); v) drills; and vi) maintenance programmes.

Reducing the structural vulnerability of schools is an ongoing objective of the National Institute of Educational Physical infrastructure (Instituto Nacional de la Infraestructura Física Educativa, INIFED) which has the normative power to assess the quality of educational infrastructure. A series of rules were issued in co-operation with CENAPRED to determine the criteria for selecting school locations related to the proximity to coasts, volcanoes and the stability of hillsides, among others. In addition, INIFED conducts visits to assess schools' infrastructure vulnerability. Currently, around 25 000 schools are assessed annually.

The Safe Schools and Safe Hospital programmes are initiatives that are promoted worldwide by the UNISDR.

Source: Based on information provided by the SEP, INIFED and SEGOB.

Strengthening the risk culture

Strengthening the risk culture at all levels of the civil society is an integral part of risk prevention. Mexico has put in place numerous institutional mechanisms to increasingly disseminate a culture of prevention. Since its creation in 1988, CENAPRED has been at the forefront of these efforts, leading the elaboration of initiatives related to increasing the population's awareness of risks, including both knowledge of hazards, exposure and vulnerabilities, as well as the understanding of prevention actions and emergency preparedness procedures.

Engaging with citizens

With an average budget of MXN 700 000 for the development and diffusion of risk education materials during the last 10 years, CENAPRED has developed a series of pamphlets, guides, games, videos and other educational materials for all categories of the population. This risk education policy specifically targets the rural population and school

children, as they can disseminate their knowledge to their family. Rural communities are a particularly vulnerable population, as they are often isolated and must count on themselves when a disaster happens. Therefore, fostering a culture of self-protection is crucial.

The illustrated pamphlets developed for the general population offer synthetic information that first explain the nature of hazards and exposure to it, illustrate the measures to take to reduce damages and provide specific information on the EWS signals and other civil protection processes to follow in case of disaster. One of these series is the "What to do in case of", which is designed to provide information on earthquakes, floods, tropical cyclones, etc. They also promote the elaboration of a family plan, including: the identification of the specific risks of the household (structural vulnerability) and the elaboration of a family evacuation plan. Finally, a house damage assessment information sheet is attached to the document and can be directly transmitted to civil protection authorities in charge of recovery and reconstruction. This kind of pamphlet offers practical and useful information, explained in a simple way, which can be understood by the general population, and addresses all of the phases of the risk cycle, from risk assessment to vulnerability reduction, emergency preparedness, and response and reconstruction. However, they may not be able to convey their message to the most deprived social groups, which may be illiterate, and who are exposed to high risk areas.

The dissemination strategy of these educational materials is based on the massive distribution of pamphlets and publications and public access through the web. Although CENAPRED has more than 14 000 prevention-related publications, its budget is not sufficient to widely disseminate these materials to the population. In 2011 for instance, CENAPRED received specific federal funding of MXN 50 million to widely spread the culture of civil protection for earthquakes, which represented 70 times its annual budget for the promotion of prevention for all disasters. Risk communication strategies are also co-ordinated with the Ministry of Public Education (*Secretaría de Educación Pública*, SEP) to disseminate prevention information to children in schools at the elementary and secondary level. Since 2009, primary school programmes have integrated a dimension of risk management in their curricula in history, ethics, Spanish, natural sciences, mathematics and geography. Furthermore, SEP distributes free books including prevention information to each level of the primary education cycle.

Finally, the General Co-ordination of Civil Protection (*Coordinación General de Protección Civil*, CGPC) and the state civil protection authorities organise civil protection days at the state level to foster the development of the culture of risk among citizens (Box 4.7). Moreover, the development of communitarian brigades is being supported by the federal government. The purpose of these brigades is to provide training on basic emergency response and risk information to the population on the community level. Municipalities like Monterrey in Nuevo León, Guadalajara in Jalisco and the Cuauhtémoc borough in the Federal District have implemented such brigades.

Educating civil protection stakeholders

The quality and continuity of risk prevention activities as a coherent feature of SINAPROC is strengthened by the knowledge and technical expertise of the professionals working within civil protection services. To strengthen the risk prevention culture, the National Civil Protection Program 2008-2012 highlighted the need to establish a National Civil Protection School to standardise areas of studies, levels of specialisation and implement tools to qualify civil protection personnel. The main objective of this school,

established in 2011, is to certify competencies for civil protection specialists. CENAPRED will develop the school's curricula, which is meant to deliver technical-professional degrees and should provide technical assistance to other schools of civil protection at state and municipal level as well as to local communities. Its three main headquarters are located in San Luis de Potosí, Chiapas and Querétaro. This federal initiative is described by the DGPC as an important step towards a more professionalised civil protection system in Mexico, which could help to build a commonly shared understanding of the civil protection culture. It should be noted that several stakeholders working in civil protection services contest the usefulness of the National School on the grounds that the trainers know less than the professionals being trained. The system's certification requirement as an employment condition for certain positions and career advancement does not attribute proper value to work experience and education attained outside of the National School.

Box 4.7. **National Days of Civil Protection**

Improving the civil protection culture is one of SINAPROC's main objectives: population awareness is a crucial element of an effective civil protection system. Self-protection capacities play an important role during emergency response. The population's knowledge on the procedures to be followed during an emergency is a key element for risk management. The Days of Civil Protection (DCP) have been created with these objectives in mind, and are highly promoted by the General Directorate of Civil Protection (Dirección General de Protección Civil, DGPC).

The purpose of these public events is to inform the population of risks. They focus on developing self-protection capacities among the population. The wide range of climates and risks in Mexico make it necessary not only to provide this information to the population but also to regionalise it. Regional days of civil protection integrate preparation on common risks for certain regions in the country regardless of political boundaries.

During these events, held annually in several states and municipalities, training and workshops are organised to train local authorities and promote the federal government's initiatives in civil protection, such as the existing financing tools for prevention and reconstruction: the Safe Cities are Resistant to Disasters (Box 5.1) and Safe Hospital (Box 4.5) programmes. Specific events for rural communities, for school children, for company workers, as well as a civil protection fair accessible to all citizens, aim to disseminate this prevention culture as widely as possible.

In parallel, the DCPs give the population the opportunity to provide inputs for policy making. The use of questionnaires during the DCPs allowed the population to participate in the development of the National Plan of Civil Protection 2008-2012. This allowed policy makers to take citizens' perspective into account, thus opening a dialogue channel between the state and the population, making the DCP a valuable mechanism not only for building capacities within the population but for increasing the efficiency of the government's programmes and plans.

Source: Based on information provided by the DGPC and CENAPRED.

Another key element for fostering the development of the culture of risk from the federal level to the local level is the development of the Safe Cities are Resistant to Disasters programme (see Chapter 5, Box 5.1) targeted at municipalities. This benchmarking programme is based on emulation among municipalities to prioritise civil protection.

Box 4.8. The Prevention Program of Civil Protection (PP5) in Chiapas

In 2009, Chiapas, with support from the UNDP and the UNAM's Geophysics Institute, presented the "Prevention Program of Civil Protection" (Programa Preventivo de Protección Civil, PP5)" to FOPREDEN. The approved project, for a total of MXN 58.9 million, was co-financed by FOPREDEN (70%) and the government of Chiapas (30%).[1]

The PP5's objective is to train the population in the most risk-exposed municipalities in the state. Integrating an integral risk management approach, it is oriented to risk prevention and emergency response at the community level. The fact that the plan is implemented at the community level is one of its main strengths. This ensures the continuity of the PP5 as communities are not affected by the changes in local governments which occur every three years.

The plan starts with the creation of community committees of civil protection (CCCP), made up of community volunteers. As these volunteers have the best knowledge of their own area's exposure to risks, they are considered to be a reliable source of information for decision makers. All CCCPs receive training providing them with the capacity to develop their own community plan of civil protection. Training is focused on integral risk management, analysis and assessment of local risks, evaluation of damages and needs in emergency situations, and emergency planning. In addition, the PP5 encourages the establishment of radio-communication systems in community leaders' homes. These leaders are in charge of identifying and monitoring risk, thus ensuring a co-ordinated and permanent communication network comprising community committees, municipal and state civil protection offices. The plan also contemplates the development of a geographic information system (GIS) to systematically gather municipalities' and communities' civil protection data.

The PP5 was first developed in the ten most risk-exposed communities in Chiapas, determined according to Chiapas' Risk Atlas and social indicators. During this first stage, 106 community committees and community civil protection plans were created. In addition, 10 municipal risk atlases have been developed and 400 radio-communication systems installed. The second part of the plan concerned the remaining 112 municipalities in Chiapas. As a whole, more than 2 500 community committees have been created and trained, reaching the 122 municipalities in the state. The communication network now integrates over 3 500 radio-communication systems connecting federal and state ministries, the municipalities and the community committees.

Note: 1. This budget comprises the 2009 and 2010 stages of the Integrated System of Civil Protection for Risk Prevention of Natural Disasters. These two stages are considered to be two different projects.

Source: Based on information provided by the State of Chiapas and Chiapas Civil Protection System website, *www.proteccioncivil.chiapas.gob.mx/site/index.php*.

In order to involve the entire civil society in the prevention strategy, the federal government has encouraged the development of family plans of civil protection (*Plan Familiar de Proteccion Civil*, CENAPRED, 2007). This programme aims at helping each family in a personalised way to create their own emergency response plan taking into consideration the specificities of their house and neighbourhood. The plan is structured in four sections: house safety, risk exposure, reaction and drills. The main advantage of this kind of initiative is that it allows authorities to disseminate prevention culture in a pedagogic and dynamic way directly to families, including sectors of the population that do not have access to this information (the elderly for example). On the other hand, it is difficult to assess the impact of this programme or the number of households that have actually created such a plan.

The federal initiatives to expand and enhance a culture of prevention achieved broad uptake amongst the general population. While many programmes focus on special sectors of the population, such as rural communities, school children and the labour force, they have been less effective with indigenous populations who are not easily reached by educational campaigns. Moreover, considering that most of the prevention information is distributed in paper format, illiterate people are excluded. The Ministry of Tourism has made efforts to provide information related to prevention to tourists, who often confront linguistic barriers, and who are often difficult to inform.

Box 4.9. **Identification and communication of risks at local level in France**

In France, regulatory documents must be prepared at local administrative levels (district and municipality) related to the communication of information about risks to citizens.

At the district level, the District Major Risks Report (*Dossier départemental des risques majeurs*, DDRM) is developed under the central government's responsibility to inform all government services about the hazards and risks facing the different municipalities within the district. The DDRM lists all major risks identified in the district as well as their foreseeable impacts on persons, property and the environment, on the basis of available knowledge. It highlights any exposed critical sites, particularly in built-up areas; lists prevention, protection and safeguard measures; and describes the mitigation modes that can be implemented to alleviate impacts of natural hazards, depending on its intensity and the vulnerability of the exposed critical sites. Prefects are responsible for annually updating the list of municipalities that are mentioned in the DDRM as being subject to specific risks. The DDRM provides background on past events and accidents and summarises the main studies, Internet sites or reference documents available for consultation by those seeking more complete information. The DDRM is updated every five years, and must be publicly accessible to citizens via the Internet.

The central government may require the preparation of a Risk Prevention Plan (*Plan de Prevention des Risques*, PPR) in the municipalities mentioned in the DDRM. The PPR represents one of the essential tools for preventing risks or reducing the vulnerability of persons and property. Based on up-to-date knowledge of natural hazards and critical industrial sites at the local level, the PPR may levy land-use prescriptions upon municipalities, particularly with regard to urbanisation and spatial planning. Its primary goal is to delimit zones exposed to hazards. It produces maps (at least one map providing information on natural phenomena, a map of weather hazards and a map of critical sites) drawn up to medium scale at 1:25 000 or more detailed if available documents so allow. The French Minister of the Environment has introduced specific mechanisms for financing their preparation, and, as a result 7 000 PPRs have now been validated for the 36 000 municipalities in France, with around 500 new PPRs prepared every year (in the long run, 1 out of 2 communes should be covered by a PPR). The completion of a PPR promotes risk awareness by means of in-depth discussions with various administrative officials, elected community representatives, local associations, the private sector, etc. Subsequently, risk-related information is transmitted and circulated to citizens via the Municipal Information Document on Major Risks (*Document d'information communal des risques majeurs*, DICRIM), which can be consulted at the City Hall.

Source: Golnaraghi, M. (2012), *Institutional Partnerships in Multi-Hazard Early Warning Systems*, Springer, World Meteorological Organisation, New York.

The crucial role of early warning systems

A clear and measurable area of SINAPROC's progress over the past two decades is the progressive development and uptake of EWSs for tropical cyclones, floods, tsunamis, earthquakes and volcanoes.

Early warning systems are crucial civil protection tools that have demonstrated their effectiveness in enabling people to take quick action to protect themselves and their property from impending risks. Effective EWSs need to be supported by hazard monitoring and forecasting capacities, and the capacity to aggregate data into risk information that can be delivered as appropriate warning messages. These systems need to be supported by parallel efforts that ensure recipients understand what actions to take. EWSs can also be used to deliver continuous situation awareness for emergency response actions on the ground. Effectiveness hinges on the planning of co-operation and co-ordination processes between technical agencies, civil protection authorities, the media and the population at large.

SIAT-CT, a national tropical cyclone warning system

Tropical cyclone warning systems have to rely upon quality meteorological services. Here, Mexico can count on a variety of monitoring and forecasting capacities, which represents both an opportunity and a challenge. These include first the National Meteorological Service (*Servicio Meteorológico Nacional*, SMN), which is the authoritative provider of meteorological information and services, supplemented by specific systems developed by the Federal Electricity Commission (CFE), Mexican Petroleum (PEMEX), the Navy, some states such as Mexico City and Jalisco, and universities. While a wealth of information can help, it could also represent a challenge if insufficient institutional co-ordination and co-operation, a lack of information exchanges and a multiplicity of weather forecasts were to lead to confusion and duplicity. A system of co-ordination was clearly required and the Early Warning System for Tropical Cyclones (SIAT-CT) was set up in 2000 precisely for these reasons.

The SIAT-CT provides a co-ordinated and harmonised national response through cyclone watches and warnings sent to the states, municipalities, federal agencies and the public at large. Co-ordinated by SEGOB and designed by CENAPRED, the SIAT-CT disseminates incremental colour-coded warning signals (blue, green, yellow, orange or red) based on the cyclone's location and estimated path when a cyclone is approaching (approaching phase) and the inverse as it becomes more distant. An inter-agency group determines the forecast for tropical cyclones, gathering information from various meteorological services (Table 4.2), as well as through international co-operation with the Regional Specialised Meteorological Center of Miami (see Chapter 7). Warning messages include recommendations for action corresponding to each colour for state civil protection authorities, the population, and the maritime and air navigation sectors. These messages are widely distributed through the National Communications Center (*Centro Nacional de Comunicaciones*, CENACOM), the communication infrastructure set up by the DGPC of SEGOB (see Chapter 5).

Table 4.2. **Early warning systems in Mexico**

Hazard	Early warning system	Institutions (*lead institutions)	Coverage	Main characteristics			
				Operational date	Warning products	Lead time	Dissemination process
Earthquake	Earthquake Warning System (*Sistema de Alerta Sismica*, SAS)	CIRES*	Mexico City	1991	Public warnings	60 seconds	VHF radio Blackberry
	Earthquake Warning System for the State of Oaxaca (*Sistema de Alerta Sismica para el Estado de Oaxaca*, SASO)	CIRES*	Oaxaca City	2004		30 seconds	Local radio Public schools
Hurricane	Early Warning System for Tropical Cyclones (*Sistema de Alerta Temprana para Ciclones Tropicales,* SIAT-CT)	SEGOB* SEMAR CFE PEMEX	Nationwide	2000, updated in 2003	Colour-coded warning: blue, green, yellow, orange, red	72 hours	Media channels
Flood	Hydrometeorological Alert System (*Sistema de Alerta Hidrometeorológica*, SAH)[1]	CONAGUA* SMN CENAPRED	Municipal level	Project	Non-standardised, mostly colour-coded warnings	90-120 minutes	Civil protection authorities
Tsunami	Tsunami Warning Center (*Centro de Alerta de Tsunami*, CAT) (international monitoring)	SEMAR* SEGOB PTWC	Pacific coast	Under development	To be developed	Minutes (local tsunamis)	To be developed
	National Tsunami Warning System *(Sistema Nacional de Alerta de Tsunamis,* SINAT) (local monitoring)	SEMAR					

Note: 1. The SAH is a hydrometeorological monitoring system mainly monitoring water levels.

Sources: OECD based on information provided by CENAPRED, CONAGUA, SEGOB and SEMAR.

The SIAT-CT integrates all four components of an efficient EWS:

- the production of hazard forecasts;
- the development of risk information;
- the issuing of warnings;
- linkages to emergency response actions.

This system has proven its effectiveness over the past decade in the lead-up to land fall of several major hurricanes, such as Hurricane Emily in 2005, and more recently during the tropical storm Ernesto in August 2012. In the latter case, 34 warning bulletins were issued and disseminated by CENACOM to 211 SINAPROC stakeholders. Local capacities to ensure "the last mile" of the EWS, that is a warning to the population in a specific location with a clear message about what action to take, have sometimes been inadequate. For example, in Monterrey people died during Hurricane Alex in 2010 because they were in a marketplace in the middle of the river bed even though a red level

warning had been issued, demonstrating the ineffectiveness of warning dissemination and impact.

SIAT-CT also represents a good example of institutional co-operation in Mexico, reflecting an achievement for SEGOB/DGPC's and SINAPROC's leadership function. This also shows the potential for such co-operative arrangements to be used for other hazards as well. Within SIAT-CT, technical organisations, critical infrastructure operators and civil protection authorities work hand in hand at all levels of government. This also helps to develop emergency plans accordingly.

Consensus forecasts are elaborated jointly by the various meteorological organisations, limiting the scope for confusion. Still, these redundancies have a cost and might be more efficiently utilised under a single roof or framework. There could also be opportunities to use the co-ordination frameworks which have been developed for tropical cyclones for other meteorological hazards. For instance, the SMN publishes an average of 6 700 warning bulletins per year and tropical cyclones represent only a limited share of meteorological hazards. Conflicting warning messages are at times issued between these various institutions, such as during a thunderstorm in Mexico City in 2010 between the SMN and the Federal District's meteorological service. The ongoing co-operation between CENAPRED and the Mexican Institute for Water Technology illustrates a step forward in fostering co-ordination. This entails developing an EWS for cold and north fronts, which create winter storms, heavy rainfall and floods.

Flood warning systems at the local level

Unlike tropical cyclones, which can be detected and forecasted several days in advance, some types of floods are difficult to forecast with precision. Monitoring water levels and flow rates and flood forecasting requires significant investments in hydrometeorological stations and modelling at the river basin scale, especially in the case of Mexico where there are nearly 100 river basins with medium to high flood risk. Another difference with tropical cyclones is that floods, even though they can have large-scale impacts, are more of a local issue. Mexico faces different types of flood risks, from flash floods to river or coastal floods, with different time scales. Developing EWSs for all of the flood risks in Mexico is therefore challenging and resource intensive, which explains why these systems are less advanced than those for tropical cyclones.

CENAPRED and CONAGUA have led an effort to develop flood warning systems over the last decade with a focus on the most densely populated areas. FOPREDEN has been instrumental in this process, financing projects at the state and municipal levels. CENAPRED, in particular, developed the methodological approach and the technical tools for the Hydrometeorological Warning System (*Sistema de Alerta Hidrometeologica*, SAH) installed in 13 cities and/or basins in the country (Figure 4.2) with automatic pluviometric stations and hydraulic stations in some cases. The colour-coded approach to warnings is also utilised in this system. CONAGUA has developed guidelines in its *Flood Control Manual* (*Manual para el Control de Inundaciones*, 2011) as well and is operating hydrologic networks in many river basins. For example, CONAGUA conducts continuous monitoring of the Río Panuco basin located in Tamaulipas, which represents a constant risk to Tampico. CONAGUA provides information on water levels to the mayor and civil protection authorities in the city to enable them to take the proper preventive measures. However, CONAGUA's networks were initially designed for water resource management, not for flood monitoring: they often monitor water levels and discharge for dam management or irrigation canals and are therefore not necessarily adapted to the

development of flood EWS. Special operating procedures are based on these systems for dam management, and this infrastructure management process is a form of early warning system. Similar networks are operated by CFE to manage their hydroelectric dams following standard operating procedures aimed at mitigating damages to the infrastructures during extreme events.

Early warning systems for heavy rainfall have been developed by some states. Even though these systems do not measure river levels, they do issue warnings about the risk of flood based on the level of precipitation, and their coverage is broader than the few existing systems at river basin level. In Chiapas, for example, the State Civil Protection Institute produces "the PROCEDA", a daily colour-coded warning map that shows projected levels of heavy rainfall in its 15 sub-regions. PROCEDA follows the same five levels of alert as the SIAT-CT and messages for specific actions to take are available in text as well as in audio format in three languages (Spanish and two indigenous languages: *Tsotzil* and *Tseltal*). Similarly, the state of Tabasco implanted 15 new monitoring stations throughout its territory to upgrade its EWS following the 2007 floods. The private sector in Tabasco has also developed capacity to receive flood warnings for local businesses (Box 4.10).

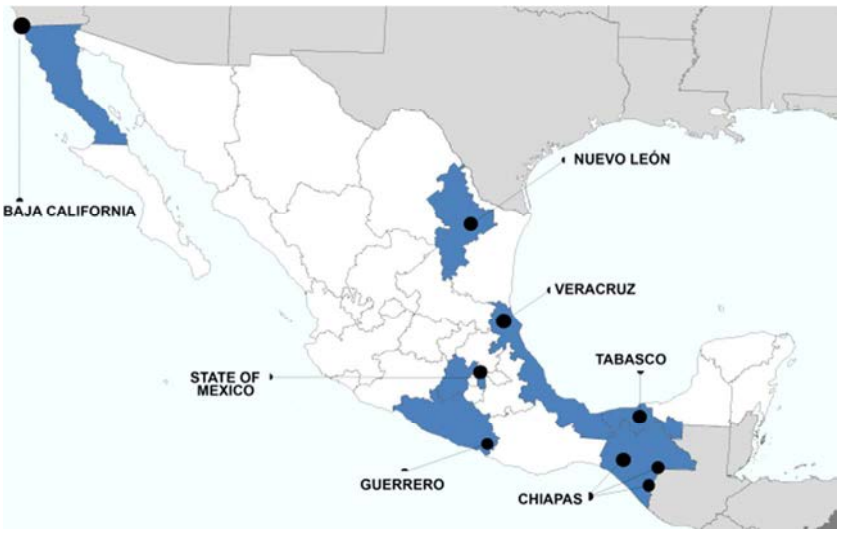
Box 4.10. **Early warning system for businesses in the state of Tabasco**

In the state of Tabasco, a specific flood early warning system dedicated to businesses was established following the massive floods which affected the state in 2007. This early warning system (EWS) was developed through a partnership between the Employers' Confederation of the Mexican Republic (Confederación Patronal de la República Mexicana, COPARMEX) in Tabasco, CONAGUA and the General Directorate of Civil Protection of Tabasco, with support from the Inter-American Development Bank. Six hundred fifty companies in Tabasco state have registered to receive this warning, allowing them to activate their emergency plans to reduce risks of damage to business infrastructures and ease business continuity. A web portal has been created (www.coparmexalerta.com) and businesses can receive warnings by e-mails and SMS. The portal also includes a diagnosis tool for businesses to help them analyse the vulnerability of their businesses to flooding and assist them in defining business continuity solutions. This project is financed equally by the Inter-American Development Bank and the businesses of Tabasco.

Source: Based on information provided by the state of Tabasco during the second OECD mission to Mexico (May 2012) and from COPARMEX website, *www.coparmexalerta.com*.

Extending river basin monitoring, modelling and flood EWS to all of the rivers at risk would require better harmonisation of the efforts between CONAGUA, CENAPRED, CFE, the SMN and the local authorities as well as financing and/or incentivising mechanisms beyond the current FOPREDEN financial resources. The creation of the five meteorological regions with their decentralised forecasting units in the SMN's modernisation plan is a first step in this direction. It may facilitate the availability of meteorological monitoring and forecasting information to inform flood and heavy rainfall EWSs at the local level. Furthermore, this could also facilitate the co-ordination between CONAGUA's hydrologists and the SMN's meteorologists. Ultimately, a national flood warning system could be useful to link all the local flood warning systems to inform federal civil protection authorities as well as the population at the national level on a daily basis, using the same model as the National Risk Atlas (see Chapter 3). Such a system could adopt the same colour-coded approach as the SIAT-CT, to create a harmonised multi-hazard early warning system that citizens would become more familiar with.

Figure 4.2. **Flood early warning systems in Mexico**



Flood early warning systems

BAJA CALIFORNIA *Tijuana* 10 pluviometric stations 2 registering centres	**GUERRERO** *Acapulco* 15 pluviometric stations 1 relay station 2 registering centres
CHIAPAS *Motozintla* 5 pluviometric stations 2 relay stations 2 registering centres *Tapachula* 7 pluviometric stations 3 water level stations registering centres *Tuxtla Gutiérrez* 8 pluviometric stations 3 water level stations 2 registering centres	**NUEVO LEÓN** *Monterrey* 8 pluviometric stations 2 registering centres 1 relay station **TABASCO** *Villahermosa* 7 pluviometric stations 6 water level stations 2 registering centres **VERACRUZ** *Poza Rica, Gutiérrez, Zamora, Martínez de la Torre, Álamo and Misantla* 5 SAH
STATE OF MEXICO *La Compañía* 5 pluviometric stations 4 water level stations 1 relay station 3 registering centres	

Source: OECD with information from CENAPRED.

Seismic warning systems in Mexico

Mexico City is located just 320 kilometres from the main seismic fault in Guerrero state. A Seismic Early Warning System (*Sistema de Alerta Sismica*, SAS) was developed and launched in 1991 to provide advance notice to federal, Federal District and Mexico state administrations, schools, civil protection authorities, private entities as well as to the subway operator in Mexico City. In cases where earthquakes exceed threshold criteria related to location, depth and magnitude, the Centre for Seismic Instrumentation and Record (*Centro de Investigacion y Registro Sismico*, CIRES), a scientific non-governmental organisation (NGO) located in Guerrero and Oaxaca, emits a radio wave to public authorities as well as to radio and television stations in case of a public warning.

A fundamental element of these systems is training and education. With such short lead times, people receiving the warning signals should act immediately to save their lives. Regular evacuation drills are organised in Mexican schools and large public buildings. The importance and efficiency of these drills was amply demonstrated during the 7.4 magnitude earthquake of 20 March 2012 which took place during the course of this review, in the presence of the OECD review team. The population in Mexico City remained very calm, both during the earthquake and the follow-up evacuation process.

A project to merge and expand the existing earthquake warning systems, Mexican Seismological Network II (*Red Sismologica Mexicana II*, RSM II), is under development. Financed by the federal government, its objectives are first to modernise and strengthen the seismic networks of the country and to promote interconnection and information exchange among all of the entities operating seismic stations. It is also meant to develop seismic information and products for decision making as well as to integrate and expand seismic early warning systems in high-risk zones. Increasing the seismic monitoring coverage to warn Mexico City and other cities should be a priority, as the SAS does not record earthquakes registered in Michoacán state, as was the case with the 6.4 magnitude

earthquake on 11 April 2012. In addition, the major earthquake of 20 March 2012 in Guerrero with a 7.4 magnitude was detected, but only a preventive warning, not a public one, was emitted.

Box 4.11. **Seismic alert systems: The SAS (Federal District) and SASO (Oaxaca)**

High seismic activity along the Pacific coast of Mexico poses a constant risk to the country. The high possibility of a major earthquake in the Guerrero Gap in particular pushed for the development of monitoring capacities.

The states of Guerrero and Oaxaca have developed seismic alert systems managed by CIRES. These systems also enable a radio signal to be sent to Mexico City and Oaxaca City as an alert in case of an earthquake. This alert is only issued if the epicenter is located on the Guerrero coast.

In 1986, the National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología, CONACYT) recommended studies be carried out for developing a seismic alert system to monitor seismic activity in the Valley of Mexico. CIRES was contracted in 1990 by the Federal District to develop the Earthquake Warning System (Sistema de Alerta Sismica, SAS). Since 1991, the SAS has been communicating the detection of significant earthquakes thanks to a network of 12 sensor stations located along Guerrero's coast. The sensors emit radio warnings for earthquakes stronger than 5.0 on the Richter scale.

The most important feature of this system is the lead time it provides to the population to move to safe areas before the arrival of a seismic wave. Since seismic waves propagate at a speed of between 4 and 8 km/s, a radio warning can be emitted and transmitted from Guerrero coast to Mexico City with a 40-80 second lead time before the ground begins to shake. Since its creation, the SAS has detected more than 2 300 earthquakes of low, moderate and high intensity. In 2007, the cities of Acapulco and Chilpancingo (Guerrero) were integrated into the system.

Recently, a Blackberry application has been developed to receive the warning on smart phones (Android and Iphone applications are being developed). In addition, 38 000 weather radios will be brought from the United States National Oceanic and Atmospheric Administration (NOAA) into the project of the National Seismic Network (Red Sismica Mexicana II, RSM II) with warning messages to be disseminated to each school, as well as to hospitals and public buildings.

In addition to the SAS, an earthquake monitoring system based on an earthquake's acceleration is also available in Mexico City. A system similar to the SAS is operated by the CIRES in the state of Oaxaca. In 1999, the state of Oaxaca developed the Seismic Alert System of Oaxaca (Sistema de Alerta Sismica para el Estado de Oaxaca, SASO), which became operational in 2003. It includes 36 seismic stations and disseminates public or preventive alerts according to the intensity of an earthquake. It has detected more than 600 seismic events. CENAPRED co-ordinates both of these systems to favour their integration. Their coverage is now intended to be extended to the states of Chiapas and Jalisco.

Source: CIRES website, *www.cires.org.mx*.

According to the National Seismological Service (*Servicio Sismológico Nacional*, SSN), the CIRES monitoring network is not adequate for such a role. If the EWS is expanded to cover several states, the institutional framework for the management of this system between the Federal District and CIRES and the federal government should be revised. Specifically, the roles of federal institutions such as CENAPRED and the SSN should be strengthened, especially if the development of the unified national seismologic network materialises.

Specific warning systems for tsunami

Sections of Mexico's Pacific coast are exposed to tsunami hazard. Although there has not been a tsunami in the recent past with impacts comparable to those that have occurred in Japan, Chile or the Indian Ocean since 2004, the frequent seismic activity and several highly populated coastal communities create the conditions to ensure that a tsunami early warning system is a worthwhile initiative.

In Mexico, early warnings for tsunamis, which are implemented through international co-operation, are not yet fully linked to the domestic earthquake monitoring system. Prevention and preparation are also less advanced than they are for earthquakes. As the result of a CENAPRED-SEMAR joint initiative, the Tsunami Warning Center (*Centro de Alerta de Tsunami*, CAT), operated by SEMAR and financed by SEGOB, was created in 2011 to disseminate the warnings it receives from the international Pacific Tsunami Warning Center (PTWC), operated by the United States' National Oceanic and Atmospheric Administration (NOAA). The PTWC issues real-time tsunami warnings based on an international seismic and oceanographic network, which are disseminated through the World Meteorological Organization Global Telecommunication System. The CAT does not currently monitor tsunamis generated by earthquakes occurring in Mexico, which would be the ones to reach the Mexican coast the most rapidly and with a potentially higher wave.

An effort to develop a tsunami warning system is ongoing, with the creation in May 2012 of the National Tsunami Warning System (*Sistema Nacional de Alerta de Tsunamis*, SINAT), between SEGOB, the Navy (SEMAR), the SCT (which is in charge of harbours), the National Seismological Service (within UNAM) and the University of Baja California.

As a tsunami can reach the coast very rapidly after an earthquake, improving the coastal population's awareness of tsunamis is crucial. In particular, stakeholders recognised the need to improve the coastal population's knowledge about what to do in case of a warning, to demarcate zones exposed to tsunamis and define the safety zones, as well as to provide harmonised signs along the Pacific coast leading to evacuation routes and safety zones. Scientific models for tsunamis built on probable scenarios of particular earthquake faults should be the basis for such actions. This would require significant research, as well as appropriate funding.

Several state initiatives are in place, for example in the state of Jalisco which demonstrated its lead in the implementation of the System of Massive Alert for Tsunamis and Tropical Cyclones, for developing emergency preparedness measures and organising a simulation exercise with all residents and businesses for a tsunami affecting the city of Puerto Vallarta. The exercise included sounding sirens and some practice evacuations from the largest coastal hotels, with for example, the following notice delivered to hotel residents: "Tomorrow, Tuesday September 21st at 10:00 am we will have an evacuation simulation at the tower and the hotel. All of the employees will participate as well as the interested guests. The city alarms will sound as most of the buildings in the bay will participate in this simulation. The government is doing the simulation to commemorate the 25th anniversary of the 1985 earthquakes and to educate people on how to proceed when this kind of event happens." The impact of these efforts in Puerto Vallarta to increase the population's awareness and preparation for a tsunami are difficult to gauge with certitude, but municipal and federal civil protection authorities reported a high number of calls from people seeking information about the arrival on the Pacific coast of the 2011 Great East Japan Tsunami.

Box 4.12. Early warning system for the Popocatepetl volcano

Early warning systems are crucial to inform the population about the threat of natural hazards. There are 14 active volcanoes in Mexico. This situation implies the development of monitoring, alert and emergency response processes. The location of the Popocatépetl volcano, whose last eruption occurred in 1994, is a common risk for three states in the country: Mexico, Morelos and Puebla. The volcano could affect approximately 25 million people in an 80-kilometre radius.

CENAPRED, with support from UNAM's Institute of Geophysics, is in charge of monitoring the Popocatépetl's activity. Permanent monitoring has been possible due to the use of specialised instruments. The system consists of a network of 25 remote stations and 1 central data-processing station located within CENAPRED, 60 kilometres from the volcano. Measurements include the volcano's seismic activity, gas emissions, chemical composition, changes in electric or magnetic fields, temperature and visual observations.

The central station generates more than 60 signals which are constantly transferred to CENAPRED and UNAM. It also issues daily bulletins which are disseminated on CENAPRED's website and a dedicated hotline provides the population with permanent information.

If an increase in the seismic activity is detected, an alert system is activated. It consists of the dissemination of automatic messages to a list of registered cell phones of emergency responder stakeholders and authorities and safety staff. The early warning system includes an alert code in order to provide information about the current situation to the institutions involved in the Popocatépetl Operational Plan, and, if needed, to inform the population to prepare for evacuation. In this respect, the warning message is colour-coded (green, yellow and red) based on the probability of an eruption and the potential risk that it represents for the population.

The Technical Scientific Advisory Committee is responsible for emitting a consensus opinion on the alert level. The General Co-ordination of Civil Protection is then responsible for informing the state government about the situation and the measures to implement according to the level of alert.

Source: Based on information provided by the CENAPRED.

Harmonising early warning systems toward a multi-hazard approach

In Mexico, the development and implementation of EWSs has been quite rapid since 2002 for many hazards. With the exception of the SIAT-CT, these mostly reflect a bottom-up, top-down approach, where a technical organisation relays messages based on its monitoring to public authorities (bottom-up) and public authorities relay this information to the public that it has been trying to sensitise on the issue (top-down). The SIAT-CT has shown the benefits of greater co-operation, which could be extended to other types of risks, such as earthquakes, tsunamis, floods and other extreme weather hazards. To this end, harmonising monitoring networks, data exchange and further institutional co-ordination and co-operation among the technical agencies is a prerequisite for achieving full organisational potential. Harmonisation, building on existing strengths, helps to avoid potential confusion generated when several systems communicate conflicting messages about the same event. Stakeholders suggested warnings could be improved if technical information is properly shared in real-time through harmonised monitoring networks. Mandates should be better clarified and redundancies avoided, in the areas of seismological and hydrometeorological monitoring.

Box 4.13. **Integrated Early Warning System in Korea**

Korea has adopted an integrated risk management approach that reflects its early warning systems (EWS) for natural, man-made and social disasters. Information from these systems is inserted into an Integrated Situation Center (ISC), which includes four sub-systems to monitor and disseminate information before and during a crisis. Through the Disaster Prevention and Meteorological Information System, the ISC monitors satellite and radar images, and contents of special weather reports. Specific monitoring systems are also established for floods, rainfall, tsunamis, earthquakes and highways (CCTV real-time monitoring). In case of a threat, alerts are emitted though the Internet to the report centre and through the cell broadcasting service (CBS), which sends a message to citizens' cell-phones to inform them about evacuation measures. In case of emergency, the ISC acts as a disaster management control tower to support response measures within a maximum of ten minutes. The Disaster Information Sharing System connects 34 organisations to real-time disaster information collection. It also centralises information from affiliated organisations, national and local authorities, civil protection entities, the media and affected citizens. Finally, the Disaster Management Information Data Base Centre provides information about the damage status while the Central Disaster Management System provides information to manage facilities, refugees and assess damage situation.

Source: Presentation by the Korean Ministry of Public Administration and Security, OECD Workshop on Inter-Agency Crisis Management, Geneva, Switzerland, 28 June 2012.

In fact, many stakeholders saw scope for the development of a harmonised multi-hazard federal warning system to avoid treating natural hazards in isolation. The Great East Japan Earthquake has shown how several natural hazards can combine with technological risks to produce complex risks. A harmonised system nationwide using the same symbology, colour-coding, protocols and dissemination channels at federal, state and local levels would increase synergies, efficiencies and avoid risks of confusion. Promoting a branding approach of the national EWS would also allow citizens to be more familiar with it, and could then serve as a powerful risk communication and awareness tool at the national level.

A national warning map could also be published daily, as in the case of the French Vigilance System (Box 4.14). As the responsibility to warn the populations and/or to decide to evacuate remain a key responsibility of the local level, a good link with the state network should be designed for such a system to be efficient: a national map with colour-coding at the state level could be produced after exchanging views with the concerned states. States could then link to it with a more precise map at a lower scale. CENAPRED could be in charge of co-ordinating such system with all the federal entities and states, based on the model used for the National Risk Atlas (see Chapter 3).

Addressing the challenge of communication

The effective communication of warnings and alerts as well as training the population to understand their meaning are key challenges for civil protection authorities. The challenge is especially important for rapid-onset hazards, such as earthquakes, tsunamis or flash floods. Partnerships with the media could be developed so that early warnings are properly communicated through all available channels, especially when there is an imminent threat. The use of social media should also be considered for communicating individual warnings. Traditional means of warnings, such as sirens and VHF-radio, remain fundamental for rapid-onset hazards, together with population awareness and training. In these cases, possibilities of direct warning from the federal level to the local population could be further explored.

However, besides the classic use of the SEGOB Media Center, no specific agreements with media channels or telecommunication operators have been signed to facilitate the dissemination of these warnings. The utilisation of private foreign companies' meteorological forecasts is also more and more common in the broadcast media in Mexico, and can create problems as far as meteorological warnings are concerned, as warning citizens remains a key governmental responsibility.

Box 4.14. **The French Vigilance System: An evolving multi-hazard early warning system**

The French Vigilance System was initially developed by Météo France after a major storm in 1999 killed 100 people, even though it had been properly forecasted by Météo France. This EWS produces daily a national colour-coded map of hydrometeorological risks in its 96 regional jurisdictions, which is widely disseminated in the media and is now known by 96% of French citizens. Since its inception by Météo France and the French civil security, this system has gradually evolved to include more hazards through the development of partnerships among technical agencies. The flood warning function was included in 2005 after operating procedures between the meteorological and the hydrological services were developed. The heat-health warning was developed between Météo France and the Health Monitoring Institute, after the massive 2003 heat wave in Europe. A storm surge warning is currently being developed between Météo France and the oceanographic service.

Source: Golnaraghi, M. (2012), *Institutional Partnerships in Multi-Hazard Early Warning Systems*, Springer, World Meteorological Organisation, New York.

Financing prevention

Investing in disaster prevention projects has often shown to be more cost-effective than paying for *ex post* disaster relief and reconstruction costs (World Bank, 2010). Aggregate calculations about the cost-effectiveness of disaster prevention, however, are a challenge for most countries as it is difficult to know what expenditures are made for prevention alone, as it is difficult to avoid double counting. Prevention encompasses many public policies, from protective infrastructures to education, land-use restrictions and building codes, and early warning systems. Many policies and programmes spanning various institutions need to be taken into account to assess the effectiveness of prevention. Precise accounting would indeed be a powerful tool to demonstrate the effectiveness of prevention and compare these costs to emergency relief and reconstruction as well as to the economic damages caused by disasters.

FOPREDEN: A dedicated fund to finance disaster prevention

The federal government provides financial support to states and municipalities for disaster prevention programmes through the Fund for the Prevention of Natural Disasters (FOPREDEN). FOPREDEN complements FONDEN – the federal government fund to finance disaster recovery and the reconstruction of public assets (see Chapter 6). Its creation in 2003 reflects a change of strategy within SEGOB to steer away from a reactive disaster management system focused on *ex post* financing towards an increasingly proactive system that promotes *ex ante* prevention. SEGOB's long-term goal in providing financial support for disaster prevention projects is to eventually decrease demand for support in reconstruction expenditures.

FOPREDEN co-finances federal, state and municipal projects in three main areas related to disaster prevention: risk assessment (e.g. risk atlas), mitigation or risk reduction (e.g. EWSs or small flood protection infrastructures) and strengthening the culture of prevention (e.g. educational materials). CENAPRED convenes technical and scientific committees to evaluate the merits of all proposals based on a clearly defined list of selection criteria and priorities related to the quality of the project, its technical relevance and the expected impacts.

Financial transfers from the central government, whether for disaster prevention or recovery and reconstruction, are confronted with a delicate trade-off between accountability and accessibility. The federal government rightly demands projects to demonstrate their utility in meeting an identified need, but several states and municipalities have found the FOPREDEN selection process overly rigorous and have abstained from applying for funds altogether. On the other hand, given the relatively modest budget of FOPREDEN compared to the enormous and widespread needs to reduce disaster damages, the objectivity and scientific rigour in the selection process needs to be preserved.

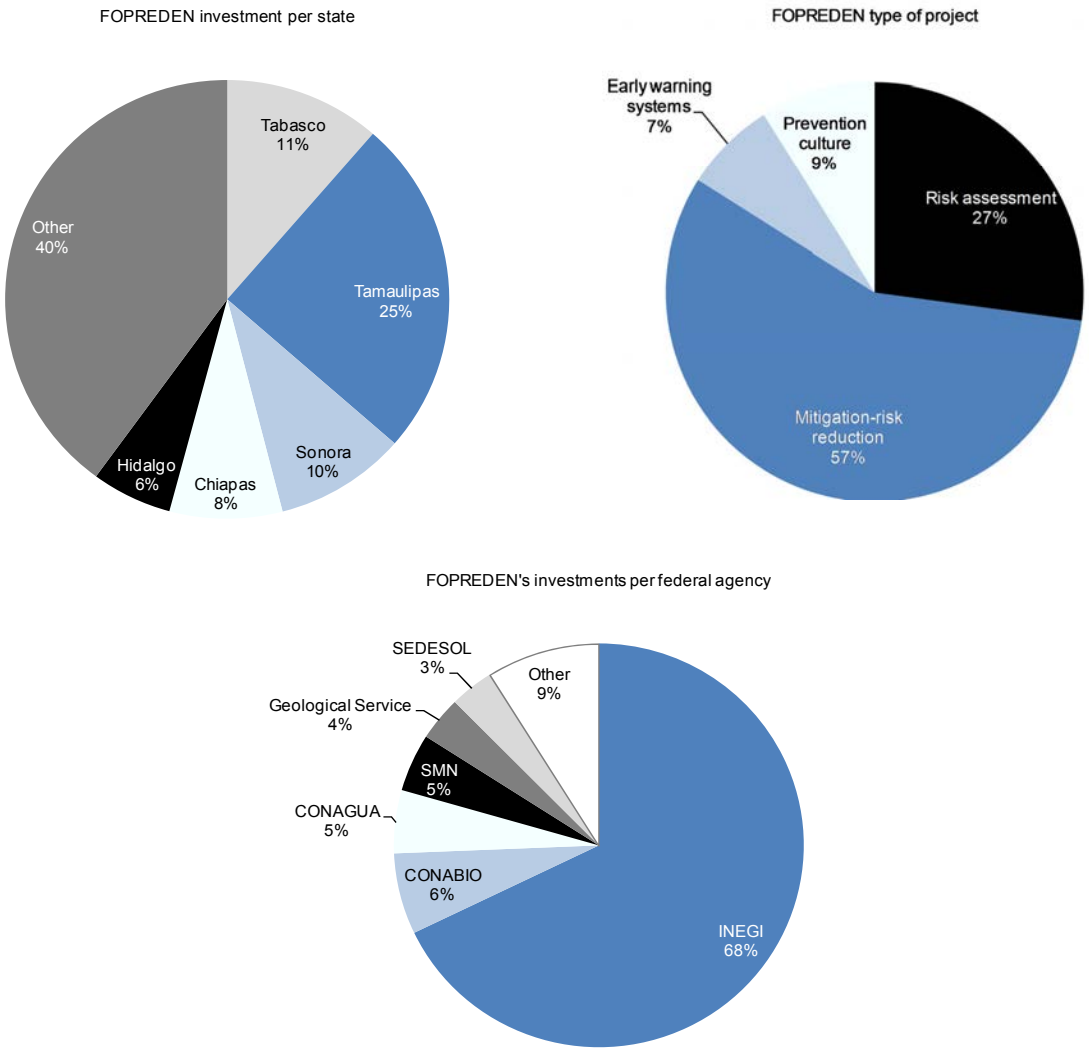
With a continuous budget of MXN 300 million annually since 2008, FOPREDEN has financed 130 preventive projects for a total of MXN 1.4 billion in the 8 years of its existence. FOPREDEN funding is modest compared to other prevention infrastructure projects, particularly the previously mentioned structural measures.

Each Mexican state has applied for and received FOPREDEN funding at least once, with an average project cost of MXN 10.6 million. More than 54% of the total transfers, however, have gone to the states of Tamaulipas, Tabasco, Sonora and Chiapas, while Veracruz (the state most severely affected by disasters in terms of reconstruction costs) has received only 1.4% of FOPREDEN total expenditure. In this respect, the distribution of FOPREDEN funding appears to be linked more to the proactive behaviour of certain states to submit proposals, rather than to identified vulnerabilities.

FOPREDEN has a clear strategy to incentivise states to develop risk atlases (Figure 4.3). Twenty-seven percent of its expenditures are related to risk assessment, and this share is expected to increase with the new operational rules that require states to have, or be in the process of developing, a risk atlas as a condition to apply for financial support for prevention projects. Among the more common prevention projects funded by FOPREDEN are those related to risk mitigation, and in particular flood risk infrastructure in small river basins. FOPREDEN also finances the development of local EWSs (7%) and projects related to the development of risk prevention culture (9%).

FOPREDEN can also finance disaster prevention projects from federal agencies. Seventeen percent of its funding has gone to finance 20 federal agency projects on a 50% cost-sharing basis. Approximately 70% of these funds went to the National Institute of Geography and Statistics (*Instituto Nacional de Estadística y Geografía,* INEGI) for the development of specific cartographic products with modern GIS and remote-sensing technologies to support the development of risk atlases. With this important project, FOPREDEN appears to have been utilised in its maximum capacity to foster the development of a holistic approach towards developing harmonised risk atlases from the national to state levels promoted by CENAPRED. In this respect, FOPREDEN played the role of a strategic federal financial instrument for prevention, financing the tools that will support all three levels of governments to develop the first step of risk prevention: risk assessment.

Figure 4.3. **FOPREDEN projects**



Source: OECD based on information from FOPREDEN (2012).

FOPREDEN's operational rules have been adapted through the years for more efficiency and transparency. The initial rules from 2003 were updated twice, in 2006 and 2010, to make it a more flexible instrument and adapt it to the requirements and specificities of the states as well as municipalities, which can now apply directly to FOPREDEN rather than through the states. The new rules (2010) modified the cost-sharing scheme, from one where a recipient state was supposed to contribute at least 30% of project funding, to a more dynamic one, where FOPREDEN may support up to 90% of the total cost according to the marginalization index developed by the National Population Council (*Consejo Nacional de Población*, CONAPO) (see Chapter 3). As a result, more than 80% of the applications have been accepted since 2008, whereas the rate was only 52% in 2004. To reinforce transparency and accountability, FOPREDEN now allocates financial resources directly to the contractors who carry out the work based on contracts and invoices and not to the states as was the previous practice, as several funded projects were not implemented in the previous scheme leading to wasted resources.

Conclusion

Mexico's ambition to place disaster risk prevention on a par with emergency response is progressing, with federal policy documents providing a strong push and guidance in this direction. Implementing this objective into concrete actions across levels of government, however, faces several challenges. In terms of reducing exposure to natural hazards, two main measures are to move populations from hazard zones and to prevent new construction through prescriptions on land use. The size of the population residing in hazardous zones in Mexico continues to increase, however, and this indicates a lack of public awareness due to ineffective risk communication, and lack of incentives to help meet the objectives of disaster risk prevention. Municipalities have the legal competence to issue building permits within their jurisdiction, and their incentives are often aligned toward new development. Furthermore, some municipalities have shown they are unable to prevent informal settlements. While there has been relatively little effort until recently to adopt non-structural risk prevention measures, major investments in structural measures to reduce exposure to floods are ongoing with mixed results. Insufficient incentives are in place to incite exposed households and businesses to move out of the most exposed areas.

While SINAPROC has ambitions to advance disaster risk reduction, its current institutional setting is anchored in emergency response. Implementation of risk prevention measures will require a joint action across levels of government, for instance to ensure the results of risk atlases are linked to land-use prescriptions in zones exposed to a high level of hazard. It is crucial, therefore, that the provision of the 2012 General Law requiring the development of a risk atlas be given priority attention in terms of implementation. In jurisdictions where there is a gap between territorial and urban planning decisions and the local risk atlas, control and sanction mechanisms combined with incentives may be needed to help close the gap. This may be justified in furtherance of instituting evidenced-based decision making and transparency, which are pillars of good governance.

Another issue is to address capacity gaps. Many municipalities lack technical capacities and resources to produce risk atlases, and in these cases it will be key to continue and strengthen partnerships to support them. Capacity building efforts can help to foster the implementation of disaster risk prevention measures at the local level. This will also create pressure upon different federal and state bodies to meet the standards for land management that they advocate for municipalities.

The establishment of FOPREDEN demonstrates the federal government's commitment to taking a comprehensive approach to risk management. It stands out amongst OECD countries as one of only a few known central government funds expressly set up to co-finance disaster prevention. Its budget is modest relative to the needs of states, but it is impossible to fund all such projects and doing so would create a culture of reliance among decentralised governments and disincentives to invest in prevention on their own. The FOPREDEN budget and magnitude of the projects are still quite modest compared to recovery and reconstruction expenditures through FONDEN. While the incentives to produce risk atlases show that FOPREDEN can impact states' behaviour, the patterns of its projects do not seem to follow an integrated preventive strategy, but more a set of *ad hoc* responses to the isolated needs of states or federal agencies.

As in many other OECD countries, tracking prevention funding is not easy, but looking at a few projects and initiatives demonstrates that FOPREDEN resources do not

represent a major share of the prevention funding in Mexico. While SEDESOL's risk prevention programme (PRAH) had a budget of MXN 190 million in 2010, which is comparable to FOPREDEN's annual resources of MXN 300 million, CONAGUA's infrastructure development projects go far beyond that in terms of public expenditure. Hydraulic projects of MXN 9 or 20 billion are being financed in Tabasco and the Valley of Mexico, and the 2030 Water Agenda has projected another MXN 107 billion in infrastructures for risk reduction over the next 20 years (SEMARNAT, 2011). The National Meteorological Service's modernisation plan is evaluated at USD 170 million. In comparison, the project for the modernisation of the seismological network (see Chapter 3) developed by UNAM is estimated to cost MXN 184 million but cannot find financial support.

Recommendations

- Build greater coherence between risk management, territorial planning and urban development and adaptation to climate change.
- Territorial and urban planning should become a national priority supported by an appropriate institutional framework.
- States and municipalities should prepare under their responsibility a disaster risk prevention plan based on a risk atlas indicating structural and non-structural measures needed to prevent disaster risk in their jurisdictions.
- Extend early warning systems on the model of the SIAT-CT and the SAS throughout the national territory, particularly for flood and tsunami warnings.
- Invest more in disaster risk prevention following thorough analysis of costs, benefits and effectiveness. A practical measure to facilitate this would be to establish a registry of 4-6 specific building codes at the federal level that municipalities could choose and adapt based on their risk exposure, particularly for earthquakes, floods and tsunamis.

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Chapter 5

Emergency preparedness and response

This chapter focuses on progress in the National Civil Protection System in Mexico in terms of effective organisational structures for contingency planning and inter-agency communication to support counter disaster plans. Effective preparedness and response are the cornerstones of civil protection and contribute key capacities to an integrated approach to disaster risk management. Efficient preparation for large-scale disasters requires organisations to develop emergency plans that are coherent and interoperable with each other. Civil protection services from different organisations at different levels of government must be able to communicate effectively and work in a co-ordinated and efficient manner, both prior to and during an event, which implies regular joint training and drills, as well as strong linkages to organisations with roles in pre-disaster phases of disaster risk management.

Introduction

Over the past 50 years, many OECD countries have benefitted from improved emergency preparedness and response planning, especially in terms of a reduced number of fatalities resulting from disasters. The purpose of planning is to anticipate future emergency situations and the resource requirements to ensure the application of effective and co-ordinated countermeasures. The exceptional events that cause high numbers of fatalities are statistically improbable, but they require preparation. A major challenge for civil protection therefore, is not only to execute an emergency plan with clear countermeasures, but to improve the capacity to anticipate the improbable and prepare for the unexpected.

The Mexican National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) was designed with a strong focus on emergency preparedness and planning, mainly because the 1985 Michoacán earthquake revealed weak capacity for co-ordinating rescue operations, continuity of basic services and delivery of relief to victims. These capacities are difficult to ensure without preparation and planning for civil emergencies with specific responses to minimise human suffering, protect property from damage and support the resumption of business activity in the most efficient, timely and targeted fashion. This chapter analyses progress within SINAPROC in terms of contingency planning, cross-sectoral co-operation and inter-agency communication to support effective preparedness and response.

Clarity of first responder roles in emergency management

SINAPROC provides a common institutional framework for co-ordinating the civil protection activities of numerous organisations from different administrative levels of government, the private sector and civil society. It helps to standardise operational rules and improve clarity about roles and responsibilities before, during and after an emergency or disaster. In Mexico, the first civil protection stakeholder to observe an emergency situation may intervene to control the situation. This policy favours responsiveness and immediate action to save lives and protect property. However, it runs counter to the practice observed in many OECD countries in which central government services should only intervene when requested by the local level, or when it has observed that civil protection services at lower levels of government have been overcome by an emergency. This view assumes that mobilising various levels of government could lead to confusion and the inefficient use of resources.

State and municipal civil protection forces

International good practice suggests the need to build up strong local and regional disaster countermeasures in case the centralised disaster management organisation is directly incapacitated by a hazardous event. In Mexico, the states and municipalities are responsible for protecting citizens (Political Constitution of the United Mexican States, Article 115 III), and an institutionalised body with clear responsibility for emergency response is supposed to be in place at each local level of government – i.e. civil protection units at the municipal level and the Council for Civil Protection at the state level.

Since most disasters begin as local emergencies, municipal and state civil protection services are usually the first to respond. All state civil protection services have developed emergency response plans as required by their civil protection laws (see Chapter 2). They

tend to intervene at the local level and activate these plans as soon as they become aware that an emergency within their jurisdiction requires more than the local capacity can handle. Each state has autonomous control in the elaboration of its emergency plan, with significant differences among states. It appears that states such as Chiapas, Jalisco, Tabasco, Tamaulipas and the Federal District follow the good practice of multi-hazard emergency plans, and they anticipate a broad range of emergency response activities, such as: search and rescue, evacuation, temporary shelters, security services, damage assessment, first aid and delivery of relief services (distribution of water, food, clothes and provision). State emergency plans are structured through standard operating procedures (SOPs) and triggered by state early warning systems. These plans include procedures for co-ordinating with municipalities, elaborating *ad hoc* institutional frameworks to organise emergency response (e.g. emergency committees, state operational centres, etc.) and inter-institutional co-ordination to determine who is responsible for doing what, when and how.

A high degree of socio-economic disparity among the almost 2 500 municipalities in Mexico, however, implies that there are uneven resources and capacities to develop and execute appropriate emergency response plans. This explains why federal level bodies need to be able to take the initiative to intervene, rather than wait for official calls for assistance. Municipalities such as Monterrey, Motozintla, Tampico and Tuxtla Gutiérrez have developed their own emergency plans to complement the state systems for emergency management. While some rural municipalities do not have an emergency plan and count squarely on the state for assisting them in emergency response, numerous examples of good practice exist where plans are in place for various types of civil contingencies. Puerto Vallarta has developed several plans to counter large-scale disruptive events, e.g. the Tropical Cyclones Plan and the Forest Fires Plan.

Several instances of multi-level emergency planning and co-ordination are in place. For example, Chiapas promotes the development of municipal emergency planning through its prevention programme PP5. Various states and municipalities showed willingness and capacity to co-ordinate emergency response plans with SINAPROC stakeholders from different levels of government, such as the Army and the Navy, neighbouring states and municipal administrations, but also with local representatives of federal institutions such as the National Water Commission (*Comisión Nacional del Agua*, CONAGUA), the Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE), the Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*, SCT), the Ministry of Social Development (*Secretaría de Desarrollo Social,* SEDESOL), the Ministry of Tourism (*Secretaría de Turismo*, SECTUR) and Mexican Petroleum (*Petróleos Mexicanos,* PEMEX). In addition, these same federal institutions have implemented their own sectoral emergency plans (see next section).

To address the uneven capacity across municipalities, the General Directorate for Civil Protection (*Dirección General de Protección Civil*, DGPC) of the federal Ministry of the Interior (*Secretaría de Gobernación*, SEGOB) promotes the development of local emergency plans through the Safe Cities are Resilient to Disasters Program (*Programa Municipio Seguro: Resistente a Desastres*). Its benchmarking approach to civil protection capacities attributes qualitative rankings to municipalities according to their level of emergency preparedness (Box 5.1).

Box 5.1. **Promoting local level resilience: The Safe Cities are Resistant to Disasters Program**

The Safe Cities are Resistant to Disasters Program (Programa Municipio Seguro: Resistente a Desastres) is one of the principal actions taken by Mexico's federal government within the Hyogo Framework for Action 2005-2015, and was an inspiration for the worldwide United Nations campaign on "Making Cities Resilient". Conceived and managed by the DGPC, it aims to develop a culture of risk management at the municipal level by classifying cities according to their level of preparedness and response capacities.

The programme establishes co-ordination and institutional participation between the three levels of government, the private and social sectors. It identifies priority actions to improve civil protection capacities for response, recovery and vulnerability reduction by implementing specific mitigation activities and partnerships across sectors and strengthening multi-stakeholder networks. Adherence to the programme is voluntary and the local government decides on its duration. Municipalities are ranked according to the completion of clearly defined capacities, which tend to build progressively upon each other (see the table below). Currently 89 municipalities in 19 states have engaged in this programme, which should be more strongly promoted for a broader implementation. The programme also integrates 27 strategic partners, including private and social sector organisations and individuals committed to fostering and strengthening the institutional capacity for emergency preparedness and response.

Activities by level and certification within the Safe Cities are Resistant to Disasters Program

	Protection is provided to the population and the municipality's goods during an emergency	Institutional co-ordination	Existence of a local civil protection legal framework	Availability of historical documentary records on previous disaster events	Training the population on civil protection activities	Specific budget allocation for civil protection activities	Continuous training of civil servants on civil protection activities	Establishment of continuity plans in the event of a change of government	Proven existence of risk transfer instruments protecting municipal infrastructure/promoting the acquisition of risk transfer instruments among the general population
Level 1									
Level 2									
Level 3									
Certification									

Source: Based on information provided by SEGOB and on the UNISDR's Making Cities Resilient Program website, *www.unisdr.org/campaign/resilientcities*.

The role of the armed forces in disaster management

Since Mexico's national territory is not under foreign threat from neighbouring countries, its armed forces can pay more attention to disaster management and internal security. The Army and the Air Force intervene in emergencies according to an operational plan referred to as the DN-III Plan, which dates back to 1966 (Box 5.2). The mission of the Army – terrestrial and air forces – in a disaster situation is "to provide support for maintaining public order, relief to people and their goods and reconstruction of affected areas".

Box 5.2. DN-III Plan: Emergency plan of the Mexican federal Army

After massive flooding of the Río Pánuco in 1966, the Army developed the DN-III Plan, which provides detailed procedures about how it should deliver assistance in the case of a disaster. Its tasks include emergency engineering and repair of civil works, transport and logistics, emergency healthcare and relief, search and rescue, as well as providing security in the affected areas. The key characteristic of this plan is that it can be activated by the Army itself: a section, a brigade or a company can spontaneously decide to provide emergency support to states and municipalities whenever and wherever in Mexico a disaster occurs. Co-ordination is organised from local to state and federal levels through the participation of the Army in the civil protection councils at all three levels of government in the SINAPROC institutional framework.

The Army has also established additional support mechanisms for emergency response. If a regional command is not able to individually address a disaster, the "Support Force for Disaster" is activated. This mechanism was created as a consequence of lessons learnt from a previous implementation of the DN-III-E Plan. Its objective is to ensure the arrival of land and air support forces to disaster areas throughout the entire national territory within two hours of being called upon.

Source: Based on information provided by SEDENA and *www.sedena.gob.mx*.

Along the same lines, the Navy has developed its own operational plan to guide interventions in civil emergencies called the Navy Plan, which has been in place for more than 50 years (Box 5.3). Like other sectoral plans, its purpose is to direct how the Navy assists the civilian population in case of emergency and in disaster areas, acting alone or jointly with federal agencies, in order to avoid or minimise the effects of destructive agents that arise against the population and environment.

Box 5.3. The Navy Plan: Emergency plan of the Mexican federal Navy

Just like the DN-III Plan, the Navy Plan provides support to civil emergency situations at its own initiative. Its activities in times of civil emergencies have expanded since 1940, when the Navy was mostly focused on evacuation, search and rescue operations at sea. Since 1950, the Navy has increased its role in emergency activities, especially including rescues at ports and coastal areas. With the development of SINAPROC in 1986, the Navy institutionalised a multi-approach programme that operates at four levels in the Mexican territory: national, littoral, regional and local. The Navy Plan is intended to cover geological, hydrometeorological and chemical risks, but in fact its actions are largely related to hydrometeorological events in littoral zones. The Navy Plan is designed as an integrated plan that considers not only emergency response, but also prevention and reconstruction. Nevertheless, the most important focus remains on emergency response activities. During the emergency response phase, the Navy Plan is structured in four areas: i) evacuation, rescue and surveillance; ii) provision of shelters and security at shelters; iii) first aid medical care; and iv) communications support. The plan includes clear procedures and a pre-established chain of command to organise the emergency activities.

Source: Based on information provided by SEMAR.

Advances in emergency planning

Federal government sectoral emergency plans

SINAPROC's organisational framework calls for its stakeholders to co-ordinate resources during emergencies and for federal level institutions to implement their own sectoral emergency plans as appropriate. In addition to the DN-III Plan and the Navy Plan, many federal government ministries and institutions have developed sectoral

emergency plans to prepare responses appropriate to their particular functions and mandate (Table 5.1). The adoption and implementation of these plans are particularly important for utilities and critical infrastructure operators, although key economic sectors and most of the public administration as well as a large part of civil society have developed emergency plans. Several key civil protection stakeholders and critical infrastructure operators stand out in this regard, including CONAGUA for water supply, CFE for energy supply, the SCT for transport and communications as well as PEMEX for the oil industry and SECTUR for the tourism sector.

As the critical agency for water supply and water resource management in Mexico, CONAGUA has developed a *Manual for Emergency Operations* for all of its river basin organisations and local directorates, as well as specific emergency plans in 90 river basins and 32 cities. These plans are mostly focused on hydrometeorological risks, specifically flooding, and comprise: hazard detection, hydraulic infrastructures management, damage assessment, evacuation routes, as well as the delivery of drinking water supply to affected people. CONAGUA's local offices follow 40 internal civil protection programmes intended to limit damages to staff and ensure business continuity.

CONAGUA provides emergency assistance nationwide for all types of disasters through its network of 19 regional centres for emergency response (*Centros Regionales de Atención a Emergencias*, CRAE), deployed throughout the national territory. Each CRAE possesses a "brigade" for infrastructure protection and emergency response: 802 emergency responders are in charge of assessing damages in the water supply infrastructure as well as providing support to the affected population (drinkable water). Moreover, the brigades are intended to assess the level of rivers that could affect evacuation routes. CONAGUA is often among the first federal agencies to be present at the local level when a disaster occurs, together with the Army and the Navy. Finally, CONAGUA has developed 230 flood emergency plans for the various river basins in Mexico.

CFE has implemented two major emergency plans: one for electricity production and one for distribution; both are adaptable to multi-hazard scenarios. The first plan focuses on rapid energy recovery in case of a blackout. Some energy plants possess special devices to re-start energy production immediately; CFE has developed a reliability index indicating the capacity of a power plant for this purpose. Moreover, additional electricity production capacities from fuel and gas power plants are available to mitigate the risk of a blackout. CFE has also created an emergency response plan for electricity distribution (*Plan Nacional para la Atención de Emergencias en Líneas De Transmisión*) and developed an accurate methodology and logistics for emergency operations at strategic locations of its network. The Emergency Plan also elaborates a communication network for isolated areas and the identification of material and human resources available for emergency response through the Early Response System for Hurricanes Impact (*Sistema de Respuesta Temprana ante el Impacto de Huracanes*, SIRETIH). Increasing hurricane damages to Mexico's electricity infrastructure in recent years (see Chapter 1) led to the creation of this system, improving CFE's capacities on early and emergency response.

Table 5.1. **Emergency plans in Mexico**

	Plan/Programme	Responsible body	Hazard			Emergency response activity							Institutional co-ordination	Standard operating procedures
			Geological	Hydrological	Technical/ chemical	Search and rescue	Evacuations	Shelter management	Security services	Damage assessment	First aid and medical care	Population services		
Federal programmes	DN-III Plan	SEDENA	●	●	●	●	●	●	●	●	●	●		Yes
	Navy Plan	SEMAR		●		●			●	●	●	●		Yes
	Emergency Plan for Roads and Bridges	SCT	●	●						●		●		Yes
	PIAE	CONAGUA		●						●		●		No
	National Plan for Emergency Response	CFE	●	●						●		●		Yes
	Tourism Safety programme	SECTUR		●			●					●		No
	Comeri 145	PEMEX	●	●	●	●	●			●	●	●		Yes
State programmes*	PRE-H													
	Emergency Plan for Airports	ASA	●	●		●	●			●		●	SCT	Yes
	Chiapas Emergency Response Plan	State civil protection	●	●	●	●	●	●		●	●	●		Yes
	Tabasco Civil Protection Master Plan	State civil protection	●	●	●	●	●	●	●	●	●	●		Yes
	Federal District's Permanent Plan for Contingencies	Civil protection	●	●	●	●	●	●	●	●	●	●		Yes
	State of Mexico's Master Plan of Civil Protection	State civil protection	●	●	●	●	●	●	●	●	●	●		
Scenario-based programmes	Popocatepetl Plan	DGPC	●			●	●	●	●		●		States of Mexico, Puebla, Morelos, Tlaxcala, SEDENA and other federal and local institutions 37th Military Region	Yes
	Colima Plan	SEDENA and other federal and local institutions	●			●	●	●		●	●		Civil protection of Colima and Jalisco	Yes
	Plan Sismo	CGPC/ Presidency of the Republic	●			●	●	●	●	●	●	●	More than 30 federal institutions	Yes
	PERE	DGPC	●		●		●		●	●	●	●	CFE, SCT, SEDENA, SEMAR, Local Ministry of Health, Civil Protection of the state of Veracruz and federal Police	Yes
	Plan “Laguna Verde”	CFE	●		●		●		●	●	●	●	SCT SEMAR-SEDENA	Yes

Note: * This list in non-exhaustive and only includes a selection of programmes.

Source: Information provided by SINAPROC stakeholders.

The SIRETIH is supported by mutual aid groups (*Grupos de Ayuda Mutua*, GAM) which seek to integrate the capacities of the local governments and civil protection units, the private sector and CFE. This mechanism enables CFE to implement joint emergency response activities if needed. A similar scheme has been implemented by PEMEX with its mutual aid circuits. In addition, CFE has developed special scenario-based plans, first for critical infrastructure (for example, hospitals and airports) and second for the Mexico City metropolitan area, due to its concentrated population and the potentially destabilising impact a blackout could have.

The SCT has developed an Emergency Guide for critical transport infrastructure (*Guía para la Atención de Emergencias en Carreteras y Puentes*), which combines rules and practical guidelines with technical data and operational procedures for emergency scenarios. The SCT guidelines focus on how to quickly repair roads and bridges that are needed to access the principal population centres. As the SCT does not have enough operational resources (i.e. machinery and equipment), the guidelines are used to unify criteria for sub-contractors providing assistance. The emergency plan is organised in three phases: before, during and after an emergency. Before the emergency, the SCT's plan foresees the establishment of an Operational Centre and ensuring the communication network. During the emergency, the SCT must set-up sign posts to identify the affected infrastructure, assemble qualified sub-contractors, provide equipment to the SCT's employees for repairing infrastructure. The SCT also oversees the National Programme for Airport Security (*Programa Nacional de Seguridad Aeroportuaria*) and the development of airport emergency plans for each airport.

Given the importance of tourism to Mexico's economy, the tourist population needs to be informed of risks it might confront. SECTUR has been working on an Emergency Plan for Tourist Safety that is mostly oriented to hurricanes in the Gulf of Mexico. The plan is not standardised through standard operating procedures (SOPs) and is largely concentrated on the control of tourist flows and liaising with airlines about the departure and arrival of flights. The plan is specially focused on crisis communication in order to standardise messages for the tourist population via the media. AA specially designated crisis committee (*Comité de Comunicación de Crisis del Sector Turismo*) is charged with issuing executive orders during emergencies, in co-ordination with the Ministry of Foreign Affairs (*Secretaría de Relaciones Exteriores*, SRE), for example informing foreign tourist operators (mostly from the United States, Canada and Europe) about the status of approaching hurricanes or deciding on preventive evacuation measures. The crisis committee is composed of SECTUR officials but in case of a major crisis scenario, the committee increases its capacity by including other SINAPROC stakeholders, such as SEGOB, the SCT and the SRE.

An illustrative case was Tropical Storm Dean, which made landfall in the Yucatán Peninsula, a major tourist destination, on a Friday in August 2007. As tour-operated flights are generally scheduled to arrive on Saturdays, SECTUR issued a recommendation through international media for tourists not to fly to Cancún. It also instructed tour operators not to cancel flights, but rather to shift arrivals to the Mérida airport, which was not exposed to hazardous conditions. Five thousand tourists were evacuated from the affected areas, which required organising specific travel and lodging arrangements. Despite these efforts, many cases of price gouging were reported in which foreign tourists paid all the cash they had on hand to evacuate the areas where the hurricane was forecast to hit. This situation could be avoided in the future if sufficient buses could be marshalled at short notice; a redundancy measure well worth it given the importance of tourism to the economy.

Due to the strategic importance of oil extraction and export to Mexico's economy, sectoral emergency plans at PEMEX facilities are critical, especially in light of their exposure to hazards (see Chapter 1). Oil extraction and refining facilities follow internal and external emergency plans, which are institutionalised under the framework of PEMEX's Security, Health and Environment General Plan. PEMEX's institutional strategy for emergency response was reorganised in 1985 to standardise emergency plans at its numerous facilities. The emergency scheme is structured through basic guidelines such as the COMERI 145 and the COMERI 146. The COMERI 145 ensures that each of PEMEX's working centres has an emergency response plan (*Plan de Respuesta a Emergencias,* PRE) and prepares staff to control and mitigate potential disasters. It can be activated internally or externally, depending on the nature of the crisis, and is supposed be based on risk analysis.

According to COMERI 145, PEMEX facilities must possess an emergency response unit. In case the response capacity of any working centre is exceeded, the scheme foresees back-up capacity via regional groups for emergency response and management (*Grupo Regional para la Atención y Manejo de Emergencia*, GRAME). These forces can be called upon to take control of a crisis in co-ordination with the staff of the internal Emergency Response Unit, and with the local civil protection authorities. There are 22 GRAME throughout the Mexican territory. Due to the vulnerability of off-shore platforms, PEMEX has also developed a special scenario-based plan for hydrometeorological events called PRE-H, which mostly focuses on responses to hurricanes and cold fronts in the Gulf of Mexico, based on early warning systems delivered by PEMEX's Meteorological Service. The information is utilised to define whether an evacuation of the off–shore platforms is necessary as well as to determine when the oil extraction on those platforms should be suspended. Two evacuation exercises are organised each year in accordance with COMERI 146. Even though PEMEX participates in the Early Warning System for Tropical Cyclones (*Sistema de Alerta Temprana para Ciclones Tropicales*, SIAT-CT), its operating rules specifically mention PEMEX's specific decision making related to platform evacuation.

SINAPROC promotes emergency plans to strengthen the culture of disaster preparedness in schools, public administrations, businesses and companies, as well as in communities and families. These include, for example, plans for schools, the internal civil protection programmes for large gathering places and office buildings, community plans and family plans. Indeed, the development of these plans is a process that is used to educate citizens about risks, prevention measures, early warning systems and emergency actions to follow when a disaster occurs. Often the plans have led to the creation of an internal brigade for civil protection, thus fostering the self-protection capacities of the association or organisation.

Initiatives to develop scenario-based emergency planning

Sectoral planning is an essential component to preparing and responding to disasters, but the development of inter-institutional response plans based on specific disaster scenarios constitutes the next level of emergency preparedness. In order to address the interconnectedness of risks and disasters that characterise some of the worst modern disasters, horizontal and vertical integration of emergency planning across municipal, state and federal levels is necessary. There are relatively few inter-institutional, scenario-based plans with SOPs involving multiple stakeholders in Mexico. Only five federal emergency plans of this kind have been developed under the SINAPROC framework: the tropical cyclone emergency response based on the SIAT-CT, the Plan

Sismo for high-magnitude earthquakes and tsunamis, the Popocatepetl and Colima volcano plans, and the plan for the nuclear plant of Laguna Verde (*Plan de Emergencias Radiologicas Externas* – PERE). The Popocatépetl and Colima volcano plans are mostly co-ordinated between the Army and the concerned states to organise the evacuation of nearby high-risk areas and to define evacuation routes. Federal emergency plans for tropical cyclones and earthquakes have also developed procedures between all SINAPROC stakeholders. The PERE is more specific to radiological risks, as the Laguna Verde plant is not located in an area exposed to earthquakes or tsunamis.

Even though there is no tropical cyclone emergency plan *per se*, the early warning system (EWS) SIAT-CT includes clear rules of operation tied to the colour-coded warning issued. Under the overall co-ordination of the General Directorate for Civil Protection (DGPC) of the Ministry of the Interior (SEGOB), emergency actions to be taken in each phase are specified for the state and municipal civil protection authorities, as well as for the federal institutions that are part of SINAPROC. For instance, under the orange alert (approaching phase), state and municipal councils for civil protection must convene, shelters are to be supplied with food and water, high-risk zones evacuated and school activities stopped. This clearly constitutes a federal emergency plan where SEGOB co-ordinates the response activities of SINAPROC stakeholders from the federal to the state and municipal levels by activating the various levels of the warning. The DGPC plays a major role as the co-ordinator of emergency actions to be taken at the local level by states and municipalities. The SIAT-CT was established in 2000 as a purely meteorological warning system co-ordinated by the DGPC, without any detailed description of the emergency actions to be taken by SINAPROC stakeholders. The system was later improved in 2003 to include these agreed-upon actions, through the joint efforts of more than 40 representatives from federal agencies, states and municipalities.

An 8 to 9.0 magnitude earthquake in the Guerrero Gap is considered to be the most important threat to Mexico and could generate a strong tsunami as well (see Chapter 1). For this reason, a Special Emergency Plan for Earthquakes (*Programa Especial de Proteccion Civil Para Sismos* – PRESISMO) was established in 2002 by SEGOB with a specific committee on earthquake emergency preparedness which regroups all of the key stakeholders, SEGOB, the Army, the Navy, the state civil protection departments, the National Autonomous University of Mexico (*Universidad Nacional Autónoma de México*, UNAM), the Centre for Seismic Instrumentation and Record (*Centro de Instrumentación y Registro Sísmico,* CIRES) and other academic and civil society organisations. SEGOB later proposed a plan in 2011 entitled "Strategy for Preparedness and Response of the Federal Administration for High Magnitude Earthquakes and Tsunamis" (the so-called "Plan Sismo").

However, the binding nature of this Plan Sismo remains unclear and it has not yet been tested in a real emergency. Nevertheless, it could represent a major step forward to define more clearly what each agency should do in the case of a major earthquake. Plan Sismo would include four directives decided by the President instructing and ordering federal agencies to support the population to preserve the rule of law and the governability of the country. The proposed plan foresees procedures that run counter to normal policy. For example, in a top-down executive exercise of power, the President would order the Army and the Navy to activate the DN-III Plan and the Navy Plan, and call upon states and municipalities to activate their civil protection councils and co-ordinate with the federal level. Plan Sismo is organised around three response areas (operational, logistics and administrative); 14 working groups are defined with their co-ordinating agencies and their members (Table 5.2). Besides the very specific PERE

related to radiological risks, this plan represents the first comprehensive emergency plan with clear co-ordination mechanisms, and could be potentially a major achievement for SINAPROC if it can be fully implemented.

Table 5.2. **Plan Sismo emergency response groups**

National Emergencies Committee		
Areas	Goals	Co-ordination
Operational	Search and rescue	Ministry of National Defence – Ministry of Navy
	Communication centre	Ministry of Public Security
	Damages assessment	Ministry of the Interior/DGPC
	Public health	Ministry of Health
	Public security	Federal Police – Ministry of Public Safety
Logistic	Gathering, organisation and distribution of emergency supplies	Ministry of Economy – Ministry of Social Development
	Centre for social problems	Ministry of Public Education
	Shelters	Ministry of National Defence – Ministry of Navy
	Strategic services	Ministry of Environment and Natural Resources
	Transport, equipment	Ministry of Communication and Transport
Administrative	International affairs	Ministry of Foreign Affairs
	Public information dissemination	Presidency of the Republic
	Economic resources management	Ministry of the Interior/FONDEN
	Follow up of actions	Presidency of the Republic – CGPC

Source: Based on information provided by the Ministry of the Interior.

Civil protection drills and exercises

Drills and training exercises provide civil protection services the conditions to simulate their responsibilities under an applicable emergency plan and to identify weaknesses that need to be fortified before an actual event occurs. They should be used to test emergency response capabilities and to familiarise the general population with the precursors of different types of hazard along with the steps that should be taken if an event of a significant magnitude should occur. Conducting regular drills and exercises has proven in many countries to reduce panic in stressful situations, to test the reliability of established emergency management processes and to identify needs for equipment and human resources.

Since SINAPROC was established, many public institutions at the three levels of government, as well as private and social organisations, regularly conduct practice drills for emergency situations. Public administration and private sector organisations required to establish internal programmes of civil protection carry out mandatory drills (Civil Protection Law, Article 79). This regulatory approach ensures that a high percentage of employees in urban areas take part in some form of drill related to civil protection functions. The DGPC provides useful guidelines for the elaboration of internal civil protection plans that detail the methodology to carry out drills (*Guia Practica de Simulacros de evacuacion en Inmuebles*). CENAPRED provides training in relation to risk assessments, the establishment of civil protection brigades, how to set up temporary shelters, etc. These guidelines are based on three major pillars: *i)* the existence of an internal civil protection brigade, determining who is going to act and how; *ii)* the

distribution of emergency equipment and its reliability; and *iii)* the existence of correct emergency signposting under official standardised norms. The drills conducted according to these guidelines go beyond emergency exercises and include a dimension of risk assessment; for example, the evaluation of the structural vulnerability of buildings (their internal and external risk exposure) and requires the existence of maps to define security areas in the neighbourhood.

Schools are particularly active in conducting drills. The Ministry of Education requires schools to conduct an annual evacuation drill that follows its guidelines. In Mexico City, the OECD observed schools that organised an evacuation exercise every month. Indeed, when a magnitude of 7.4 earthquake occurred on 20 March 2012 during the fact-finding mission, the OECD Review team witnessed televised footage of drills that were being carried out in schools and businesses when the actual event occurred, transforming the simulation exercise into a small-scale emergency response.

One of the most important general drills is carried out every September, to commemorate the 1985 earthquake in Mexico City. On this occasion in 2012, more than 6 million people in the nation's capital and other states participated in the Macro-Drill (*Macro Simulacro*), based on an 8.1 magnitude earthquake scenario. This large-scale drill enabled civil protection authorities to raise the public's awareness as well as to stress test the institutional co-ordination capabilities of civil protection authorities and various government departments to assess public sector capacity to co-operate.

Co-ordination of emergency response

Emergency response to large-scale disasters entails the integration of multiple public and private organisations and functions. Ineffective co-ordination of these resources has proven in many OECD countries to compound the negative impacts of disaster situations. There is no one-size-fits-all solution to the question, "How should a government co-ordinate emergency response?" The appropriate practice will take into account a country's size, geography and political form of government. Mexico is a large country, geographically diverse with exposure to various forms of extreme natural hazards to which portions of its population are highly vulnerable (see Chapter 1). It is governed by a federal system with states that maintain strong political autonomy. Under such conditions, a certain measure of decentralised responsibility for formulating and executing emergency response plans is appropriate. Reliance on numerous organisations across different levels and sectors of government, however, raises the possibility of numerous and conflicting orders being issued which may lead to bottlenecks and duplication of efforts. To avoid these pitfalls, it is important to identify a key governmental level for disaster management. In Mexico, it is the state level, where day-to-day government is the most actively managed.

SINAPROC Manual of Operations

The *Organization and Operations Manual of the National Civil Protection System* (*Manual de Organización y Operación del Sistema Nacional de Protección Civil*, the "Manual") describes 10 key functions in emergency response and establishes responsibilities and tasks for all 34 emergency response stakeholders at the federal level of government. These ten key functions include: *i)* alerts; *ii)* emergency planning (addressed in the previous sections); *iii)* emergency co-ordination; *iv)* damage evaluation; *v)* security; *vi)* research, rescue and assistance; *vii*) critical services and equipment;

viii) medical services; *ix)* supplies and procurement; and *x)* social communication (Table 5.3).

According to the Manual, SEGOB provides executive co-ordination for civil protection and chairs the National Emergencies Committee (*Comité Nacional de Emergencias*, CNE). States and municipalities are responsible for technical co-ordination, which is often shared with federal agencies such as: *i)* SEGOB for alerts, emergency planning, emergency co-ordination and damage evaluation; *ii)* the Ministry of Public Security for security; *iii)* the Army and the Navy for research, rescue and assistance; *iv)* the Ministry of Health for public health issues; and *v)* DICONSA, a state-owned company for food supplies. All other stakeholders have a role of co-responsibility in their respective areas.

The Manual provides SINAPROC stakeholders with a standardised framework for the elaboration of emergency plans. While it is agreed and referred to throughout SINAPROC as a guide to their actions, it is not completed by written SOPs. This allows each stakeholder to act with a certain degree of flexibility on the one hand, but also leads to several redundancies. Many stakeholders consider the Manual to be valuable at the conceptual level, but not the practical level. The institutions referred to in it do not always possess the capacity to provide the services they are supposed to ensure, while some institutions possess more capacity and responsibility than the Manual recognises (Table 5.3).

Table 5.3. **Participation matrix in SINAPROC's sub-programme of emergency response**

	Alerts	Emergency plans	Emergency co-ordination	Damage evaluation	Security	Rescue and social assistance	Strategic services, equipment and public goods	Health	Procurement of food, water, other goods	Social communication
Airports and auxiliary services		◆					◆			
Communication media									◆	◆
Diconsa, S.A.*		◆	◆						●	
Federal Attorney for Environmental Protection		◆	◆			◆				
Federal Electricity Commission (CFE)	◆	◆	◆	◆		◆	◆	◆	◆	◆
General Attorney of the Republic		◆			◆					
State's Employees' Social Security and Social Services Institute (ISSSTE)		◆		◆		◆		◆	◆	
Mexican Petroleum (PEMEX)	◆	◆	◆	◆		◆	◆			
Mexican Red Cross	◆	◆	◆	◆		◆		◆	◆	
Mexican Social Security Institute (IMSS)	◆	◆	◆	◆		◆	◆	◆	◆	
Mexican Telephones (Telmex)		◆					◆			
Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA)		◆	◆	◆						
Ministry of Communication and Transport (SCT)	◆	◆	◆	◆		◆	◆			
Ministry of Economy (SE)		◆	◆	◆			◆			
Ministry of Energy (SENER)		◆	◆	◆		◆	◆			
Ministry of Environment and Natural Resources (SEMARNAT)		◆	◆	◆		◆	◆			

Table 5.3. **Participation matrix in SINAPROC's sub-programme of emergency response** (*cont.*)

	Alerts	Emergency plans	Emergency co-ordination	Damage evaluation	Security	Rescue and social assistance	Strategic services, equipment and public goods	Health	Procurement of food, water, other goods	Social communication
Ministry of Finance (SHCP)		◆	◆							
Ministry of Foreign Affairs (SRE)		◆	◆							
Ministry of Health (SALUD)		◆	◆	◆		◆	◆	●	◆	
Ministry of the Interior (SEGOB)	⊙/●	⊙/●/◆	⊙/●	⊙/●	⊙	⊙	⊙	⊙	⊙	⊙
Ministry of National Defense (SEDENA)	◆	◆	◆	◆	◆	●	◆	◆	◆	
Ministry of Navy (SEMAR)	◆	◆	◆	◆	◆	●	◆	◆	◆	
Ministry of Public Education (SEP)		◆	◆	◆		◆				
Ministry of Public Security (SSP)			◆		●					
Ministry of Public Service (SFP)		◆	◆	◆					◆	
Ministry of Social Development (SEDESOL)		◆	◆	◆		◆				
Ministry of Tourism (SECTUR)		◆								
Municipal governments, delegations and states	●	●	●	●	●	●	●	●	●	●
National Association of Chemical Industry	◆	◆	◆							
National Autonomous University of Mexico (UNAM)	◆	◆						◆		
National Chamber of Processing Industry		◆								
National Chamber of Radio and Television Industry	◆									◆
National System for Integral Family Development (DIF)		◆	◆					◆	◆	
National Water Commission (CONAGUA)	◆	◆	◆**	◆	◆**	◆	◆	◆**	◆**	◆**

⊙ Executive co-ordination[1]

● Technical co-ordination[2]

◆ Co-responsability[3]

Notes: *The SINAPROC Manual still includes the National Company of Popular Subsistence (CONASUPO) as a SINAPROC stakeholder. However, this former state-owned company disappeared in 1999 (Information updated by the Ministry of the Interior). 1. Executive co-ordination: In charge of establishing co-ordination and communication channels between municipalities, states, departments, agencies and institutions involved in risk prevention activities. 2. Technical co-ordination: ministries, agencies, etc. from all different levels of government assume the responsibility of providing guidance, technical knowledge and resources according to their area of expertise to all of the other stakeholders involved in prevention activities, promoting and integrating planning, operation and the evaluation of the performed tasks, in addition to the achievement of the operations and activities within their competence. 3. Co-responsability: these entities and/or institutions are responsible for providing support, human and material resources, in addition to developing their own activities.

Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, SEGOB, Mexico.

Organisation of emergency response under SINAPROC

In principle, as stated in both the 2000 and 2012 General Laws for Civil Protection, the first civil protection authority that observes an emergency situation has the duty to immediately assist the population under the area of its responsibility as well as to inform specialised civil protection agencies. The municipal civil protection authorities call upon the state in which they are located if they require additional capacities to deal with an

emergency, and the state may call upon federal support if need be, which could ultimately call for international aid through the Ministry of Foreign Affairs (Annex G).

In practice, states are usually highly proactive and intervene during emergencies to support affected municipalities. This holds true for certain federal level stakeholders of SINAPROC as well, where the Army and Navy emergency plans are self-activated. Organisations such as CONAGUA, CFE and PEMEX have established a local presence throughout the country, and are represented on the municipal civil protection councils as well as on the state councils. Furthermore, their specialised emergency units are located in regional emergency centres and can be directly triggered without being called upon by a municipality or state.

State and municipal civil protection councils co-ordinate their own resources, but the resources devoted to civil protection at these levels is highly uneven, thus negatively impacting on their co-ordination capacities. In Mexico, mayors are elected for a non-renewable, three-year term, and civil protection units, especially in small and medium-sized towns, do not typically have priority. States like Chiapas, Mexico, Jalisco, Nuevo León and the Federal District have invested significantly in their civil protection systems, and can support effectiveness at the municipal levels as well.

The civil protection service of the Federal District, for example, has an annual budget of MXN 1.4 billion. The state of Chiapas' civil protection has 300 staff and can intervene to support its 120 municipalities through 9 Regional Civil Protection Councils. Jalisco also has divided its territory into seven civil protection regions and developed its emergency planning accordingly. The states of Mexico and Tabasco, and the Federal District, have implemented this regional internal division as well. The municipality of Tampico possesses contingency plans that sub-divide its territory into six areas, which has led to improved emergency management outcomes. The Cuauhtémoc Borough in Mexico City also created six civil protection territorial directorates for the same purpose. In Nuevo León, the state has fewer emergency forces but highly effective capacities for situation awareness, communication, transport and co-ordination; civil protection units are integrated into the state's ultra modern crisis room (known as C5). This diversity in capacities and approaches across states could present a challenge when emergencies require scaling-up support to work in tandem with the federal level.

To co-ordinate the diverse plans put in place at the federal level, Mexico established a National Emergencies Committee (CNE), which is chaired by SEGOB or its General Co-ordinator for Civil Protection. The CNE ensures a clear command and control system, and has improved both the efficiency of information sharing for damage and needs assessments as well as the effectiveness of using this information for decisions about where emergency responders would be most helpful to support the affected population.

All federal agencies are first-line responders (e.g. the Army, Navy, CONAGUA, CFE) and activate their emergency plans from local offices based on regional structures. The criteria for convening the CNE are unclear, as few situations lead to its activation: *i)* when states require support from the federal level through an emergency declaration; *ii)* Plan Sismo – even though it is not yet officially published; and *iii)* apparently the tropical cyclones EWS SIAT-CT, which mentions the establishment of the Municipal and State Civil Protection Council for the orange warning level.

Box 5.4. The Operational Committee of Italy's National Civil Protection Service: An instrument of multi-stakeholder co ordination

The Operational Committee (OC) of the Italian Department of Civil Protection (DCP) ensures, at national level, the joint management and co-ordination of emergency response activities. It is composed of representatives from operative structures of the national civil protection service and notably from the DCP, the armed forces, the fire department, police forces, the Italian Red Cross, the National Health Service, voluntary organisations and technical and scientific agencies. The ingenuity of this committee is that it ensures not only inter-governmental co-ordination for decision making in civil protection matters (including central, regional and municipal governments), but also representation from the private sector and notably from critical infrastructure providers.

The Operational Committee may be convened, and is chaired by, the Head of the DCP as he deems necessary. It gathers within the National Operational Room in the DCP compound in Rome, which converts into a crisis cell equipped with technical and communication systems to provide assistance for meetings. The committee is provided an integrated picture of unfolding events through monitoring and surveillance technologies, and in this way can receive, collect, process and verify information. It is responsible for assessing requests from affected areas for defining intervention strategies and for guaranteeing the co-ordinated deployment of resources and the intervention of emergency response participants. The committee also supplies emergency information to alert and activate different structures of the National Civil Protection Service. Connections can also be established with the operational rooms of regional, provincial or municipal authorities and with critical infrastructure operators through a secure system.

Source: Presentation by the Italian Department of Civil Protection, OECD Workshop on Inter-Agency Crisis Management, Geneva, Switzerland, 28 June 2012.

The role of the CNE is to assess the nature and magnitude of a situation, to determine emergency measures and the appropriate resources to face the crisis at hand, to co-ordinate the deployment of capacities and supplies, and provide financial resources accordingly. It also follows up on the implementation of these actions and is in charge of issuing information to the population through the media. The CNE meets in the National Operations Center (*Centro Nacional de Operaciones*, CNO), which can use either SEGOB's facilities in its building in the centre of Mexico City, or the modern bunker of the Ministry of Public Security, which is located outside the centre, and is well-equipped with high-tech monitoring and data aggregation tools (similar modern crisis situation rooms exist also in the Federal District [C4I4] and the state of Nuevo León, Box 5.5).

While the General Co-ordinator for Civil Protection chairs the CNE, its general directorates provide specific resources to emergency response in their respective areas of expertise. The DGPC ensures the incident control system and has a pool of emergency co-ordinators who can be deployed in the field to co-ordinate locally with state civil protection services. These Linkage and Co-ordination Missions (ECO-Missions) allow the DGPC to monitor emergency response activities in affected areas. The DGPC also operates the National Communications Centre (*Centro Nacional de Comunicaciones*, CENACOM) and the CNO.

CENAPRED has developed and operates the SAVER tool (see Chapter 3), which maps the populations potentially affected by an event. This tool provides much of the information needed for emergency management through its geographic information system (GIS), such as the location of hospitals, safe transport access, etc. It also provides a map of the most severely affected areas after a disaster, based on its data for social vulnerability and is available to the CNE and all civil protection authorities.

Box 5.5. Communication centres: The C4I4 centre in Mexico City and the C5 centre in Nuevo León

Mexico City and Nuevo León have built state of the art situation rooms to monitor events in real time, collect and aggregate information and enable decision making for emergency situations.

In Mexico City, the Center of Command, Control, Communication, Computing and Intelligence, Integration, Information and Investigation (C4I4), started operations in October 2011. This ultra-modern crisis centre was created in the framework of the Safe City Bi-Century Project (Proyecto Bicentenario Ciudad Segura), launched in 2008. The centre integrates all of the city's public safety real time monitoring and databases, linking within a single hub 47 public safety agencies including police, fire and medical services, as well as federal institutions (e.g. SEDENA and SEMAR) and private entities. The C4I4 centre monitors accidents, disruptive events, crimes and disasters through a network of 13 000 surveillance cameras dispersed throughout Mexico City, and data assimilated by 5 co-ordination centres. During an emergency, it acts as a command centre which can quickly deploy first responder units. For instance, in case of earthquakes, cameras can scan the population and infrastructures in under five minutes, providing decision makers with an initial diagnostic. This helps target on-site verification missions, such as helicopter surveillance, and special assistance programmes in response to the emergency situation. The centre also produces intelligence to rapidly inform the media and the population about safety measures to follow, including through social media channels.

Nuevo León has developed the Centre for Integrated Co-ordination, Control, Command, Communications and Computing (C5) under the authority of the Secretary of Safety. This centre visually monitors emergency situations to permit first responders to react as soon as possible. Four specialised committees operate the centre: the Technology Committee is responsible for the formulation and implementation of the Strategic Plan for Computing and Telecommunications and processes data to the Integral Public Safety System; the Service Committee operates emergency call centres and produces indicators in support of immediate emergency response. It also provides support for GIS and monitors traditional and social media. The Operation Committee conducts video surveillance and co-ordinates responses to accident situations. The Regional Committee ensures information exchange with the federation, the states, state institutions and Nuevo León's municipalities, and supervises emergency assistance provided by emergency centres.

Source: Federal District and Nuevo León Civil Protection Systems.

FONDEN is in charge of providing immediate financial assistance for emergency supplies through its Emergency Fund (see Chapter 6). As soon as a state asks for federal support, this emergency financing mechanism can be activated to finance supplies such as food, fresh water, fuel, shelter supplies and medicine.

The General Co-ordination for Civil Protection provides essential tools for the emergency response system to run. This provides flexibility to the system, but may present challenging situations, given that many other federal stakeholders have a large and dispersed operational capacity throughout the national territory.

Co-ordination among the federal agencies that participate in the CNE at the top level could be improved by using harmonised protocols and SOPs. Indeed, there are many parallel and independent reporting processes between the various agencies. Standardised incident control systems, such as the National Incident Management System (NIMS) in the United States, provide immediate information about emergencies in a harmonised format to all stakeholders, as does the Common Emergency Communication and

Information System (CECIS) in the European Union. At the local level, some municipalities have made efforts to implement these models, including Puerto Vallarta, which implemented the Federal Emergency Management Agency's (FEMA) Incident Command System model to improve its planning, management and local inter-agency co-ordination during an emergency.

Box 5.6. **Emergency response protocols: United States National Incident Command System**

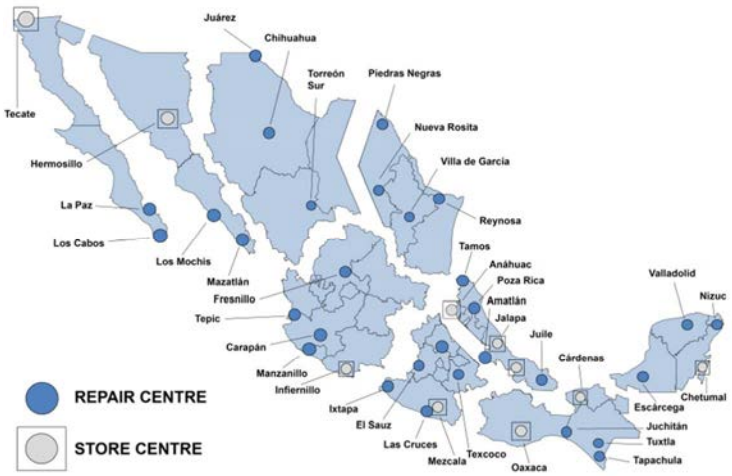
The United States has developed incident command systems (ICS) in various institutions since the 1970s, in order to manage and organise emergency response. The framework was reshaped in 2005 as the National Incident Management System (NIMS), which defines common protocols and competencies for emergency management. The current ICS consists of a standardised emergency management structure implemented at federal, state, tribal and local governments, NGOs and the private sector to respond to demands arising from crisis situations, regardless of jurisdictional and political boundaries. Aimed at fostering interoperability and inter-agency co-operation, the ICS provides schemes for 14 management characteristics related to incident command, operations, communication, planning, logistics, finance and administration and intelligence and investigation. Management objectives and action planning are centralised in a single unity of command to prevent diverging orders and promote accountability to a unified command and reporting institution. In this way agencies are able to respond to emergencies in a cost-effective and co-ordinated manner, which permits the development of mutual objectives and strategies. At the same time, the ICS is flexible enough to be implemented for all kinds of incidents, large or small. To ensure effective communication, a common inter-agency terminology was developed. Moreover, information exchange is facilitated by Public Information Officers who are in permanent contact with the Incident Command Organization and the Safety Officer. To promote an inter-disciplinary approach, guidelines and trainings are offered to promote uptake of ICS in the Food and Drug Administration, healthcare and higher education sectors.

Source: Department of Homeland Security (2008), "National Incident Management System", Department of Homeland Security, Washington, DC.

Generally, co-ordination appears to be mostly based on informal approaches from the local to the federal level, and practices and procedures are not often written and documented. A significant change in personnel could lead to the need to establish new working relationships, which are at the heart of ensuring that the system functions. The ongoing development of the Co-ordination and Response System (*Sistema de Vinculacion y Respuesta*, SVRES) may lead to better co-ordination. Currently being tested by the DGPC, with the support of the FEMA of the United States, SVRES offers a secured tool to the emergency services at the national level to share all of the information about the emergency. Increased efficiency among the federal emergency response could also be achieved with a harmonisation of the location of their respective regional emergency response centres: CONAGUA has 19 centres, CFE has 9 regions, PEMEX has 22 emergency groups and the DGPC has divided the country into 5 zones (Figure 5.1). Emergency plans could then be developed accordingly by pooling these dispersed federal emergency resources together.

Figure 5.1. **Emergency response regional centres, Civil Protection Regional Division in Mexico**

CFE's repair and store centres by region[1]



CONAGUA's emergency response centres

Civil protection regions in Mexico

Notes: 1. The update of CFE's Repair and Store Centres is one of nine strategies defined by CFE for the hurricane season.

Source: Based on information provided by CONAGUA, CFE and the CGPC.

Crisis communication and information systems

Crisis communication has been a key function of SINAPROC since its creation. The DGPC of the Ministry of the Interior operates CENACOM and transfers warnings from the SIAT-CT and other warning systems. CENACOM facilitates the dispatch and receipt of information between the states and federal components of SINAPROC. States send official declarations of emergencies to CENACOM and the DGPC is in constant contact with the state civil protection services via a telecommunication systems including land-line telephones, cell phones, the federal government's radio network, as well as e-mails and specialised phone lines with the Laguna Verde nuclear plant and PEMEX. SINAPROC stakeholders considered its technical capacities, however, to be lower than the desirable capacity found in some ultra-modern facilities in Mexico, such as the Bunker of Public Security or the communication centers of some states (for example the C4I4 in Mexico City and the C5 in Monterrey). While CENACOM fulfils its function of receiving and communicating official information and bulletins, it is not equipped to manage telecommunications for all major disasters. For example, under the Plan Sismo, the Ministry of Public Security is in charge of communications. With 14 staff to cover operations on a 24/7 basis, CENACOM lacks human capacity.

Reliable crisis communication requires some redundant capacity in the telecommunication systems for emergency responders and the general public to use the same bands simultaneously. Several crises in Mexico have shown that mobile and land-line telecommunication networks become saturated and civil protection services do not possess a specific protocol to ensure priority access to the mobile network. This is the practice in many OECD countries, for example in Italy and the United States, where partnerships with telecommunications operators provide specific numbers to access the network in situations where rationing results due to heavier than anticipated traffic. A few senior officials from the CGPC are equipped with satellite phones; however, receiving conditions are not always conducive since the location of its main office building is in the business centre of Mexico City, where elevated towers can interfere with the signal. With the launch of three new telecommunication satellites dedicated to security issues (the Mexican Satellite System, MexSat), it is planned that specific communication protocols and services will be made available for SEGOB in the framework of Plan Sismo. The first satellite was launched at the end of 2012 and the constellation is meant to be operational in 2014.

Despite this obstacle to continuous communications capacity, SEGOB has shown its capacity for business continuity. The DGPC counts two mobile telecommunication units, which can be moved to damaged areas when a major disaster happens. They can also be utilised as back-up in case CENACOM is no longer operable, thus ensuring the continuity of its operations. Ultimately, PEMEX's telecommunication network remains an available communication channel for high-level authorities in Mexico, as it provides a protected land-line service. While these communication systems provide a certain degree of diversification for crisis communication, there do not appear to be SOPs requiring their use. For example, the General Director for Civil Protection was using Blackberry Messenger to communicate with the Office of the Presidency during the Mexico City earthquake on 20 March 2012.

Integration of NGOs, voluntary groups and the private sector into emergency response

Civil society has played an important operational role in civil protection in Mexico. In the context of the 1985-86 earthquakes, when the emergency response capacity of official authorities was saturated, Mexican civil society demonstrated a high level of spontaneous self-organisation, especially in the form of spontaneous search and rescue and donating money to support relief activities. Today, local volunteer organisations can be found throughout the country with skills in fire-fighting and delivery of paramedic services. There are 36 officially registered volunteer organisations associated with civil protection, though the exact number of personnel is unknown. The 2000 and 2012 General Laws on Civil Protection recognise the legitimacy of volunteer groups and clarify that they must act under the direction and co-ordination of the state and municipality civil protection authorities. The DGPC has taken concrete steps to improve the co-ordination and control of these human resources by establishing a Directory of First Responders (see Chapter 7) and a National Network of Communitarian Brigades (see Annex H).

Co-ordination mechanisms have also been established with the private sector to reinforce emergency response capacities. For instance, the 2012 General Law gives increased importance to the internal units of civil protection in large gathering areas, typically office buildings, both for the public and private sector, as well as in hotels and other venues where many people convene at the same time (Box 5.7). The state of Mexico implemented the Mutual Support Program to integrate private companies in civil protection activities including not only emergency response activities, but also prevention and recovery activities. An agreement between TELMEX and the state of Tabasco helped the state to obtain phone lines in shelters during an emergency. In the Federal District, an agreement with hotels ensures the use of hotel rooms for people who may lose their homes due to a disaster.

The co-ordination between civil society organisations and government civil protection authorities is key to large-scale emergency management missions. Given its historic role and its institutional development, the Mexican Red Cross is considered to be an important operational component of SINAPROC.[1] With strong human resources (3 800 physicians and nurses) and important material resources (19 000 ambulances) the Mexican Red Cross has a wide presence in the Mexican territory, including 167 hospitals. Its functions during times of emergency are focused on providing healthcare to the affected population, assessing the number of victims and injures and distributing medicine, food and clothing. Although the role of the Red Cross is explicitly defined in the SINAPROC Manual, public authorities have, in the past, taken decisions outside its control that impeded its effectiveness. In the future, attention could be paid to ensure that resources sent from abroad are delivered to affected areas within a reasonable amount of time. As in many other countries, the co-ordination of civil society organisations and public authorities can present some challenges, particularly in case of an emergency.

Box 5.7. Internal civil protection units: A good practice in business continuity

The Federal District Civil Protection Law requires organisations located in large buildings to establish civil protection programmes and train internal units. This measure has proven to enhance the safety of workers and contributes to business continuity. The Secretariat of Civil Protection in Mexico City publishes technical guidelines for the operation of these internal civil protection programmes and is responsible for their approval. So-called "delegations" promote the development of these programmes among concerned stakeholders and provide training to organisations that are required to develop them; usually a large structure that concentrates many people or vulnerable groups, such as: multi-family housing buildings, strategic services, official premises, medium and high-risk commercial premises and infrastructures.

All internal programmes must include three sub-programmes for prevention, emergency response and recovery, typically providing for compulsory drill exercises, signals to safe areas, evacuation paths and training opportunities.

Internal units are particularly essential for emergency preparedness as they are integrated by volunteers who are used to the premises and functioning of the institution and who are trained by accredited third parties. These service providers can help draft civil protection programmes, once they have been authorised and registered by the secretariat. Accredited third parties are also required to authorise internal programmes.

These internal programmes enable micro-level emergency response as internal units are the first responders along with delegation civil protection units. To ensure the spread of and compliance with these internal programmes in the concerned infrastructures and institutions, fines are levied for failure to establish an internal programme or lack of training courses during their development.

Source: Federal District Civil Protection Law.

Feedback mechanisms and lessons learnt

Feedback mechanisms within the civil protection system are crucial to draw lessons from disasters and to make adjustments to improve the entire disaster risk management system. Periodic reviews of emergency plans would ensure that the planning assumptions are based on up-to-date information and data, for example about the geographic concentration and demographic distribution of damages. Many OECD countries have found that post-disaster reviews provide a valuable means of checking an emergency plan and amending procedures and protocols that did not work well. This process should have a formal linkage to regulatory or legislative process so that modifications to improve emergency preparedness and response plans become embedded in future practice. Appropriate feedback for the civil protection system will include an immediate assessment of the performance of the emergency response plan to test its reliability and efficiency, and foresee how to disseminate this knowledge to all members of the national system. Through this process, both effective and ineffective practices can be detected and lessons can be shared among civil protection stakeholders.

At the federal level, there is no regular, formal, institutionalised mechanism to draw lessons from disasters and analyse them to review and revise public policies. Federal institutions organise conferences, meetings and seminars for civil protection stakeholders, which are sometimes used for informal knowledge-sharing. SINAPROC organises a well-attended conference every year before the beginning of the tropical cyclone season where experiences learnt from the previous season's emergency response are shared, but this is not a systematic approach connected to revising policy or practice. Also related to

tropical cyclones, the SIAT-CT early warnings system was updated following a feedback mechanism that could be considered to be good practice. Created in 2000, the overall performance of the SIAT-CT system was assessed in 2002 along with its capacity to face high-impact hurricanes. As a result of this assessment, in 2003, more than 40 stakeholders from the federal, state, municipal and local levels met with the scientific community to produce a new version of the early warning system.

At state level, some standardised feedback processes have been developed. The state of Tabasco, for instance, created a committee for monitoring and updating civil protection plans. This committee is in charge of compiling the information after a disaster to assess performance deficiencies and opportunities for improvement. However, this practice is not widely developed in other Mexican states.

SINAPROC has shown openness to learning from major disasters that occur in different countries, which can represent an important source of reference, including the opportunity to identify good practice without suffering through the experience itself. The Chilean earthquake and tsunami of 2010 have strengthened the interest of SINAPROC authorities in developing more efficient and accurate tsunami early warning systems and emergency plans. The 2011 cascading disaster that occurred in Japan, with an earthquake, tsunami and nuclear accident, also pushed SINAPROC to act, as reflected in the extended scope of Plan Sismo, which was published by SEGOB in 2011, and has now been extended to tsunamis. The creation of the National Tsunami Warning System in May 2012 also drew impetus from these events.

Feedback mechanisms should also be developed not only to review emergency preparedness and response mechanisms, but for the whole risk management cycle. For example, the evolution of the rules of operation of FONDEN's Reconstruction Fund (Chapter 6) is related to the lessons learnt from the 2010 floods in Tabasco and Nuevo León. The "lessons learnt" process is a long-term issue that, in the case of Mexico, involves a multiplicity of actors and institutions. Although there are no clear institutionalised feedback mechanisms, SINAPROC constitutes a permeable and reactive system that allows gradual improvements of many emergency plans at civil protection proceedings. The elaboration of the new 2012 General Law on Civil Protection is, in part, a consequence of a constant and gradual feedback process. In this sense, the GCPC has played an important role as the facilitator of sharing experiences and lessons gathered over the past 26 years of its existence.

Conclusion

The establishment of SINAPROC in 1986 led to the extensive development of emergency management plans amongst the federal institutions that mobilise the most important response capabilities. Critical services and infrastructure operators, key economic sectors, and in fact most of the public administration, as well as a large part of civil society are prepared to activate an emergency plan in case a disaster occurs. This major achievement complements the pre-existing plans of the armed forces and can be seen as progress compared to the insufficient governmental preparedness and emergency response highlighted during the 1985 earthquakes in Mexico.

SINAPROC was initially created with a strong focus on improving the co-ordination of emergency response. The sectoral emergency plans developed by federal institutions also specify procedures and clarify roles in emergency response. Institutional co-ordination is also supposed to result through meetings of SINAPROC's stakeholders,

at the level of government affected by the situation at hand. This flexible approach entails significant autonomy in the decision-making processes of the various stakeholders engaged and appears to be effective to deal with most emergencies. However, it relies on willingness to co-operate, strong leadership in the crisis room and personal relationships. Inter-institutional, scenario-based plans with SOPs should be developed to describe how different actors in the system are supposed to co-ordinate.

A common emergency information system and incident control system should be established to better link emergency responders from local to federal level, sharing information and establishing a clear chain of command among all SINAPROC stakeholders during an emergency. The location of the regional emergency response centres of different federal agencies should be planned in joint consultation to maximise the coverage of emergency services to rural areas. SOPs for convening the CNE seem to be missing.

Efforts to strengthen crisis communication capacities should be pursued, including through developing priority access to telecommunication networks for emergency responders, strengthening the national communication centres and networking with the state crisis centres (such as the C4I4 and the C5).

Recommendations

- Further develop scenario-based emergency response planning.
- Establish a common emergency information and incident control system among SINAPROC's stakeholders.
- Strengthen crisis communication capacities of SINAPROC's stakeholders.
- Strengthen co-ordination mechanisms with volunteer organisations and NGOs.
- Broaden business continuity planning efforts in the public and private sectors, particularly for SMEs.
- Maximise synergies between the General Directorates of the CGPC, moving them to a common site in a less earthquake-prone area.
- Reinforce feedback mechanisms and the sharing of good practices and lessons learnt.

Note

1. Another volunteer organisation is the search and rescue brigade "Los Topos", which developed spontaneously during the September 19, 1985 earthquake. This self-financed group acts independently and autonomously, deciding whether and when to mobilise its personnel who have experience in digging through collapsed buildings and rescuing trapped persons.

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Chapter 6

Recovery and reconstruction

Public policies to limit the longer term social and economic impacts of disasters are essential components of a holistic approach to civil protection. This chapter considers practices in support of business continuity planning, early recovery and reconstruction. It examines the actions of key industries to maintain operations and public policies in support of low income households affected by disasters. It also describes changes made over time to refine Mexico's innovative risk transfer mechanisms for financing the reconstruction of public infrastructure through the FONDEN Disaster Reconstruction Fund. This specific financial mechanism is tailored to the country's high exposure to hazards.

Introduction

Communities can suffer severe negative impacts in the short to medium term following a disaster due to losses of capital stock, lost economic growth and inflation due to the scarcity of goods. While direct damages such as lost lives, destroyed homes and damaged businesses capture public attention, negative economic impacts in Mexico result to a great extent from damage to public infrastructure. The typical landscape of a disaster includes roads that are washed away or encumbered with debris, faltering water purification and electricity plants, and damage to telecommunications. Businesses may suffer physical damage to buildings and inventory, lost orders, displaced workers, a reduced customer base and extended periods of interruption.

In addition to immediate relief needs such as basic shelter, cleanup efforts and business continuity, an integrated approach to disaster risk management should consider how medium-term objectives such as economic recovery and extensive repairs to infrastructure and housing can best be met. Economic recovery in the long run depends on how quickly such assets can be repaired, as well as the quality of the new capital stock compared to the pre-disaster state.

The longer a community takes to recover from a disaster, the less likely it is that the local economy will ever return to the productive level it had before the disastrous event. Ensuring the business continuity of key services such as health, telecommunications, energy or water supply, and implementing dedicated social programmes can help to minimise a disaster's impacts in terms of a prompt return to normality and preventing capital flight. In addition, the financial impacts of disasters can be mitigated *ex ante* through pro-active financial management tools, most notably risk financing and risk transfer tools and compensation arrangements provided by the private sector or government, as a complement to physical risk-reduction measures. These tools provide financial protection and may reduce costs by re-profiling risks across time so that they can be better managed or by transferring risks to those better able to absorb them. They hedge the economic impacts of disasters, thus averting potentially devastating drops in welfare, accelerate recovery and foster reconstruction; but striking the right balance is important to ensure that individuals and businesses have incentives to invest in preventative measures (OECD, 2012).

This chapter analyses *ex ante* financial arrangements to support rapid reconstruction and temporary relief policies to stimulate local consumption with targeted support for small and medium enterprises (SMEs). It considers whether the institutional arrangements for such measures reflect good governance practices and whether the strategy takes account of how such support can undermine the incentives to invest in better quality construction and non-structural prevention practices. The chapter also addresses the *ex ante* pooling arrangements adopted by Mexico to ensure adequate financial capacity to cover peak risks, as well as capital market solutions in catastrophic risk transfers, such as risk securitisation (OECD, 2010).

Business continuity and early recovery as a civil protection objective

The aftermath of an emergency requires specific strategies to stem or limit secondary impacts. These include plans to ensure the continuous functioning of basic services and the economy of the affected area – business continuity – as well as a rapid return to a normal life for citizens at the household level to restore basic living conditions and avoid social unrest – often referred to as early recovery.

Business continuity

Business continuity planning constitutes a key element to reduce the potential disruption of the supply of goods and services, especially in vital systems such as hospitals, water and energy, public security, transport and communications. After a disaster, the economic recovery of a country or region may depend heavily on the continued productive capacities of such essential services and SMEs, and need to be accompanied by specific programmes. For public and private sector organisations alike, the first step in business continuity planning is to model the potential impacts and consequences of a hazard on the organisation's entire range of activities and identify its essential parts and functions as distinct from what can be discarded temporarily. While efforts have been made in Mexico to improve and develop business continuity plans, especially at the federal level and by operators of critical infrastructures providing strategic services, implementation remains widely uneven at more local levels and in smaller organisations.

Business continuity planning works hand-in-hand with civil protection planning in Mexico, as it is a key aspect of the emergency plans developed at the three levels of government (see Chapter 5). All public sector members of Mexico's National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) have to develop business continuity plans in their internal programme of civil protection (see Chapter 5), and the General Directorate for Civil Protection (*Dirección General de Protección Civil*, DGPC) leads the strategy to develop these plans. In addition, the DGPC works with representatives from the social and private sectors to promote business continuity for governmental institutions so as to ensure government continuity, i.e. continued political leadership.

As in most OECD countries, business continuity planning is more developed and integrated in large enterprises than in SMEs. Mexican Cements (*Cementos Mexicanos*, CEMEX), the world's third largest building materials supplier and cement producer, and Mexican Telephones (*Teléfonos Mexicanos*, TELMEX), the largest telecommunication company in Mexico, have developed specific services to support business continuity planning, specifically in the domain of data management, hosting and recovery. In the energy sector, Mexican Petroleum (*Petróleos Mexicanos*, PEMEX) maintains strategic stocks throughout the country to ensure that the oil supply for Mexico City and other major cities will not be disrupted in the event of a disaster. The Federal Electricity Commission's (*Comisión Federal de Electricidad*, CFE) emergency plan focuses on electricity supply continuity in disaster-affected areas. In August 2012, for example, only one day after Hurricane Ernesto had interrupted electricity supply to 85 450 inhabitants in the states of Quintana Roo and Campeche, 60% of the damaged connections had already been restored. Business continuity of health and water services is planned for in the Safe Hospitals Programme (*Hospital Seguro* – see Chapter 4) and the National Water Commission's (*Comisión Nacional del Agua*, CONAGUA) emergency plan (see Chapter 5).

The federal government supports business continuity in some economic sectors, such as tourism; the Ministry of Tourism (*Secretaría de Turismo*, SECTUR) places specific emphasis on supporting micro-businesses. Microcredit is provided through the Ministry of Economy in order to quickly reactivate the tourism industry in disaster affected areas. Among the effective practices in place to foster business continuity are the establishment of "supply committees", which ensure the supply of consumer goods, and the

development of an official business continuity standard designed to foster broader uptake by SMEs.

Public policies in support of early recovery

Early recovery refers to actions that address the immediate needs of communities following a disaster; they are demand-side oriented (distinct from the supply-side focus of business continuity planning). These actions may involve financing the purchase of basic supplies for households, removing debris and cleaning streets, and providing job opportunities for people who have lost their livelihoods. Each of these actions helps households, businesses and communities to restore normal living conditions and operations.

The key to successful early recovery is the evaluation of needs and damages. A rapid, dependable and effective early recovery scheme sets the foundation for the reconstruction process during which long-term investments are made, such as repairs to infrastructure. Shortages of basic necessities and logistics bottlenecks may stir negative reactions among the population, which can generate social unrest, diminish trust in institutions and weaken public participation in participatory governance. An agile early recovery strategy reduces social tensions, may restore trust in government and establishes the legitimacy of risk management authorities. The maintenance or restoration of public order and security is also an important condition of the early recovery phase, together with the provision of basic supplies and immediate relief. Proactive and clear public leadership is necessary to address the needs of vulnerable populations and to ensure public order.

Mexico has put several early recovery mechanisms in place oriented primarily towards the most vulnerable social groups. After the Army and Navy complete the emergency phases of the DN-III Plan and Navy Plan (see Chapter 5), they also provide capacity for clearing rubble and removing debris. The presence of these military institutions in affected areas also helps to support public order and security. The Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL) manages a programme to create temporary employment in affected areas, which helps to increase local production and stimulate local demand while indirectly supporting recovery operations. Typically these include family or community projects to restore or rebuild housing, working in shelters cooking or cleaning. The programme is implemented for one month after the onset of a disaster and pays participants 99% of the minimum salary with a four-hour work day.

A specific fast-track financial mechanism was created in 2000 to make the supply of basic goods available to states and municipalities for early recovery. As soon as an emergency declaration is accepted by the Ministry of the Interior (*Secretaría de Gobernación*, SEGOB), the Emergency Fund (*Fondo Revolvente*) can be used within a few days to finance large amounts of food, protective sandbags, medical treatments, mattresses and blankets, cleaning tools and materials, etc. (see Annex I). In 2011, approximately MXN 580 million were disbursed by SEGOB through this mechanism managed through its Fund for Natural Disasters (*Fondo de Desastres Naturales*, FONDEN – see next section). Control mechanisms have been specifically designed to ensure transparency and limit the risk of malfeasance and mismanagement of these public funds. Moreover, some states have created their own funds to limit aid requests to the federal government in particular situations (Box 6.1).

Box 6.1. State funds for civil protection

The recently enacted General Law on Civil Protection (2012) encourages the development of local funds for civil protection in the states and municipalities. Some states, such as Mexico and Jalisco, have also made efforts in this direction, thereby increasing their emergency preparedness capacities while reducing dependence on federal support.

In December 2010, the Congress of the state of Mexico approved a budget line of MXN 150 million to create the Fund for Disasters and Environmental and/or Anthropogenic Accidents of the State of Mexico (FDEAA). Similar to FONDEN funds, the purpose of this mechanism is to provide relief to the population during an emergency and to carry out prevention and mitigation activities beforehand to reduce any eventual impact caused by emergencies or disasters. The FDEAA is an additional mechanism which is parallel to the resources allocated individually by the state ministries and municipalities for emergency response and recovery. For the year 2012, the fund's endowment amounted to approximately MXN 200 million.

In Jalisco, funds for emergency response activities are included in the ordinary annual budget of the State Unit of Civil Protection and Firemen (Unidad Estatal de Protección Civil y Bomberos Jalisco, UEPCB); in fiscal year 2012 they amounted to MXN 102 million. The executive branch has also set up an Operational Trust Fund (MXN 1.5 million in 2012) and a special part of the civil protection budget is allocated for the State Emergency Fund, FONDEN (MXN 6.5 million in 2012). These funds are used to support emergency response when the state's capacities have not been exceeded, which is a condition for accessing federal funds. In this way, the State Emergency Fund enables municipalities to obtain financial support for search and rescue, evacuation and reconstruction activities when support from the federal government is unavailable.

Source: Jalisco state Civil Protection Law; information provided by the state of Mexico, Operation Rules of the Fund for Disasters and Environmental and or Anthropogenic Accidents of the state of Mexico.

An additional fast-track instrument to finance immediate needs is made available to states and municipalities once a disaster has been officially recognised. All tasks related to debris removal, water supply and distribution, provisional shelters, schools and bridges, i.e. everything related to the restoration of public services, can be immediately financed through the so-called "Immediate Partial Support" (*Apoyos Parciales Inmediatos*, APIN) a mechanism established by FONDEN and granted by the Ministry of Finance (*Secretaría de Hacienda y Crédito Público*, SHCP). The one and only condition is that provisional works should not last for more than 30 days and that their funding should be considered as part of the funding for reconstruction to avoid the federal government paying for the same expense twice. Co-ordination between FONDEN (SEGOB) and the Budgeting Policy and Control Unit (UPCP) of the Ministry of Finance is well established for this purpose. Finally, there have been instances, such as in 2011, when the federal government has made special financial resources available to states through the emission of zero coupon bonds.

The early recovery phase also entails conducting comprehensive damage assessments, both to identify the needs of the population and to initiate the reconstruction process. Assessing damages and the needs of the affected population is a crucial process in order to provide the appropriate support during the early recovery phase. The Red Cross follows a specific process of needs diagnosis (*Análisis de Vulnerabilidad y de Capacidad*, AVC), which has at times led to unexpected requests. For example, among the needs that isolated communities in the state of Tabasco identified after massive flooding in 2007 were boats for fishing, to continue their livelihoods, and also ice machines, to conserve

the fish they caught for sale rather than pay for ice from a separate producer, who could undercut their margins by selling them ice at a premium. Accurate needs assessment is key for authorities who need to gain the public's trust in the general recovery and reconstruction process, and is essential to ensure the population will receive the resources it needs when it actually needs them.

SEGOB, through the DGPC, is responsible for the implementation of the initial actions related to damage assessment and needs identification. The first situation report contributes to identifying the needs of the population and identifies damage to critical infrastructure and the emergency response capacities of the public authorities. It integrates information received from other federal government bodies and serves as the base document for taking decisions during emergency response. The methodology is established and standardised with the state system's of civil protection through a training process during the "Regional Days of Civil Protection" or upon specific demand from states or municipalities.

Financial mechanisms in support of reconstruction

Large-scale disasters can severely affect public infrastructure, such as roads, bridges, schools, hospitals, dams, and the production and transmission of water and electricity. In Mexico, the federal government administers a comprehensive approach to disaster risk financing, with linkages to prevention, early recovery, reconstruction and risk transfer. Many countries have established disaster funds to finance the reconstruction of damages incurred during a disaster, rather than divert funds from devoted budget lines on an *ad hoc* basis. However, such schemes face complex challenges. First, they need to respond to public expectations of rapid disbursement, while at the same time ensuring transparency and oversight to guarantee that public funds are used for their intended purpose. Second, such schemes may lead to moral hazard with the unintended consequences such as a lack of investment by households and businesses in prevention measures or insurance.

Disaster risk management financial instruments: Programmes for reconstruction and prevention

SINAPROC is guided by a vision of integrated risk management that incorporates several programmes and financial mechanisms to support early recovery from disasters, reconstruction of public infrastructure and even prevention projects. The FONDEN programme provides financial support for the costs of reconstruction and repairs to public infrastructures, investments in disaster risk prevention (the FOPREDEN) and early recovery transfers to low-income households (the Emergency Fund). Unlike many other countries, in Mexico the same ministry that co-ordinates emergency preparedness and response (SEGOB) also has key responsibilities for the administration of these programmes, which facilitates the full use of data and information collected about disaster damages.

The federal government established FONDEN in 1996 as a cost-sharing mechanism through which states and municipalities may access federal resources to rebuild their public infrastructure damaged by a disaster related to a natural hazard – it does not cover man-made events. Every year at least 0.4% of the annual federal budget must be made available for disaster risk financing, which represents approximately USD 800 million per year.[1] More specifically, the federal budget and Fiscal Responsibility Law states that there should be at least a minimum threshold of 0.4% of programmable expenditure

comprising both budgetary resources and funds available as reserves for FOPREDEN, FONDEN and CADENA (the Ministry of Agriculture's catastrophic fund). Each programme draws from the same federal expenditure budget: FOPREDEN, the FONDEN Emergency Fund, the FONDEN trust fund and CADENA. At the end of the fiscal year, should there be any remaining budgetary resources either in the FONDEN programme or FOPREDEN, they are transferred to the FONDEN trust, and count as part of the minimum 0.4% of the following year's budget allocation. The Ministry of Finance can intervene in case resources are insufficient to provide supplemental funds, drawing on resources from budget surplus income. During the period 2000-10, the average annual expenditure of FONDEN federal resources was MXN 4 627 million, including the 100% financing of federal infrastructure and the 50%, on average, of state infrastructure.

Governance and process of FONDEN expenditures

States do not have direct access to federal resources to reconstruct their infrastructure; these resources are available through the FONDEN trust, which pays out directly to specified contractors. The FONDEN trust is co-managed by SEGOB and the Ministry of Finance and holds the allocated reconstruction funds before they are approved for the reconstruction process (see Annex J). All of the resources for federal infrastructures are provided through the FONDEN.

The fiduciary of the FONDEN trust is the state-owned development bank BANOBRAS, which operates according to the mandate of the Ministry of Finance. It disperses approved expenditures to the businesses contracted by the federal and state entities with responsibility for the infrastructure according to scheduled reconstruction operations. In some cases, state government resources have had to be deposited in the FONDEN trust to initiate the reconstruction of their infrastructure. The FONDEN trust does not transfer resources for reconstruction to the federal ministries or to state governments, but directly to contractors in order to ensure efficiency and transparency in the use of public resources.

SEGOB is responsible for managing the process to access FONDEN's resources and issuing disaster declarations. SEGOB reviews the related funding applications, determines the appropriate allocations and requests the Ministry of Finance and Public Credit to convene the FONDEN Technical Committee to authorise the transfer of funds to a subaccount for the reconstruction programme in the FONDEN Trust. BANOBRAS transfers funds from this subaccount to the contractors implementing the reconstruction works. Previously, invoices showing reconstruction advances could be submitted.

The process for declaring a disaster and for allocating reconstruction funds from FONDEN has been improved over the years to ensure transparency, efficiency and accountability. After the onset of an event that exceeds its own resources and operational capabilities, a state can request assistance from FONDEN to co-finance reconstruction. The Technical Committee is convened to determine precisely which municipalities are in a state of disaster and can therefore be subject to a formal disaster declaration.

As a preliminary step, the Technical Committee, composed of technical agencies such as CENAPRED or CONAGUA, assesses the intensity of the event in order to evaluate whether it is a recurrent or a non-recurrent natural hazard based on pre-established criteria. If the declaration of disaster is accepted by the committee, a Damage Assessment Committee is convened to determine the needs of immediate support for early recovery to be financed through the FONDEN's APIN fast-track scheme.

Next, SEGOB publishes the official disaster declaration (four days after the disaster), which allows federal resources to be spent to finance recovery and reconstruction. SEGOB also makes available the damage assessment tool *FONDEN online* to conduct a multi-sectoral damage assessment. This online password protected tool enables each federal agency and entity to present detailed damage reports through pre-established forms including estimated costs of reconstruction, and to geo-reference damaged infrastructures with four photographs of each asset. The damage diagnosis should be completed within ten days and can be extended for ten days if necessary. After that, each line minister and federal agency in charge of every industrial and lifeline sector should send the final diagnosis of the damages and the resources needed under its sector to SEGOB within the next seven days. This standardised approach allows more efficient control of these multiple requests by the Damage Assessment Committee, as well as by FONDEN and the SHCP before they authorise the allocation of the funds.

The Ministry of the Interior co-ordinates the transfer process with federal agencies and states who own damaged infrastructure from the onset of a disaster until the approval of expenditures. Its responsibilities include monitoring the correct application of the resources in every reconstruction programme, including at federal and state level. Federal agencies and states have responsibility for contracting with the third parties who actually carry out the reconstruction work.

Box 6.2. **Changes to FONDEN's operational rules**

One of FONDEN's strengths has been the ability of its managers to identify challenges facing its administration and to design improvements. In 2010, the General Rules of FONDEN introduced several important changes:

- the timing for an official "Declaration of natural disaster", as well as the number of days involved to request and authorise funds were significantly reduced;
- support for DRM was enhanced in the case of state governments and the disincentives for non-insured public infrastructure were reinforced;
- there has been a gradual acceptance of financial requests for the improvement of public infrastructure using FONDEN resources. It has been necessary to differentiate requests for reconstruction of public infrastructure from those for improvement or upgrading, since there were so many cases in which the ratio of expenses between reconstruction to improvements was one to ten;
- to increase transparency and build a policy of checks and balances, civil society representatives can intervene as observers through all of the processes involving public resources for reconstruction (*tercero independiente*).

In order to avoid delays to reconstruct state infrastructure, the federal government finances up to 50% of the approved costs. Since the reconstruction of public infrastructure can take from six months to two years (or even more because of technical delays), there is no need to allocate all of the financial resources at once in one disbursement, which would reduce the immediate availability of funds for other purposes. Instead, all reconstruction resources are disbursed according to a calendar presented by the technical authority involved, depending on the specific infrastructure. As a consequence, FONDEN resources may continue to be disbursed to finance the reconstruction of public infrastructure damaged by disasters that occurred several years earlier. For example, in 2010, MXN 41.5 million were approved by the Technical Committee to rebuild public infrastructure but only MXN 13.4 million were disbursed in that year.

Distribution of FONDEN funds since 1999

As per the 2009 FONDEN rules of operation, FONDEN finances 100% of the reconstruction costs of federally owned infrastructure damaged by natural events such as earthquakes, floods and hurricanes. Since the establishment of FONDEN, the federal government has financed on average 50% of the total reconstruction costs of state and municipal infrastructure damaged by such natural events. Every state in Mexico received funding from FONDEN at some point between 1999 and 2010 (Figure 6.1). The amount of funds disbursed by FONDEN to co-finance reconstruction costs is between 50% and 60% of the total direct damages estimated for all of Mexico when we exclude two states: Quintana Roo – where numerous economic damages are related to private tourism infrastructure – and Tabasco – where other significant reconstruction resources were approved after the 2007 flooding. A major proportion of FONDEN resources (92%), goes to three sectors: transport infrastructure (mostly roads and bridges), hydraulic infrastructures, and housing and urban areas (Figure 6.1).

FONDEN expenditures are highly variable from year to year, which is a challenge in terms of ensuring the availability of resources required for reconstruction. For example, 2010 was a peak year, with major disasters impacting 18 out of 31 states and 850 out of 2 500 municipalities. The annual allocation for FONDEN resources was below the level required to cover all funding requests, but in such cases the Ministry of Finance can allocate more resources to FONDEN; in 2010, MXN 20.3 billion were allocated through this mechanism. Mexico has also turned to insurance and other risk-transfer mechanisms, taking advantage of access to international markets to deal with the challenge created by this uncertainty (Figure 6.4). Figure 6.1 also shows that between 2002 and 2009, most of FONDEN resources came from its trust fund.

Figure 6.1. **FONDEN (1999-2010)**

A. Disbursements

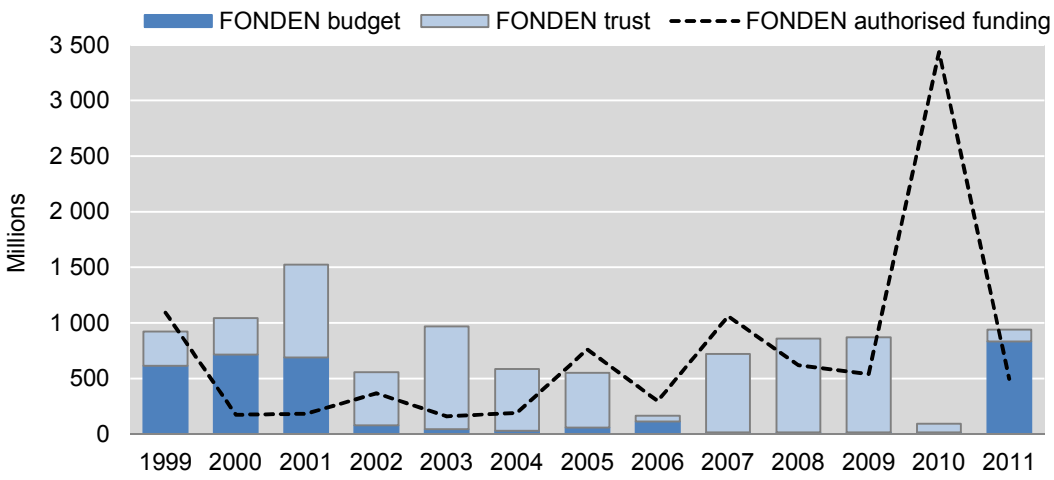
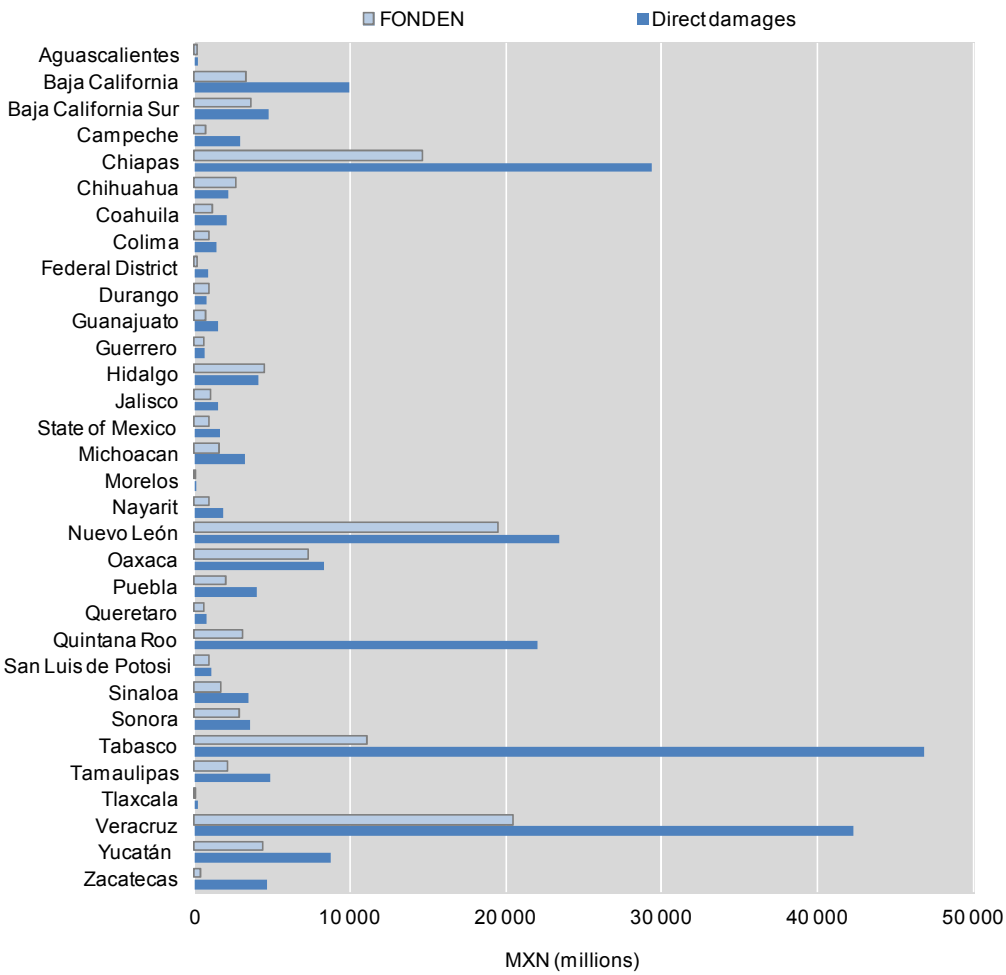
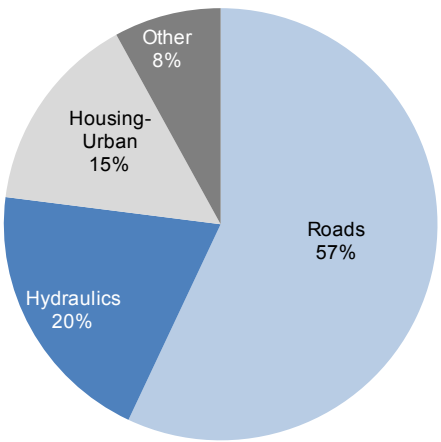


Figure 6.1. **FONDEN (1999-2010)** (*cont.*)

B. Direct damages by state



C. Direct damages by type of infrastructure



Notes: Reconstruction funding takes into account the contributions from the states. The economic losses are CENAPRED consolidated data and do not take into account secondary effects.

Source: Based on information provided by CENAPRED and the General Directorate of FONDEN (May 2012).

Financing reconstruction versus financing disaster risk prevention

One of Mexico's long-term objectives is to establish a coherent balance between resources for prevention *ex ante* and for recovery *ex post* to achieve an optimal use of public resources. In 2004, it created a Disaster Prevention Fund (FOPREDEN) to co-finance state and federal projects related to risk assessment, risk reduction and capacity building for disaster risk prevention. With this support, Mexico encourages agencies to invest in areas where returns may only become apparent over the long term (see Chapter 4). These investments, when appropriately planned, should strengthen the resilience of society and robustness of infrastructures, and thereby reduce spending on disaster reconstruction and recovery costs. One important aspect of FOPREDEN is that it requires states to complete a risk assessment (including the development of a risk atlas) as a pre-condition for eligibility for financing any other type of qualified project. This policy is highly laudable as it promotes informed decision making about investment in risk reduction.

The use of FOPREDEN by eligible parties has not reached the level anticipated; its expenditures are equal to only 2% of the FONDEN expenditures and have fallen over the past three years (Figure 6.2). This may be due to the conditions for access to FOPREDEN resources, which depend on states and municipalities submitting proposals of acceptable quality, and willingness to co-finance a certain share of the project costs. Many proposals do not meet acceptable standards of quality set by FOPREDEN's Scientific Advisory Committee. The solution to this challenge is not to lower the standards, but to promote awareness of the fund throughout the civil protection community and to encourage applicants to develop quality disaster risk prevention proposals. Despite promotional efforts made in civil protection workshops and the Regional Days of Civil Protection, there still are not enough proposals made and resources go unspent for many years. Recent changes to the FOPREDEN operational rules, however, have simplified the process for states and municipalities to apply for these funds, and it is expected that the number of applications will increase with help from SEGOB to counsel and guide project proposals.

Figure 6.2. **FONDEN-FOPREDEN**

A. Total expenditures for the 2004-2011 period

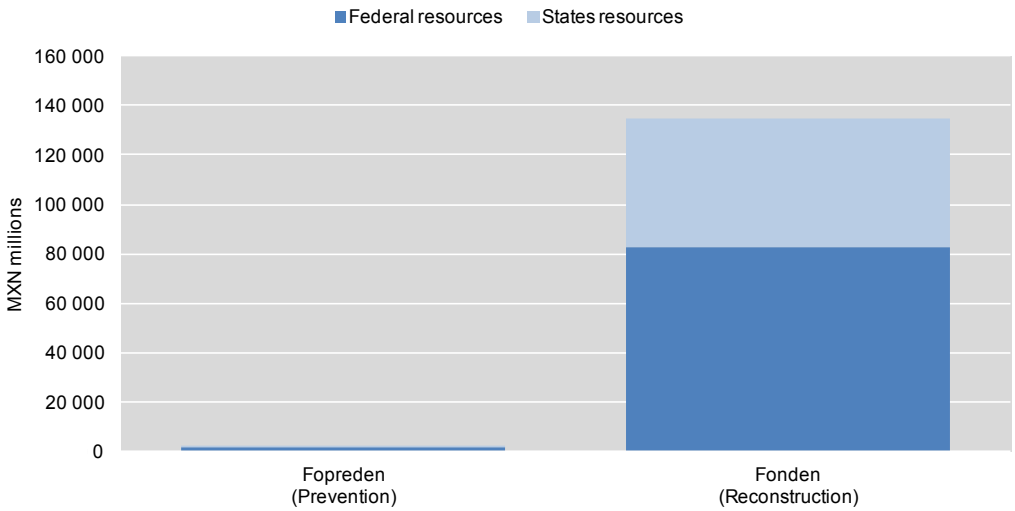
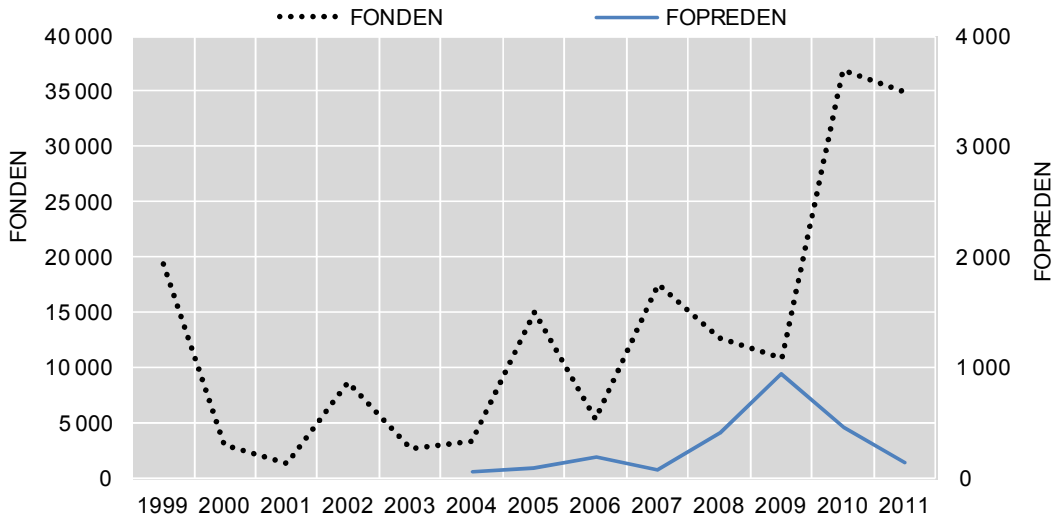
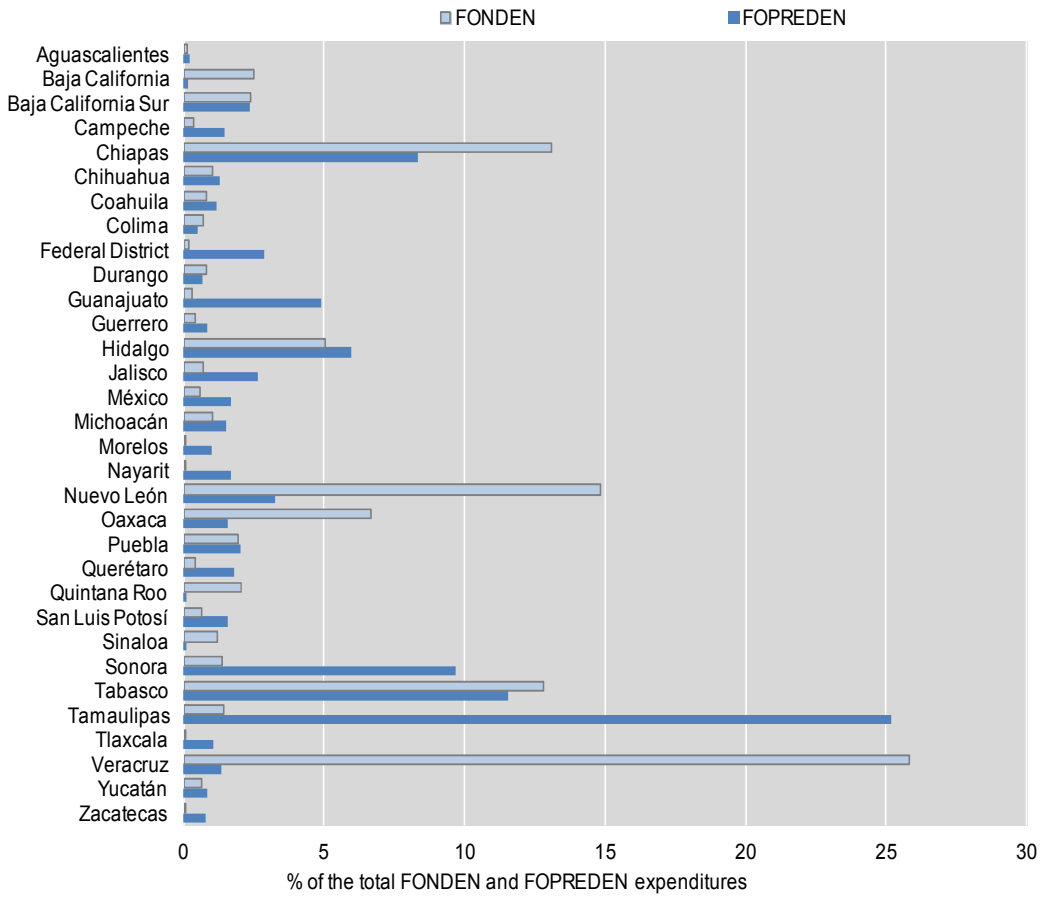


Figure 6.2. **FONDEN-FOPREDEN** (*cont.*)

B. Yearly expenditures for the 1999-2011 period



C. Yearly expenditures per state

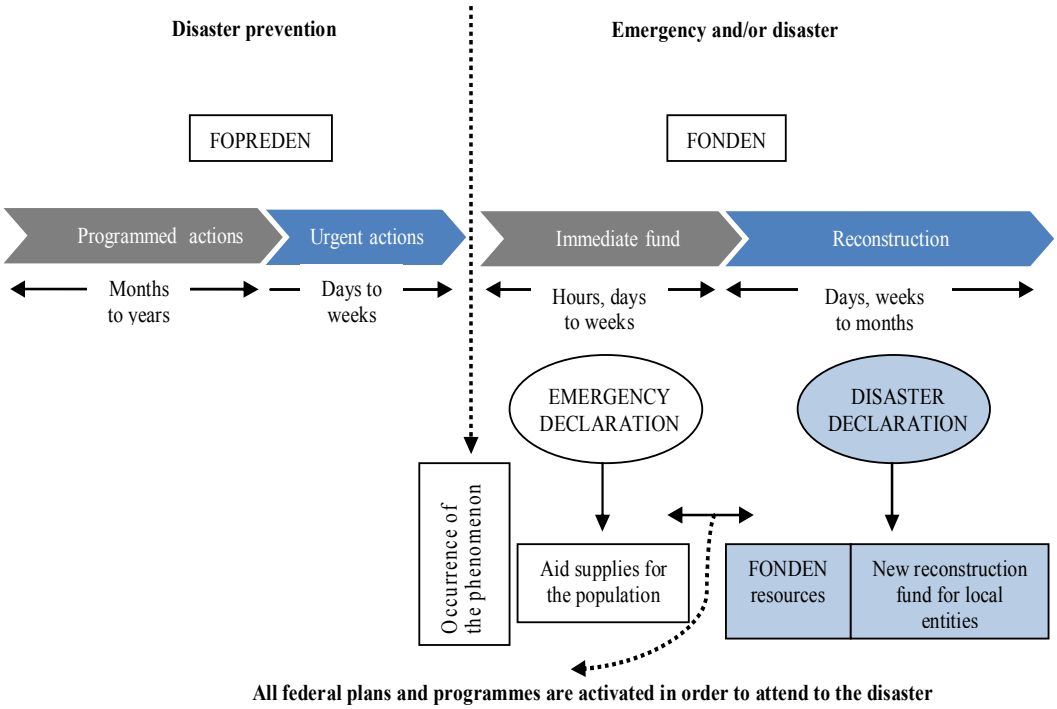


Source: Based on information provided by the General Directorate of FONDEN (May 2012).

As with FONDEN, all states have received at least some financial support from FOPREDEN. While FONDEN investments are directly commensurate to the costs of repairs, there is no such guide for FOPREDEN disaster risk prevention expenditures. The state of Veracruz, for instance, has received comparatively low financial support from FOPREDEN, despite having suffered the highest economic losses over the last decade, whereas the state of Tamaulipas has received the highest amount of FOPREDEN funding, while financial damages during that period were close to the national average. There is no co-ordinated line of action between FONDEN and FOPREDEN funding, which may imply that states affected by natural hazards do not sufficiently recognise the need to invest in prevention.

Regarding the broader objective of using FOPREDEN to funnel a greater proportion of resources toward investing in disaster risk prevention, it should be noted that FONDEN inherently includes some aspects of risk prevention. Infrastructure repairs, for example, are supposed to comply with updated building norms that improve safety and make them more resistant to disaster damages. Concerns have been voiced, however, that contractors sometimes use inferior building materials to repair infrastructures, which leads to recurrent losses when the same infrastructure is damaged by a subsequent natural hazard. Greater monitoring and control of the materials used by contracted third parties might be required to avoid this in the future. Second, FONDEN can also finance housing relocation, and it finances a SEDESOL reconstruction programme to relocate poor households, schools and hospitals outside hazard-prone areas to safer locations.[2]

Figure 6.3. **Financial instruments to prevent and respond to disasters**



Source: Information provided by the General Directorate of FONDEN.

FONDEN has no specific budget, however, to improve infrastructures: when a natural hazard damages or destroys infrastructure, FONDEN is used to finance its reconstruction,

but there is no financial track specifically related to the additional costs of improving infrastructure besides the application of the updated building standards. The 2009 FONDEN rules, as well as the 2010 general rules, both explicitly cope with requests for infrastructure improvement or upgrading by giving first priority to reconstruction. Requests for improvements to "build back better" have been substantial in some years, and though they are conditioned on the availability of financial resources, it is estimated that some years they may amount to as much as 25% of FONDEN resources. In the future, such expenses could become one of the main challenges facing FONDEN as infrastructure ages and if community development leads to greater exposure to natural hazards.

Ensuring adequate funding for FONDEN remains crucial, especially if future damages are expected to increase as a consequence of climate change and increased vulnerability. In this respect, anchoring the FONDEN budget allocation in the annual Federal Budget Law is an important element of SINAPROC. In addition, complementing FONDEN resources through risk financing and transfer instruments has become a stable aspect of Mexico's risk financing strategy.

Risk transfer and insurance

Insurance can transfer a certain level of the direct financial costs of disasters and enhance certainty about liquidity during the crucial periods of recovery and reconstruction. This is true for businesses and households, but can also apply to governments that need to rebuild infrastructure but do not have sufficient fiscal capacity. In Mexico, the insurance market is not very well developed for households and businesses, and the government has opted to subscribe to innovative insurance products such as excess losses insurance and multi-risk catastrophe bonds, to protect itself against adverse consequences. One of the challenges it faces is further developing risk transfer tools to diffuse the culture of insurance more broadly in society through appropriate policy and incentive mechanisms.

Ensuring the availability of federal finance for reconstruction through innovating risk transfer mechanisms

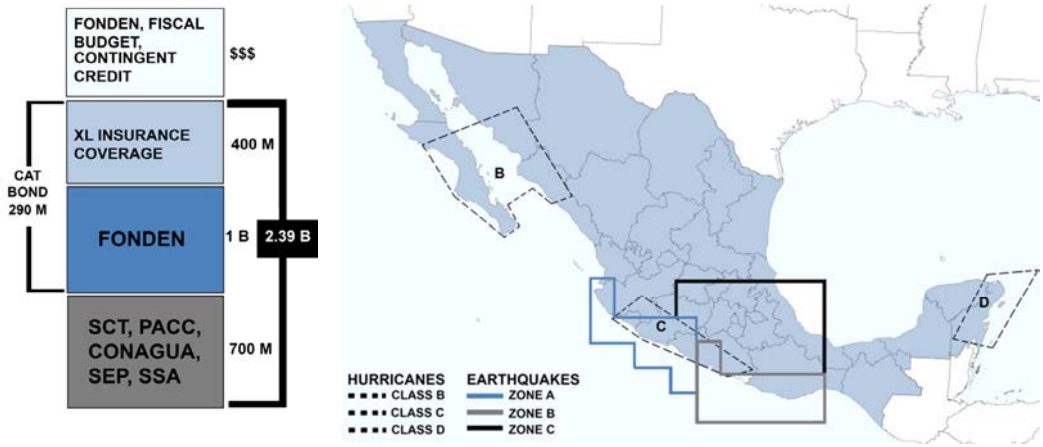
The key to the effectiveness of FONDEN is the capacity to secure sufficient funds when a disaster strikes. Furthermore, as shown in Figure 6.1, large-scale disasters can largely exceed FONDEN resources, even with stable budget allocations of at least 0.4% of the annual federal budget. In this context, risk transfer mechanisms can offer innovative solutions. Since 2006, Mexico has developed insurance mechanisms to cover FONDEN resources through two schemes.

Mexico's parametric catastrophe bond

In 2006, FONDEN issued its first catastrophe bond called Cat-Mex, which was designed by the Ministry of Finance with support from the World Bank. Catastrophe bonds are risk-linked securities that transfer a specified set of risks from a sponsor to investors. Cat-Mex was the first catastrophic bond in Latin America. It relied upon a combination of a parametric reinsurance scheme and a cat bond covering earthquakes in specific zones of the Mexican territory. With coverage up to USD 450 million for 3 years, the insurance claim may be triggered by a declaration of disaster if an earthquake occurs that meets specified threshold criteria, e.g. magnitude, depth and with its epicentre located in specific zones.

Mexico launched a larger catastrophe bond, the Multi-Cat Mexico 2012, covering extended earthquake zones as well as hurricanes from two zones in the Pacific and one in the Atlantic. Specific indexes on the pressure of the tropical storm and the magnitude, depth and location of the earthquakes can trigger a payment of the coverage up to USD 315 million, with USD 140 million for earthquakes, USD 100 million for Pacific coast hurricanes and USD 75 million for Atlantic hurricanes (Figure 6.4). Mexico paid a premium of USD 95 million for the period 2009-2012, and FONDEN financed USD 15 million of studies for its design.

Figure 6.4. **FONDEN insurance coverage**



Source: Information provided by the General Directorate of FONDEN.

Mexico's excess loss scheme

Mexico purchased an excess loss scheme (XL coverage) designed to cover against disaster losses by using the deeper resources of international capital markets. The XL coverage was launched in 2011 on the reinsurance market. When funding requests to FONDEN exceed USD 1 billion, the XL coverage can provide additional financial resources up to USD 400 million. The premium paid by Mexico reached USD 100 million and represents 25% of the coverage. The high cost of the premium can be explained by the significant disaster losses registered in 2010, a catastrophic year with close to USD 3.5 billion in funding requests to FONDEN. The number of reinsurance companies participating in the programme is expected to increase, and the ratio of premium to coverage is expected to improve with subsequent issuances of this product.

The development of risk-transfer products requires extensive analysis and modelling. Investors want to quantify with precision the risk they would be taking by investing in a cat bond or an excess loss scheme. Risk analysis tools have been developed in Mexico since 2007 to quantify risks and develop loss estimates based on risk scenarios (Box 6.3). Significant synergies exist between this analytical work and the risk atlas efforts that CENAPRED promotes at the national level (see Chapter 3), which could be further leveraged for an integrated risk assessment and management process in Mexico.

FONDEN and the Ministry of Finance have developed impressive efforts to design, promote and issue risk-transfer products on the international insurance-reinsurance market and to develop related technical tools in the last five years, such as R-FONDEN. Ultimately, if insurance products were to become more widely used in Mexico, FONDEN

could limit its interventions to the development and financing of specific risk-transfer schemes for large-scale disasters. This would require broader take up of insurance products by federal and state entities, businesses and households.

Box 6.3. **R-FONDEN: An innovative tool for risk analysis**

FONDEN and the Ministry of Finance created a tool called R-FONDEN (Loss Estimation for Federal Risk System) with the support of the Institute of Engineering of the UNAM to quantify risks and develop loss estimates based on risk scenarios. Based on a database of public assets containing geo-coded information about infrastructures, their building characteristics and replacement cost, R-FONDEN can estimate disaster losses through probabilistic simulations of historic and potential hazards (earthquakes, hurricanes and floods) and modelling of their impact on the referenced infrastructures. This probabilistic modelling of losses is fundamental to design and issue risk-transfer products.

Source: Based on information provided by the General Directorate of FONDEN.

Other insurance coverage for public infrastructures

FONDEN creates incentives for states to insure infrastructure against damage from natural hazards. While FONDEN covers up to 50% of the reconstruction cost the first time an infrastructure is damaged, it will only cover 25% the second time it is damaged if no insurance has been subscribed, and no funding will be granted the third time. Over time, this should lead to a situation where all states will have insured their infrastructure or they will be ineligible for FONDEN cost sharing to finance repairs. States should consequently insure 50% of the value of their infrastructure, even though FONDEN rules do not mention a minimum value. In theory, states could take advantage of FONDEN by insuring their infrastructure for a very small amount and still receive the maximum federal coverage against recurrent losses. FONDEN also provides financial support for the development of infrastructure inventory databases at the state level, similar to its own database of federal infrastructures. Loss estimates can then be performed with R-FONDEN, so that states can develop the information needed to subscribe their own insurance and risk-transfer scheme at the state level.

The use of insurance coverage by states is still relatively limited compared to federal assets, but there are examples of good practice that could serve as a model. The state of Jalisco subscribed to a state infrastructure insurance policy in 2011 which covers housing, state and municipal roads and bridges, hydraulic and urban infrastructures reconstruction costs in case of geological and hydrometeorological risks. For a premium of USD 15 million, 50% of the state and municipal infrastructures are covered as well as housing reconstruction and eventually relocation. Reimbursements are made based on a pre-established table which summarises all reimbursements for each type of infrastructure and damages. The state of Chiapas has also contracted a state and municipality infrastructure insurance, which was utilised in 2010 when Chiapas issued nine declarations of disasters, which all led to reimbursements after detailed analysis of the reinsuring companies. Furthermore, insuring new infrastructures is mandatory in Chiapas under its new State Law for Civil Protection. As of 2011, however, only five states had contracted an insurance policy (Table 6.1). Article 18 of the 2012 General Civil Protection Law makes it mandatory for states to obtain insurance coverage for their assets and infrastructure. It is expected that the strong incentives set up by FONDEN such as the ongoing asset inventory initiated in ten states will facilitate this development.

Table 6.1. **State insurance coverage and asset inventories**

State disaster insurance policy in 2011

State	Chiapas	Guerrero	Hidalgo	Jalisco	Veracruz
Duration	1 year	1 year	1 year	2 years*	1 year
Sectors	Housing Hydraulic Roads Urban	Housing Roads	Housing Hydraulic Roads Urban	Housing Hydraulic Roads Urban	Education Housing Hydraulic Roads
Insurer	Interacciones	Banorte – Generali	Inbursa	Inbursa	Interacciones
Covered risks	Geological and hydrometerological	Any direct physical loss or damage caused by natural disasters recognised by the federal government (geological and meteorological events)	Geological, hydrometeorological, the coverage is not restricted to the list	Any risk of physical loss or damage caused by a natural disaster declared by the federal government as an emergency or disaster for the state of Jalisco	Any risk of physical loss or damage caused by a natural disaster and recognised as such by the federal government

Status of state inventories of infrastructures

State	Nuevo León	Sonora	Tabasco	Baja California Sur, Chiapas, Chihuahua, Coahuila, Colima, Hidalgo, Oaxaca, Puebla, San Luis Potosi, Veracruz
Date	N/A	2011	2011	Ongoing with technical support from FONDEN
Sectors	Education Health Urban Roads	Health Housing Hydraulic Roads Urban Coastal areas	Housing Hydraulic Roads Urban	
Actions	Asset inventory	Asset identification Risk studies	Asset identification	
FONDEN support		MXN 13 104 000 (70%)	MXN 3 825 205 (60%)	

Note: * Jalisco: Including the 2012-13 one-year insurance covering renewal.

Source: Based on information provided by the General Directorate of FONDEN.

As FONDEN resources finance 100% of the reconstruction costs of federal assets, it is crucial for FONDEN to ensure that these infrastructures are covered by insurance in order to protect its resources. Such insurance remains uneven, however, across federal ministries. For example, CFE's electricity infrastructures are insured through a specific insurance scheme financed by its own budget. Therefore, CFE does not need FONDEN support for its reconstruction. CFE carries out a risk analysis for industrial security for every power plant on a yearly basis, with the methodology demanded by international insurance companies. The case of the federal roads, however, is the opposite as they have not been insured by the Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*, SCT) since 2000. This may change as insurance for disaster damages to highways is positioned to be acquired through the Road Insurance Project. For the development of specific insurance coverage for infrastructures, federal

agencies count on the Ministry of Finance Insurance Unit for technical support. A comprehensive insurance policy for federal agencies does not exist. Obviously FONDEN and its risk-transfer instruments represent a form of insurance mechanism for public infrastructures, but there is still a need to better articulate FONDEN global coverage and the specific insurance schemes contracted by federal agencies.

The promotion of insurance at the level of households and businesses

Governments can alleviate some of the pressure that disasters place on public budgets by fostering conditions for the uptake of private insurance amongst households and businesses. Increasing insurance coverage for households and SMEs, however, is a key challenge for Mexico; the property insurance penetration rate is second lowest amongst OECD countries (Swiss Re, 2012). The SHCP has initiated a pilot programme to promote insurance at the household level through TELMEX offices, to have closer access to the citizens. Five thousand life insurance policies were sold during this six-month programme, which offered the population low-cost insurance schemes, demonstrating that reluctance to purchasing insurance can be overcome.

Extending such initiatives to households as well as to SMEs is highly valuable as the low coverage rate induces adverse selection, making insurance products too costly compared to current household income levels. Existing insurance regulations for earthquake coverage place significant reserve requirements on insurers, which creates disincentives for the insurance industry to extend the penetration of property and casualty insurance. Incentives to promote the insurance culture should be established, or some form of compulsory household insurance could be considered to address this situation. To foster such a mandatory scheme in Mexico, a clear mandate needs to be established by law and capacity for monitoring and sanctions as demonstrated in the case of mandatory liability insurance coverage for automobile accidents would need to be provided.

Conclusion

SINAPROC contributes broadly to business continuity planning through oversight of emergency planning requirements, including support for the development of internal civil protection units in large buildings and places of large gatherings. These units have demonstrated effectiveness to enhance safety, and therefore protect human resources, which are key to business continuity.

Establishing FONDEN within SEGOB presents advantages. By integrating the administration for disaster risk financing directly within the public body responsible for co-ordinating emergency responses, data and information collected in the course of damage assessments can more easily be leveraged to reassess risks, develop risk atlases and emergency plans as well as estimate the financial resources needed to support recovery and reconstruction of future disasters. The current funding arrangement provides clarity and reliability to a key aspect of disaster risk management, and should be maintained. The governance of the FONDEN trust and its procedures for disbursements have proven their effectiveness in balancing the need to ensure accelerated recovery and reconstruction funds with the need to ensure transparency and accountability in the use of public funds.

The improvement or upgrading of public infrastructure should be an integral part of disaster risk prevention, but each instrument within FONDEN has its particular purpose. The improvement of public infrastructure is the responsibility of the federal and state

governments. Specific financial mechanisms need to be considered to achieve that goal. FONDEN should focus on reconstruction, and FOPREDEN could play a more important role in prevention by financing the upgrading of public physical infrastructure, since resources can be transferred between these funds. Federal agencies should also take responsibility by allocating their own resources for the maintenance and improvement of their infrastructures, not only when a disaster hits, but as an ongoing policy.

FONDEN has been a driving force in encouraging states to insure their assets, going as far as to condition repeated reimbursement of reconstruction costs related to damaged infrastructure dependent upon the asset being insured. Mexico could consider, however, earmarking federal contributions to states to ensure that they pay insurance premiums on their public infrastructure.

Recommendations

- Implement the integration of FONDEN and FOPREDEN financial instruments to allow investing more in prevention, especially in years when disaster losses are relatively low.
- Sustain FONDEN resources through a clear and accountable disaster risk financing instrument.
- Promote the development of the insurance culture through incentives or regulatory changes to enlarge household insurance coverage.
- Broaden business continuity planning efforts in the public and private sectors, particularly for SMEs.
- Continue to periodically review FONDEN to ensure its efficiency as a cornerstone of the national risk financing strategy.

Notes

1. Article 37 of the federal budget and Fiscal Responsibility Law (FBFRL).
2. With the following budget: MXN 8 000 for the land, MXN 8 000 for basic services (water, electricity) and MXN 120 000 for the reconstruction of houses.

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Chapter 7

International co-operation to strengthen civil protection

International co-operation plays an important role in comprehensive civil protection as risks do not stop at borders. This chapter examines the foundations for international co-operation in the Mexican National Civil Protection System. It identifies good practices in cross border co-operation between Mexico and its neighbouring countries in areas such as risk prevention, data sharing for the operation of early warning systems and preparation with joint training and exercises. It also considers co-operation in the broader international context of the provision, receipt and distribution of humanitarian assistance to and from other countries in the immediate aftermath of a disaster and the emerging role of Mexico as a donor of humanitarian assistance.

Man-made territorial boundaries do not protect a country from disruptive events that originate beyond those boundaries. Extreme natural hazards, and climate-related hazards in particular, may require some OECD countries to scale-up preparedness, response and recovery capacities with the aid of foreign partners, intergovernmental institutions and relief organisations. Recent events such as the Great East Japan earthquake and tsunami have shown that the magnitude of natural hazards, in conjunction with knock-on effects, may exceed even the highest levels of preparedness and response capabilities. Such events illustrate the importance of multilateral and bilateral co-operation in civil protection both before and during the immediate aftermath of a disaster. Once immediate relief actions have been performed, the role of international co-operation may focus on helping to finance the reconstruction of damaged or destroyed infrastructure, as well examining lessons learnt and sharing them with neighbouring countries, regional partners and even distant countries.

Good practices in disaster risk management have emerged at the international level in recent years, thanks in part to the willingness of countries to take a critical look at their own performance after a disaster and reflect upon what could be done differently in the future. Even the most advanced countries continue to struggle, however, to implement many of these recommendations on such cutting-edge questions as risk assessment in complex systems, calculating the cost-benefit ratios of long-term investments in disaster risk prevention and mitigation, the development of human and technological capacities for hazard monitoring and mapping, early warning systems and rapid response, and the imperative need to build community resilience. For these reasons, international co-operation plays a key role in the civil protection strategies of countries to ensure that they learn from partners and explore cost-effective approaches to guarantee the rapid scaling-up of capacities that are proportionate to their needs.

This chapter discusses the policies and programmes that are in place in the National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC) to promote the effective and efficient co-ordination of disaster preparedness and response at the international level. In particular, it examines institutional arrangements and practices to share technical expertise, regular conduct of joint exercises, cross-country training and collaborative scientific research, and data and information sharing between hazard monitoring services. Bilateral and multilateral agreements in the field of civil protection that serve these purposes have proven to help mutualise common risks and address capacity gaps such as weak informational infrastructure or notification, tardy co-ordination of relief operations leading to under-response, uncoordinated relief measures resulting in over-response, or the incapacity to contain or minimise disaster spillover effects that could affect populations across borders.

Mexico began developing its civil protection policies in 1985 to become practically self-sufficient in terms of managing its own emergencies. In the past, Mexico was primarily a recipient of international civil protection assistance, but it is now an important regional partner in its own right. This chapter examines how Mexico has leveraged SINAPROC to engage in international co-operation both as a donor and recipient of civil protection assistance. Political support at the federal level for many of these activities is apparent, but some of the state governments that are the most well placed to manage co-operation directly with neighbouring states do not have the resources to properly develop concrete actions on a formal and consistent basis. Mexico makes full use of several international organisations with activities related to disaster risk management, leveraging their convening power and expertise to access risk management tools and

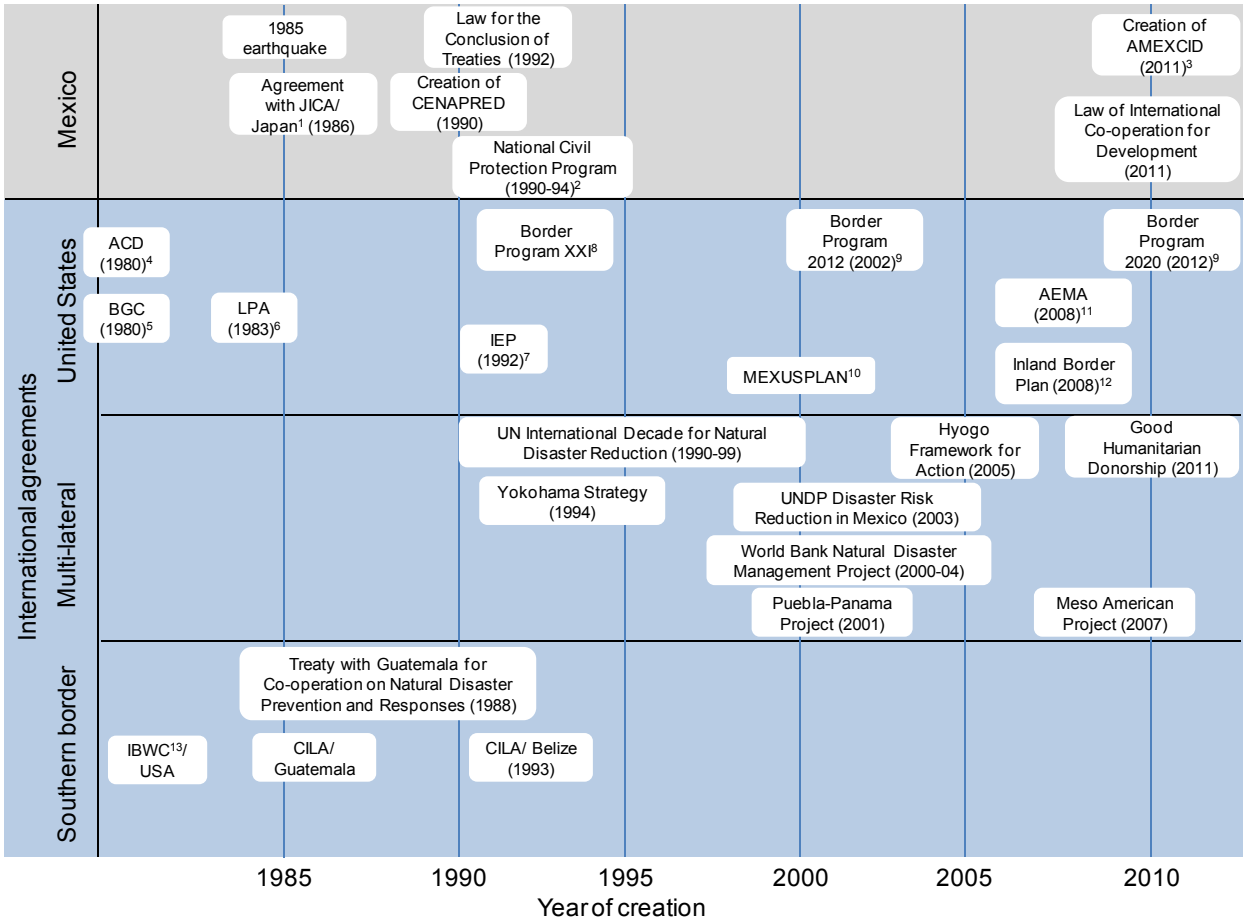
programmes, as well as spread its own innovations that merit the attention of other countries.

Foundations of international co-operation in civil protection

International co-operation played an important role in the aftermath of the 1985 Michoacán earthquake, when over 250 entities provided humanitarian assistance, including national governments, non-governmental organisations (NGOs), international humanitarian agencies, etc. (Pan-American Health Organization, 2006). The delivery of international assistance in this instance was concentrated heavily on the emergency response and early recovery phase. In subsequent years, international technical co-operation has played an instrumental role in strengthening Mexico's own civil protection capacities. Likewise, SINAPROC's vision to achieve integrated risk management is a testament to its openness to doctrines of disaster risk management promoted by such international fora as the United Nations International Strategy for Disaster Reduction (UNISDR), the United Nations Development Programme (UNDP) and the World Bank's Global Facility for Disaster Reduction and Recovery.

The Ministry of Foreign Affairs (*Secretaría de Relaciones Exteriores*, SRE) centralises and guides the federal government's international co-operation in the arena of civil protection, managing the conditions for providing and receiving official international assistance before and during emergencies. In particular this covers: *i)* the negotiation and implementation of agreements and programmes related to civil protection with neighbouring countries; *ii)* the development of technical co-operation both as a recipient of aid and as a donor itself through the newly created Mexican Agency for International Development Co-operation (*Agencia Mexicana de Cooperacion Internacional para el Desarollo*, AMEXCID); and *iii)* co-operation with international organisations and agencies in the field of risk management. At the same time, several federal entities with responsibilities related to civil protection functions are involved in the management of international co-operation, in particular the Ministry of the Interior (*Secretaría de Gobernación*, SEGOB) and its General Co-ordination of Civil Protection (*Coordinación General de Protección Civil*, CGPC). State and local entities are involved in decentralised international co-operation efforts, as acknowledged by the Law for the Conclusion of Treaties (*Ley sobre la Celebración de Tratados*, LCT) in 1992. This law grants local governments and agencies the standing to enter into inter-institutional agreements (although not treaties) with foreign governmental agencies and international organisations[1] within the boundaries of their area of competence and/or territorial jurisdiction. This law has given impetus to develop international co-operation activities in a decentralised manner. Figure 7.1 and Table 7.1 summarise Mexico's main international partners and areas of international technical co-operation with significance for civil protection (see Annex K for more information on these subjects).

Figure 7.1. **Timeline: International co-operation in civil protection**



Notes: 1. This agreement led to the Japanese International Co-operation Agency (JICA) providing financial resources for the construction of CENAPRED. 2. The National Civil Protection Program 1990-94 included the principles of the UN International Decade for Natural Disaster Reduction 1990-99. 3. Mexican Agency for International Co-operation in Development. 4. Agreement of Co-operation for Disasters (ACD) for emergency management in bordering areas. 5. Border Governor Conference (BGC). 6. La Paz Agreement (LPA) on Co-operation for the Protection and Improvement of the Environment in the Border Area (LPA), signed in 1983. 7. Integrated Environmental Plan (IEP) for the Mexican-US Border Area. 8. The La Paz Agreement led to the establishment of joint working groups in charge of environmental concerns and the Border XXI Program (1996-2000). 9. The Border Program 2012 (BP2012) was created by the US Environmental Protection Agency (EPA) and the Federal Attorney for Environmental Protection (PROFEPA) – an internal body within SEMARNAT – in partnership with other federal agencies from both countries, the ten border state governments and US tribal government. In 2012, the BP2012 evolved to the Border Program 2020. 10. MEXUS joint contingency plan signed between SEMAR and the US Coast Guard (USCG) in 2000. 11. The Agreement on Emergency Management Co-operation in Cases of Natural Disasters and Accidents (AEMC) superseded the ACD. 12. Mexico-US Joint Contingencies and Emergencies Plan for Preparedness and Response to Events Associated with Chemical Hazardous Substances in the Inland Border Area (Inland Border Plan) (2008). 13. In 1944, the International Boundary and Water Commission (IBWC, CILA in Spanish – *Comisión Internacional de Límites y Aguas*) was created with the Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Río Grande though an International Boundary Commission that was established in 1889. 14. From 1965 to 2010, international technical and scientific agreements were signed with France (1965); Israel (1966); the United States (1972); Venezuela (1973); Brazil (1974); Finland, Iran and the United Kingdom (1975); Spain (1977); Colombia (1979); Switzerland (1980); Australia and Italy (1981); Denmark (1982); Egypt (1984); China and Korea (1989); Bolivia, Chile and Uruguay (1990); Ecuador and Paraguay (1992); Bulgaria and Romania (1994); Belize, Costa Rica, the Czech Republic, El Salvador, Honduras and Nicaragua (1995); Argentina, Indonesia, Panama, Peru, the Russian Federation (1996); Germany (1997); Lebanon (2000); Guatemala (2001); Algeria (2010).

Sources: Figure created with information from diverse national institutions and international organisations.

Table 7.1. **International co-operation**

		Agreements				Risk management cycle			
		Political	Technical	Scientific	Financial	Prevention	Monitoring systems	Emergency response	Recovery
United States	Treaties	•	•	•		•	•	•	
	IBWC/CILA			•			•		
	EPA	•				•		•	
	NOAA[1]			•		•	•		
	FEMA	•	•			•		•	
	United States Coast Guards		•					•	
	United States Geological Survey		•						
	Incorporated Research Institutions for Seismology		•			•			
	Border Governor Conference	•						•	
Central America	Belize	•	•	•			•		
	Guatemala	•	•	•		•	•	•	
	Meso-America project	•		•	•	•	•		•
Rest of the world[2]		•	•[3]	•		•		•[3]	
International organisations and agencies	UNDP		•			•			
	World Bank		•		•	•			
	UNISDR	•				•			
	WMO		•	•			•		
	ECLAC		•			•			
	USAID		•			•		•	
	UNESCO		•	•		•			
	UN-SPIDER		•	•		•	•		
	JICA		•	•		•		•	

Notes: 1. It notably includes the Pacific Tsunami Warning Center (PCTW). 2. Agreements for scientific and technical co-operation with several Latin American countries. 3. Good Humanitarian Donorship Programme.

Source: Based on information from diverse national institutions and international organisations.

Cross-border co-operation in civil protection matters

When natural hazards repeatedly cross territorial boundaries, neighbouring countries have an interest to face the common threats together. This may take the form of sharing hazard monitoring data and real-time updates, as well as defining common protocols for communication and early warning, and conducting joint emergency operations. Mexico shares borders with Belize, Guatemala and the United States. Many zones along these borders are exposed to natural hazards, including hurricanes, earthquakes and floods. Mexico has developed extensive international co-operation with these countries, as well as with other countries in Central America (i.e. Costa Rica, El Salvador, Honduras, Nicaragua and Panama).

Cross-border co-operation with the United States

Mexico has concluded numerous co-operation agreements with the United States related to civil protection and disaster risk management, both at the national and local levels. The management of water resources along the border was first formalised with the International Boundary and Water Commission (IBWC) in 1889[2] to manage jointly the Río Bravo, and the water resources of the Colorado and Tijuana rivers (Box 7.1). The IBWC currently monitors the implementation of international agreements signed between Mexico and the United States, including compliance with responsibilities and rights related to these common water resources. The Mexican branch, known as the *Comisión Internacional de Límites y Aguas* (CILA), monitors water levels of the Río Bravo and notifies the General Directorate of Civil Protection (*Dirección General de Protección Civil*, DGPC) if flood thresholds are expected to be exceeded. It also co-ordinates with the United States' branch in the implementation of joint programmes. This cross-border co-operation mechanism is well established and has demonstrated its efficiency in regulating water issues. While floods are not very frequent in these river basins, the IBWC mechanism provides a good example of cross-border data exchange and standard operating procedures (SOPs), and is considered by Mexican authorities to be a model of cross-border governance for different areas of international co-operation and border areas.

Box 7.1. **The IBWC with Belize, Guatemala and the United States**

Transnational risks require bi-national or multinational co-ordination and co-operation amongst the potentially affected countries. The historic and geographic importance of the Río Bravo led to the establishment of an International Boundary and Water Commission (IBWC, established in 1889), which is divided in two co-ordinated branches – one in each country, CILA in Mexico and IBWC in the United States. The IBWC was created with the United States to manage the Río Bravo, and the Colorado and Tijuana rivers' water resources, which spread across the two countries. In 1944, the Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Río Grande expanded the commission's responsibilities and formally enacted the functioning of the Mexico-US IBWC.

The IBWC manages water demand for irrigation purposes through the operation of dams. It has also developed a flood protection programme and a civil contingency programme in case its infrastructures are affected. Joint activities include the regulation and conservation of the Río Bravo's water resources; construction, operation and maintenance of bi-national dams; and the protection of lands along the river from floods by levee and floodway projects. The IBWC also includes a mutual information-sharing process. The National Water Commission (Comisión Nacional del Agua, CONAGUA) and CILA are in charge of managing two bi-national dams located on the Mexico-United States border (the Amistad Dam – located between the states of Coahuila and Texas – and the Falcon Dam – located in Tamaulipas and Texas).

The high-profile issues associated with the northern border tend to overshadow the fact that Mexico's territory shares six river basins with Belize and Guatemala. Mexico created an IBWC with Guatemala in 1961 in order to manage water resources from the Suchiate, Usumacinta and Chixoy rivers, and in 1990, a treaty was signed to strengthen this co-operation. An IBWC with Belize was created in 1993 to monitor the Río Hondo and Arroyo Azul water levels and water quality. It also provides for the management of three bi-national hydro-climate stations that function to measure the water quantity flowing every day to monitor climate data. These commissions are intended to provide bi-national solutions and joint management for issues related to boundary demarcation, use and treatment of water, floods and hazard controls in the border areas and risk management. The Mexican sections of each IBWC are decentralised entities dependent on the Ministry of Foreign Affairs.

Sources: International Boundary and Water Commission (IBWC), *www.ibwc.state.gov;* Ministry of Foreign Affairs, *www.sre.gob.mx/cilasur/index.php/consulado*.

In addition to water use, a series of bilateral agreements addressing cross-border disaster risk management has been in place between Mexico and the United States for many years (Box 7.2). While the first agreements were meant to address all types of natural hazards, more recently co-operation has focused on environmental risks, and especially those associated with chemical pollutants. Concrete steps have been taken in this domain, such as the elaboration of joint contingency plans developed in the Border Program 2020, and both countries are committed to joint efforts to safeguard against risks due to the cross-border transport of hazardous waste. The heads of state civil protection services are actively involved in the Border Program 2020, together with the DGPC, and have so far focused on co-operation to deal with chemical spills and accidents in the border area.[3]

Box 7.2. **Bilateral co-operation with the United States**

The 1980 Agreement of Co-operation for Disasters (ACD)[1] between Mexico and the United States was intended to create co-operation mechanisms along the border area to manage jointly natural hazards such as hurricanes, floods, earthquakes, freezes, landslides, etc. A multi-department Advisory Committee for Natural Disasters was established in both countries, including representation from the Ministry of the Interior, the Army, the Navy and the Ministry of Finance in Mexico, and the Federal Emergency Management Agency (FEMA) and the External Aid Office for Disasters from the United States Department of State. In 2008, the Agreement on Emergency Management Co-operation in Cases of Natural Disasters and Accidents (AEMC) superseded the ACD.

In 1983, the La Paz Agreement[2] put in place plans for emergency preparedness and response to environmental disasters, and introduced the concept of the "border region", defined as "the area situated 100 kilometres on either side of the inland and maritime boundaries between the parties" (Article 4). It remains a pillar of cross-border co-operation between the two countries.

The Border Program 2012 (BP2012) was launched in 2002 to promote protection of the environment and public health in the Mexico-United States border region. Initiated by the Environmental Protection Agency (EPA) in the United States and the Mexican Ministry of the Environment (SEMARNAT) in partnership with other federal agencies and the ten border state governments, its objectives relate to disaster risk prevention, the formulation of joint contingency plans for all 14 pairs of "sister cities", and the development of a chemical emergency advisory/notification mechanism between Mexico and the Unite States.

The AEMC, signed in 2008, has expanded co-operation to the entire territory of both countries, increasing the range of possibilities for implementing joint emergency response programmes. It seeks to establish a Mexico-United States Working Group on Emergency Management, with representatives from SEMARNAT, the Ministry of Agriculture (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación, SAGARPA), the Center for Investigation and National Security (Centro de Investigación y Seguridad Nacional, CISEN) and the National Institute of Immigration (Instituto Nacional de Migración, INM).

Notes: 1. All of this builds on previous efforts. For example, an Agreement for Aid in Case of Disasters was established in 1968 between Mexico and the United States through the exchange of diplomatic notes, and was replaced by the 1980 agreement. 2. According to La Paz Agreement, the objectives of the agreement are to establish the basis for co-operation between the Mexican and US governments "for the protection, improvement and conservation of the environment and the problems which affect it, as well as to agree on necessary measures to prevent and control pollution in border area, and to provide the framework for development of a system of notification for emergency situations" (Article 1).

Source: Treaty between the United States and Mexico on Co-operation in Case of Natural Disasters, signed 15 January 1980, *Diario Oficial de la Federación*, decree published 4 May 1981; Treaty between the United States of America and Mexico on Co-operation for the Management of Emergencies in Case of Natural Disasters and Accidents, signed 23 October 2008, *Diario Oficial de la Federación*, decree published 18 March 2011; Treaty between the United States of America and Mexico on Co-operation for the Protection and Improvement of the Environment in the Border Area, La Paz Agreement, signed 14 August 1983, entry into force 16 February 1984.

Two more international agreements distinguish between co-operation along the inland border areas and those that occur in coastal waters. The Mexico-United States Joint Contingencies and Emergencies Plan for Preparedness and Response to Events Associated with Chemical Hazardous Substances in the Inland Border Area (IBP), applies to significant incidents and emergencies involving chemical hazardous substances that affect or have the potential to affect the environment along the Inland Border Area of Mexico-United States. The MEXUS Joint Contingency Plan on Pollution Events in Coastal Waters formally establishes cross-border co-operation between the United States Coast Guard and the Mexican Navy in response to pollution incidents that could seriously affect the coastal waters and coastal regions of both countries, or in cases where the impact on the waters of one country would be of such a magnitude to request assistance from the other country, which would be co-ordinated under the concepts and operational provisions discussed in the plan.

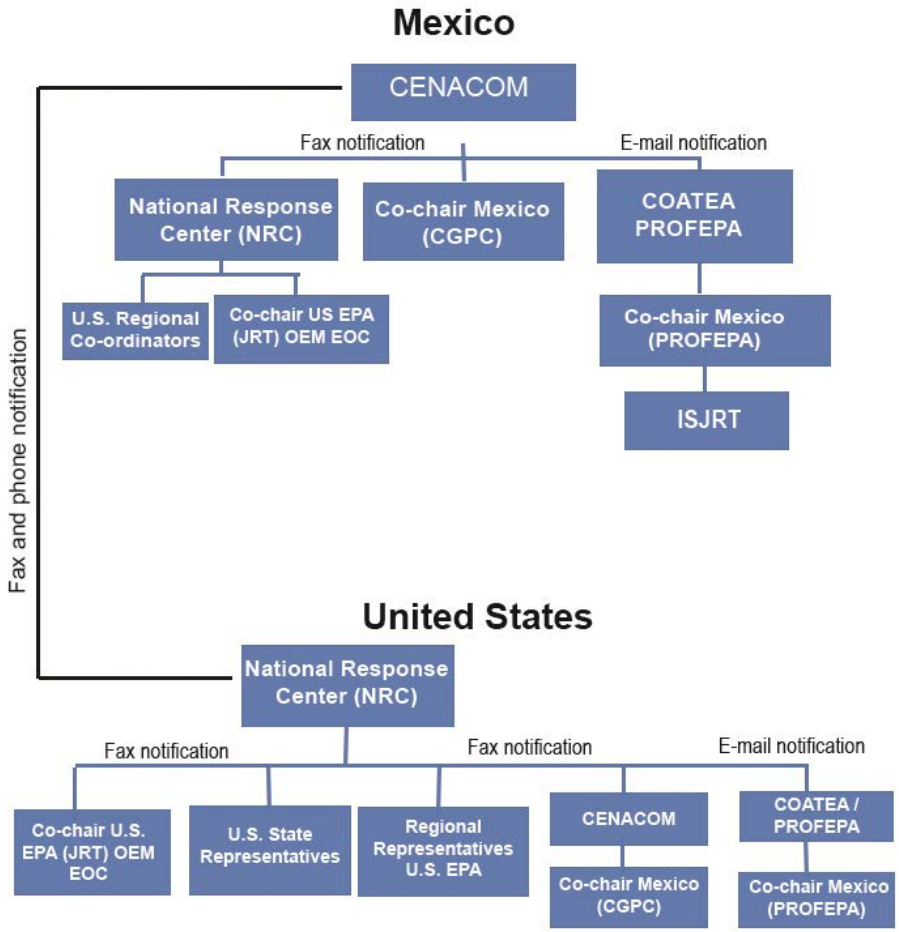
The IBP and the MEXUS plans clearly specify the procedures to follow for notification, activation, deactivation and response activities, as well as the governmental agencies or bodies to be involved. The IBP notification procedures set out an institutional co-ordination mechanism and communication protocols between the two countries, with the DGPC sharing the responsibility of co-chair with Mexico's federal Environmental Protection Agency (*Procuraduría Federal de Protección al Ambiente*, PROFEPA) (Figure 7.2). While the IBP and the MEXUS plans are focused on chemical risks and oil spills, their importance is based on the establishment of well-defined procedures and roles for official bodies on both sides, which could then potentially be expanded to other hazards.

The Border Governors Conference (BGC) creates a venue for governors of federal states in Mexico and the United States located along the shared border, to discuss transboundary issues such as migration and drug trafficking. In 2007, it created a specific work programme to plan for cross-border natural disasters, and proposed a five-year Joint Strategic Emergency Response Plan, with the possibility of establishing memoranda of understanding for mutual assistance in case of emergencies (Good Neighbor Environmental Board, 2008). The heads of civil protection authorities at state and municipal levels also liaise through the BP2020 meetings; 14 "sister cities"[4] agreements have been established in this context (Figure 7.3). In addition, four regional working groups have been formed to address common environmental concerns. These groups were created during the development of the BP2012 and include representatives from bi-national organisations, NGOs and the academic and private sectors (US EPA, 2012). Such multi-level activities have facilitated the implementation of joint emergency response planning, training and cross-border drills, and have helped to strengthen co-operation between bordering local governments.

SINAPROC co-operates with two major United States federal agencies in the fields of emergency response and disaster prevention: the Federal Emergency Management Agency (FEMA) and the United States Agency for International Development (USAID). FEMA co-operation with Mexico is mainly focused on providing support and training to federal and local authorities. In Puerto Vallarta, guidelines and report templates from FEMA's Incident Command System management are used to set up a crisis communications centre. USAID supports disaster risk reduction programmes in Mexico and has developed a Latin America Disaster Risk Reduction Plan for 2012-14. This plan notably aims at strengthening early warning systems, increasing the capacities for disaster risk reduction in urban settings, developing technical assistance and conducting trainings. Workshops such as the Seismology Workshop (2011) are organised with experts from

Central America, Mexico and the United States to foster the dissemination of research. The Regional Disaster Assistance Program provides technical assistance and trainings in Latin America. Mexico receives USAID funding for disaster preparedness, emergency response and management programmes, as well as USAID emergency response support. In 2007 and 2010, USAID provided Mexico relief funds and emergency supplies in the wake of hurricanes and floods. The Mexican federal government plays an important co-ordination and communication role in the emergency response for important cross-border natural events, such as hurricanes.

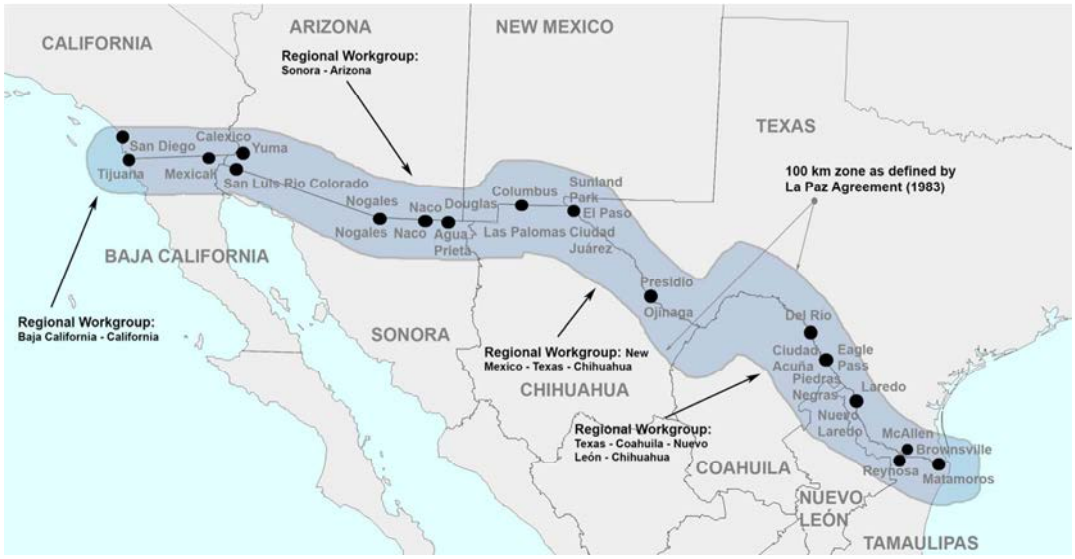
Figure 7.2. **IBP Institutional notification procedures**



Notes: CENACOM – National Communications Center (SEGOB); COATEA – Center for the Orientation of Emergencies (PROFEPA); EOC – Emergency Operations Center; ISJRT – Incident-Specific Joint Response Team; JRT – Joint Response Team (Co-chairs: Mexico PROFEPA, Civil Protection and US EPA); OEM – Office of Emergency Management; PROFEPA – Federal Attorney for Environmental Protection.

Source: US EPA (2009), Mexico-United States Joint Contingency Plan, Preparedness for and Response to Emergencies and Contingencies Associated with Chemical Hazardous Substances in the Inland Border, US EPA, Washington, DC, *www.epa.gov/oem/docs/chem/ipmjcp-e.pdf.*

Figure 7.3. **Mexico-US sister cities and regional groups**



Notes: Sister cities (Mexico-United States): Tijuana-San Diego, Mexicali-Calexico, San Luis-Yuma, Nogales-Nogales, Naco-Naco, Agua Prieta-Douglas, Puerto Palomas-Columbus, Ciudad Juarez-El Paso, Ojinaga-Presidio, Ciudad Acuña-Del Río, Piedras Negras-Eagle Pass, Nuevo Laredo-Laredo, Reynosa-McAllen, Matamoros-Brownsville.

Source: Based on information from the United States Environmental Protection Agency (EPA); *www2.epa.gov/border2020.*

While international agreements and joint co-operation mechanisms related to risk management have been established between Mexico and the United States, both at the federal and local levels, cross-border co-operation has not been developed to its full potential. A strong emphasis is placed on chemical hazards but does not encompass a wider all-hazard approach. Common threats such as earthquakes on the western side of the border and hurricanes on its eastern side are not addressed. Strengthening this co-operation could lead to greater efficiency for both countries, and could address the harmonisation of monitoring and warning systems and evacuation orders for hurricanes (as conflicting information across the border could lead to confusion) and the development of common emergency and evacuation plans, which could include specific procedures to cross the border. During Hurricane Alex in 2010, the United States agreed to ease the entrance of citizens and food supplies across the border in order to by-pass the affected areas in Mexico and to more quickly reach their final destination in Mexico.

Cross-border co-operation with Belize and Guatemala

International co-operation in civil protection between Mexico and its southern neighbours, Belize and Guatemala, likewise requires additional attention and resources. Natural hazards have occurred across the southern borders that have led to emergencies inside Mexico, especially in Tabasco and Chiapas, where local and state civil protection authorities recognise the need to step-up co-operation with their counterparts across the border. During the 20th century, 5 earthquakes with a magnitude above 7.0 occurred within 150 kilometres of Mexico's southern borders. Mexico's territory is also situated downstream from these countries in several cross-border watersheds that have produced disastrous floods. This includes the Río Usumacinta flowing from Guatemala, which

contributed to the catastrophic floods in Tabasco in 2007. International boundary and water commissions (IBWC) have been established with both Belize (in 1993) and Guatemala (in 1961) (Box 7.1). The IBWC/Belize is in charge of monitoring Río Hondo water levels and for managing three bi-national hydro-climate stations. Real-time monitoring of water levels and data exchange between the countries, however, still lacks the desired technical capacities.

The threat of earthquakes and floods in the Guatemala border area calls for enhanced bi-lateral co-operation. While the 1988 Treaty for Co-operation on Natural Disasters Prevention and Response provides a basic agreement and establishes a bi-national advisory committee, there is a lack of formalised joint planning, training and procedures for emergency response at the local level. This might be addressed by strengthening the participation of state civil protection officials from Tabasco and Chiapas who have demonstrated capacity to consult Guatemala's civil protection authorities.

Chiapas created the Ministry for the Development of the South Border and International Co-operation to develop joint projects with border cities in Guatemala similar in principle to the "sister cities" scheme found in the northern states. The civil protection service of Chiapas has also established co-ordination channels with the Co-ordinator for Disaster Reduction in the Republic of Guatemala (*Coordinadora Nacional para la Reducción de Desastres*, CONRED) and with the Co-ordination Center for Natural Disaster Prevention in Central America (*Centro de Coordinación para la Prevención de los Desastres Naturales en América Central,* CEPREDENAC) to facilitate technological and strategic exchanges.

International co-operation in crisis management

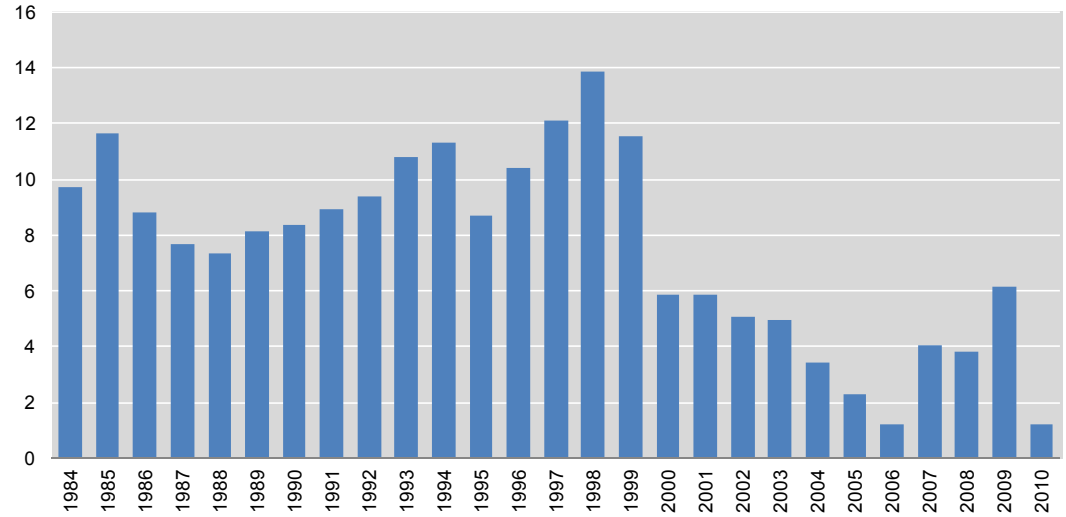
In the event of a large-scale disaster, worldwide media attention often triggers offers for humanitarian assistance from a multitude of stakeholders: international humanitarian organisations, national development agencies and emergency responders, NGOs, private companies and even citizens. Organising and managing this wave of goodwill during times of crisis requires a clear framework to ensure resources are used efficiently, and to avoid diversion of resources from the national civil protection system.

Provision of international humanitarian support to Mexico

As a key stakeholder within SINAPROC, the Ministry of Foreign Affairs manages offers of humanitarian assistance in co-ordination with the General Co-ordination for Civil Protection (CGPC) of the Ministry of the Interior. The federal government can call for international humanitarian assistance through the President when emergency response capacities are insufficient to manage a major disaster. While many offers of assistance have been made since the 1985 Michoacán earthquake, Mexico has not requested any through this mechanism. Figure 7.4 shows that beginning in 2000, there has been a sharp decrease in humanitarian assistance provided to Mexico. While disaster damages continue to increase, Mexico has enjoyed consistent economic growth for over 20 years and is perceived to be less suitable as a recipient of humanitarian assistance than it was in the past. Canada, France, Germany, Spain and the United States continue to provide bilateral assistance, but a sign of change was apparent in 2002 when Mexico was removed from the European Union's list of beneficiaries, which is the largest provider of humanitarian assistance worldwide.

Figure 7.4. **Humanitarian assistance to Mexico (1984-2010)**

Million USD



Source: *OECD Stats database*, *http://stats.oecd.org*, consulted in September 2012.

Once the SRE receives offers for international assistance, the decision to accept it and to direct it is made in co-ordination with the CGPC. The SRE also has a role to co-ordinate internally with other Mexican ministries and agencies to obtain the most efficient and simple emergency response. The *Organization and Operations Manual of the National Civil Protection System* articulates the various roles of each ministry and agency in the co-ordination of humanitarian support under the leadership of the SRE (Table 7.2). In particular, specific mechanisms have been established to ease customs formalities for humanitarian support.

When a major disaster hits Mexico, support may be offered from a broad variety of sources in addition to that coming from countries and international organisations for which the SRE is responsible. For instance, after major flooding in Tabasco in 2007, bilateral aid came from Australia, Belgium, Cuba, Germany, Ireland, Italy, Peru, Spain and the United States, among others, but also from major private companies such as Wal-Mart, football clubs such as Real Madrid, Red Cross organisations from many countries, and more widely from individuals. In fact, significant donations and material resources came from Mexico's large diaspora in Canada, Spain and the United States. The SRE has developed procedures to open dedicated bank accounts abroad to collect financial support from these sources and channel it directly to identified and assessed needs.

NGOs and other volunteer groups also play an important role in emergency response; however, their involvement is often insufficiently co-ordinated with public authorities, which can lead to ineffective use of the resources provided. For example, during the 2007 floods in Tabasco, NGOs were already active in the area while the federal government was still trying to manage international aid offers, which resulted in costly co-ordination difficulties. Consequently, the federal government developed guidelines for co-operation with international NGOs inspired by the Red Cross Guidelines for International Aid Management. The DGPC is developing a Directory of First Responders in order to increase its management capacity to mobilise the most capable and qualified

organisations. This directory is not limited to international NGOs, and includes national volunteers and private institutions. At the state level, Tabasco put in place institutional measures to better co-ordinate the disparate initiatives of various sources of assistance, including a specific Commission for Humanitarian Aid to manage NGO and international aid. A total of 13 commissions have been created for specific areas related to emergency response. These commissions are headed by a state ministry which provides leadership to other ministries that may be related to the area.

Table 7.2. **Co-operation activities promoted by the SRE for international support**

Ministries co-operating with the SRE	Activities related to international co-operation emergency response
Ministry of Finance (SHCP), Administrative Service of Taxes (SAT), Mexican Customs	Gathering of supplies according to the Law of Customs and the needs estimated by SEGOB
Ministry of Economy (SE)	Authorisation of food and goods imports according to the Law of Foreign Trade
Ministry of Health (MH)	Emission of sanitary permits for the entry of medicines and medical staff
Ministry of Agriculture, Livestock, Rural Development and Food (SAGARPA)	Phyto-sanitary permits for the import of agricultural supplies, search and rescue animals and food which requires authorisations
Ministry of Communications and Transport (SCT) and Ministry of National Defence (SEDENA)	Circulation permits for foreign cargo or emergency vehicles that transport hazardous materials
Ministry of National Defence (SEDENA)	Flying and landing permissions for aircrafts – in co-ordination with the General Directorate of the Protocol of the SRE
Ministry of Navy (SEMAR)	Authorisation for foreign ships to navigate in Mexican territorial waters
National Institute of Migration (INAMI)	Authorisations for the entry of international experts
Ministry of Public Education (SEP)	Authorisation for the works of specialists who come to Mexico to provide support as doctors, nurses, rescue teams, construction engineers, among others
Ministry of Social Development (SEDESOL)	Co-ordination for the storage and distribution of international aid

Source: SEGOB (2006), Organization and Operations Manual of the National Civil Protection System, *Diario Oficial de la Federaión*, Mexico D.F.

Mexico as a provider of international humanitarian support

As civil protection capacities have developed since 1985, Mexico has increased its capacity to export know-how and material assistance as an emergent donor of international humanitarian support. In 2011 it joined the Good Humanitarian Donorship initiative (GHD) and committed to follow its guidelines, which involves following recognised practices when providing in-kind contributions, technical co-operation and emergency response aid in case of a disaster. The SRE manages these activities in co-ordination with SINAPROC stakeholders such as the Mexican National Centre for Prevention of Disasters (*Centro Nacional para la Prevención de Desastres*, CENAPRED), the Ministry of National Defense (*Secretaría de la Defensa Nacional*, SEDENA) and the Ministry of Navy (*Secretaría de Marina*, SEMAR). CENAPRED provides "seed co-operation" to help affected countries build their own capabilities and address their specific civil protection needs. It also developed tools for earthquake-resistant construction in Haiti after the 2011 earthquake. The experience acquired by SEDENA, SEMAR and other civil protection stakeholders during international co-operation activities is collected by DGCP and used to improve internal manuals of procedures at domestic level, thereby strengthening emergency response capabilities in Mexico. At the local level, municipalities have also provided assistance, for example the municipality of Motozintla in Chiapas, which in times of emergency

informally allows displaced Guatemalan populations to stay in temporary shelters in Mexican territory.

Table 7.3. **International humanitarian assistance by Mexico (2004-2010)**

Year	Institution	Country	Event
2004	SEMAR	Indonesia	Tsunami
2005	SEMAR	United States	Hurricane Katrina
2007	SEDENA	Bolivia	Heavy rain
2007	SEDENA	Peru	Earthquake
2007	SEDENA	Nicaragua	Hurrican Dean
2007	SEMAR	Nicaragua	Hurrican Felix
2007	SEDENA	El Salvador	Hurrican Felix
2009	SEDENA	El Salvador	Heavy rain
2008	SEMAR	Belize	Tropical storm Arthur
2008	SEDENA	Ecaudor	Heavy rain
2008	SEMAR	Cuba	Hurricane Gustav
2009	SEMAR	Haiti	Hurricane Ike
2009	SEMAR	Guatemala	Forest fire
2010	SEDENA	Haiti	Earthquake
2010	SEDENA	Chile	Earthquake
2010	SEDENA	Venezuela	Heavy rain
2010	SEMAR	Guatemala	Tropical storm Agatha
2010	SEDENA	Colombia	Heavy rain

Source: Based on information provided by SEDENA and SEMAR.

International and bilateral co-operation in disaster risk management

Many countries in the last decades, including Mexico, have recognised the importance of shifting their disaster risk management strategy from a focus on emergency response and recovery toward a more holistic approach with greater emphasis on risk prevention and risk reduction. In parallel, international donors and United Nations agencies with a role in disaster risk management have moved from a traditional humanitarian and emergency support view to the promotion of disaster risk reduction through technical co-operation. Mexico has actively promoted the Hyogo Framework for Action since its adoption by 168 member countries of the United Nations in 2005 at the World Disaster Reduction Conference held in Kobe, Japan. In the same vein, as Mexico has gradually become more of a provider than a recipient of humanitarian aid, it is strengthening its technical assistance to different countries in the field of civil protection.

The role of international co-operation in support of SINAPROC's development

International co-operation has played a major role in the development of SINAPROC's capacities. The Japanese International Co-operation Agency (JICA) provided financial resources for the construction of CENAPRED facilities and its development of joint training programmes between Mexican and Japanese scientists and engineers. This co-operation has been instrumental in strengthening the disaster risk prevention approach in Mexico as well as in fostering a better understanding of risk exposure and vulnerabilities to natural hazards. Mexico's Disaster Reconstruction Fund

(FONDEN) received technical assistance from the World Bank to issue its first catastrophic bond in 2006 and utilised the World Bank Multi-Cat Programme for the issuance of its Multi-Cat bond in 2009.

International co-operation was recognised in the 1995-2000 National Programme of Civil Protection as an important means for developing the capabilities of the country. It is still considered as such today, as Mexico continues to develop its capacities through technical co-operation. For the modernisation plan of the National Meteorological Service (*Servicio Meteorológico Nacional*, SMN), Mexico partnered with the World Meteorological Organisation to carry out a performance assessment of its weather monitoring activities, and produced a ten-year strategic plan for its modernisation, with a clear focus on disaster risk management. This assessment was financed by Spanish and Finnish co-operation agencies and led to a World Bank loan of USD 100 million for its implementation.

From a beneficiary of international assistance to a partner

Mexico makes active use of its membership in several international organisations both to spread its recognised good practices in the realm of civil protection and to refine its concepts of integrated risk management. Through the United Nations, Mexico was an active player in the International Decade for Natural Disaster Reduction and participated actively in the development of the Hyogo Framework for Action in 2005; the Safe Cities are Resistant to Disasters and Safe Hospital programmes (see Chapter 4) are examples of how Mexico implements the United Nations International Strategy for Disaster Reduction (UNISDR) initiatives.

Several states view collaboration with the UNISDR as helpful to align local policies and actions to the broader international vision for disaster risk reduction. The state of Chiapas reflects UNISDR views in its policy to assess how foreign investment projects may contribute to greater vulnerability to disasters; it also evaluates whether foreign investment will improve its Human Development Index, which has steadily improved in recent years. In the Federal District, the civil protection service implemented the UNISDR World Disaster Reduction Campaign on Making Cities Resilient (UNISDR, 2010). Likewise, several programmes with the UNDP have helped to increase local awareness of major hazards and to build operational capacities on the ground. For example, UNDP has run the Disaster Risk Management Programme in the south-east region of Mexico (DRMP) since 2002, which carries out activities in the states of Campeche, Chiapas, Oaxaca, Puebla, Quintana Roo, Tabasco and Yucatán. This technical assistance programme, which is principally financed by the Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL), works in 185 municipalities in the region to strengthen local and institutional capabilities for disaster prevention, preparedness, response and recovery (UNDP, 2012).

Collaborative scientific research related to disaster risk management with technical institutions in various countries has fostered progress in the gathering of data and methodologies for analysing that data. CENAPRED co-operated closely with the Economic Commission for Latin America and the Caribbean (ECLAC), to develop a methodology for annual assessment of the socio-economic impacts of the main disasters in Mexico. It has developed technical co-operation activities with the United States Geological Survey (USGS) related to seismic and volcanic monitoring. At the same time, the centre is involved in international committees and initiatives such as the International Platform for the Reduction of Earthquake Disasters (UNESCO-IPRED) and the

United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). The National Seismological Service also co-operates with institutions such as the Incorporated Research Institutions for Seismology (IRIS), USGS and the Pacific Tsunami Warning Center (PTWC). The Ministry of Navy co-operates with the United States National Oceanic and Atmospheric Administration (NOAA) to improve its technical capabilities for oceanographic monitoring, which aids in early warning capacities for tropical cyclones.

Mexico is a major promoter of disaster risk management at the international level. As a highly exposed country, it has credibility in pro-actively engaging partnerships to foster policy co-operation at the national and local level. Mexico has increasingly taken an active role to promote disaster risk management activities at the international level, and ensures that these also feed into the domestic policy agenda. For example, it included principles of the United Nations International Decade for Natural Disaster Reduction 1990-99 into its National Civil Protection Program 1990-94. The organisation of the 2010 United Nations Climate Change Conference in Cancun benefited from this dynamic, where the creation of a Green Fund for the financing of climate change adaptation in the most vulnerable countries is set to significantly change the conditions for investment in disaster risk reduction in the years to come. The SRE and the General Directorate of Global Subjects (*Dirección General para Temas Globales*, GDGS) are active promoters of these initiatives. More recently, Mexico was instrumental in promoting disaster risk management in the context of its G20 Presidency in 2012, with a focus on disaster risk assessment and risk-financing strategies.

Transition from beneficiary of international assistance to donor

Mexico's role as a major international promoter of disaster risk management is further reflected in the development co-operation that it engages in with different countries. While SINAPROC has used international co-operation to strengthen many capacities throughout its system, its components also support the development of civil protection capacities in different countries. Institutional developments in Mexico, such as the creation of AMEXCID (established in 2011), will further enable Mexico to foster, co-ordinate and evaluate its international co-operation activities as an emerging leader in south-south co-operation.

In terms of reversing roles and acting as a donor of technical assistance, SINAPROC stakeholders have focused their efforts for international co-operation in regions where they can be the most effective. Due to fewer cultural and linguistic barriers, most collaboration is centred on Central America. The National Meteorological Service, for example, intends to develop a regional weather monitoring and forecasting centre for its southern region based in Chiapas, which will also monitor the weather conditions throughout Central America. The Mesoamerica Project (MP), created in 2007, is a regional initiative between Mexico, Belize, Colombia, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua and Panama for collaboration in regional integration and economic and social development. A specific work area under this project is devoted to disaster prevention and mitigation. CENAPRED performs an advisory and technical support role for two major programmes in this area: the Mesoamerican System of Territorial Information (*Sistema Mesoamericano de Información Territorial*, MSTI) and the project for the Management of Financing for Disaster Risks. Similarly, FONDEN provides technical support to Latin American countries in the area disaster risk financing.

CENAPRED also exports its technical and scientific know-how in collaboration with the Japan International Co-operation Agency to support countries through the Training Program for Third-party Countries, an international course on earthquake-resistant infrastructure design and construction. In 2007, it launched a new stage of co-operation focusing on civil protection and disaster prevention, involving countries from Central America, South America and the Caribbean. In recent years, CENAPRED has provided technical support to countries such as Colombia (2008) for disaster prevention and management, and to El Salvador in the context of the TAISHIN project focusing on the improvement of technology used for earthquake-resistant social housing (2008-2012).

Conclusion

Mexico has actively engaged in bilateral and international co-operation initiatives in the field of civil protection. It has formalised a number of working agreements with the United States, notably in the management of shared water courses, and in the context of emergency preparedness, in particular emergencies involving chemical hazardous substances and pollution events in coastal waters. Along its southern borders, international co-operation is also required to effectively manage the effects of earthquakes and floods. While some co-operation agreements are in place for flood monitoring, they are less developed than in the north. Additional support is required to enhance emergency response capacities such as joint planning, training and standardised procedures Finally, co-ordination with foreign non-governmental organisations could be further developed to ensure resource efficiency, particularly during large-scale emergency responses.

Mexico is also starting to leverage its capacities for civil protection to engage further in international co-operation. The creation of the Mexican Agency for International Co-operation and Development offers a number of opportunities to further south-south co-operation.

Recommendations

- Foster the establishment of bi-national or regional co-operation agreements along the south borders with Belize and Guatemala to formalise emergency response co-operation and establish well-defined protocols, procedures and roles.
- Further develop partnerships between the co-operation agency AMEXCID and SINAPROC stakeholders to share international good practices and develop capacity-building programmes with other countries focused not only on risk management, but also on knowledge sharing.
- Clarify the regulatory framework for NGOs delivering humanitarian assistance.

Notes

1. Mexico's Law for the Conclusion of Treaties distinguishes between "international agreements" and "inter-institutional agreements". States and municipalities are not competent to conclude international agreements (as this power is reserved for the President); however, they may enter into inter-institutional agreements with international organisations and agencies of foreign governments. This practice does not require the approval of the Senate, which is one of the main differences with international treaties concluded by the federal government.
2. In 1944, the Treaty for the Utilization of Waters of the Colorado and Tijuana Rivers and of the Río Grande expanded its responsibilities and modified its name to International Boundary and Water Commission.
3. BP2012 Goal 5 also includes acts of terrorism at the border. However, the DGPC is not involved in these issues as this is a matter of public security and is not a responsibility of civil protection.
4. The definition of "border region" provided by the La Paz Agreement led to developing the concept of "sister cities". Ninety percent of the 11.8 million people of the border area resides in 14 paired sister cities. These cities are linked not only by environmental issues or natural events, such as earthquakes in the California-Baja California border or floods in the Arizona/Sonora and Texas/Chihuahua borders, but also by economic or social issues: the rapid population growth of the border is leading to a rapid spread of urban areas, land-use changes and low-income dwellings with no insurance or civil protection culture.

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Annex A

States and municipalities interviewed during the peer review

Figure A.1. **Map of Mexico**

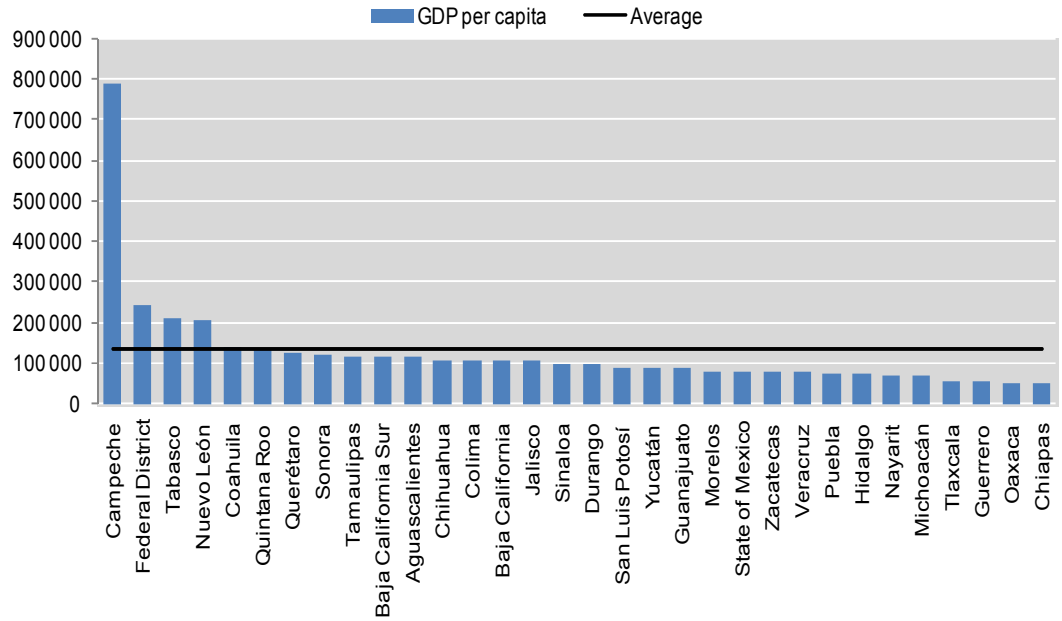
Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Federal District

The Federal District is Mexico's economic centre, contributing a higher share of GDP (about 17.16%) than any federal state. With a population of approximately 8 million people, and 20 million people in the greater metropolitan area, its population density is among the highest in the world (8 400 inhabitants/km²). The demographic and geological characteristics of the nation's capital make it one of the areas with the highest seismic risks in the world. Its soil consists of highly compressed lacustrine clay, interspersed with layers of sand, which amplifies seismic hazards. It is also located in a closed basin, making it susceptible to flooding.

Figure A.2. **Annual GDP per capita by state (2010)**

MXN, current prices



Source: INEGI.

State of Colima

Colima is located on Mexico's Pacific coast, and is part of the West-Center civil protection region comprising nine federal states. Its main exposure is to earthquakes, volcanic eruptions and hurricanes. With a population of just 650 000, it is among the least populated of Mexico's federal states. Recent natural hazards have led to significant damages, including a magnitude 7.6 earthquake in 2003 that destroyed 2 005 houses and damaged an additional 6 615, which resulted in over 10 000 people homeless. A 1959 hurricane led to approximately 2 000 fatalities; however, there were much fewer deaths when Hurricane Joba hit in 2000, with only 2 lives lost, perhaps due to the strong focus recently on civil protection activities.

State of Chiapas

Chiapas is located in the south-east region of Mexico and has a population over 4 million. Its territory includes 260 kilometres of coasts with 2 135 localities no more than 30 meters above sea level, exposing more than 245 000 people to coastal floods. These areas are also exposed to a high level of seismic hazard. Its recent Civil Protection Law (2011) is highly aligned with national policies on disaster and risk prevention. Chiapas put in place the State Procedure for Rain Alert (PROCEDA) based on a colour-coded warning system for rainstorms. Chiapas has its own catastrophe insurance policy to cover damages to roads, water infrastructure and public housing. Through its "Civil Protection Prevention Program" (PP5), Chiapas has made dedicated efforts to transfer civil protection knowledge to the population, strengthen self-protection measures and raise the population's risk awareness. Among the civil protection challenges facing the state of Chipas is its highly dispersed rural, indigenous population (20 047 inhabited

areas within the state, 12 838 of which have a population less than 50), which have been unable to sustain local civil protection capacity.

State of Coahuila

In recent years, Coahuila has been affected by natural hazards such as forest fires, frosts, extreme rainfall, drought and floods, among others. This complexity has led to the declaration of emergencies and disasters in virtually all of its municipalities. For instance, in 2010, as a result of the rains produced by Hurricane Alex, 32 of the state's 38 municipalities were declared as disaster areas by the Fund for Natural Disasters (FONDEN). Coahuila's government is trying to improve its civil protection capacities within the framework of its Special Programme of Civil Protection 2011-17, establishing strategic objectives and specific action lines for the years to come.

State of Jalisco

The state of Jalisco is one of the most populated states in the country, with over 7 million people as of 2010. After the Federal District, the state of Mexico and the state of Nuevo León, it contributes the most to Mexico's GDP. Located on the Pacific coast of Mexico, it is a member of the West-Center civil protection region and is in charge of regional co-ordination. The state is exposed to natural hazards such as earthquakes, hurricanes and tsunamis. In order to improve its internal co-ordination, the state has divided its territory into seven regions, similar to the practice at the national level. Jalisco has focused on strengthening land-use regulations to improve risk management at the local level. Specific actions to improve targeted capacities include the System of Massive Alert for Tsunamis and Tropical Cyclones, and the establishment of a local fund for civil protection services. It has carried out massive drills to prepare for tsunami alerts, with the participation of tourist hotels.

State of Mexico

The State of Mexico is the regional co-ordinator for the Central civil protection region. The state surrounds the northern, western and eastern borders of the Federal District, comprising part of the metropolitan area of Mexico City. It is one of the most densely populated areas in the country, with an estimated increase of 1 000 habitants per day – mostly due to internal migration from other states. Urban sprawl and the development of illegal settlements in zones prone to flood hazard have increased along with the growth of its population.

State of Nuevo León

The state of Nuevo León is located in the north of Mexico, sharing a 19-kilometre border with the United States. It contributes 7.5% of Mexico's GDP, the third highest in the country, and its capital, Monterrey, is one of the most industrialised cities in Mexico. The metropolitan area includes 12 municipalities, with a total population over 4 million. Although seismic risk in Nuevo León is low, hurricanes and floods have caused significant damages to its infrastructure. In 2010, Hurricane Alex led to damages in excess of USD 2 billion. The state faces challenges related to land use and illegal dwellings in some municipalities; however, major infrastructure projects are underway to

reduce the impact of future floods, such as deepening the dried river bed that runs through the centre of the city.

State of Tabasco

With a population over 2 million and 17 municipalities, the state of Tabasco contributes 3.7% of the national GDP. Its principal geographic features are plains, with 92.5% of the territory no more than 30 meters above sea level. This south-eastern state includes coastal areas on the Gulf of Mexico and a border with Guatemala. Two rivers converge in its territory: the Grijalva and Usumacinta, which make up 27% of Mexico's hydrological resources. These characteristics increase its exposure to floods; damages over the past six years have been in excess of MXN 45 billion. In 2007, heavy rains caused the overflow of the Grijalva river basin, flooding about 80% of Tabasco's territory. The event affected over 1 million people. As a consequence of this disaster, the state government implemented the High Risk Areas Relocation Programme, relocating 2 840 houses and businesses previously situated in high flood risk areas. The 2007 flood pushed the state to take a proactive stance on civil protection activities, developing programmes and plans to reduce physical vulnerability and improve its hydraulic infrastructure.

State of Tamaulipas

Located in the north of Mexico, Tamaulipas is one of six Mexican states sharing a border with the United States. Its coastal region on the Gulf of Mexico is highly exposed to hurricanes and tropical cyclones. In 1967, tropical cyclone Beulah, a category 5 hurricane, hit three municipalities. Hurricanes Keith (2000) and Alex (2010) caused damages to 19 municipalities. According to the National Oceanic and Atmospheric Administration (NOAA), 67 tropical cyclones occurred in Tamaulipas between 1854 and 2011. These coastal meteorological phenomena produce significant floods, as do heavy rain falls. Seismic activity is relatively mild, and from 1983 to 2011 there were only 11 earthquakes recorded, each with magnitudes less than 4.8. As observed in other states, population increase, land use and illegal dwellings represent some of the state's challenges related to civil protection.

Table A.1. **Municipalities interviewed**

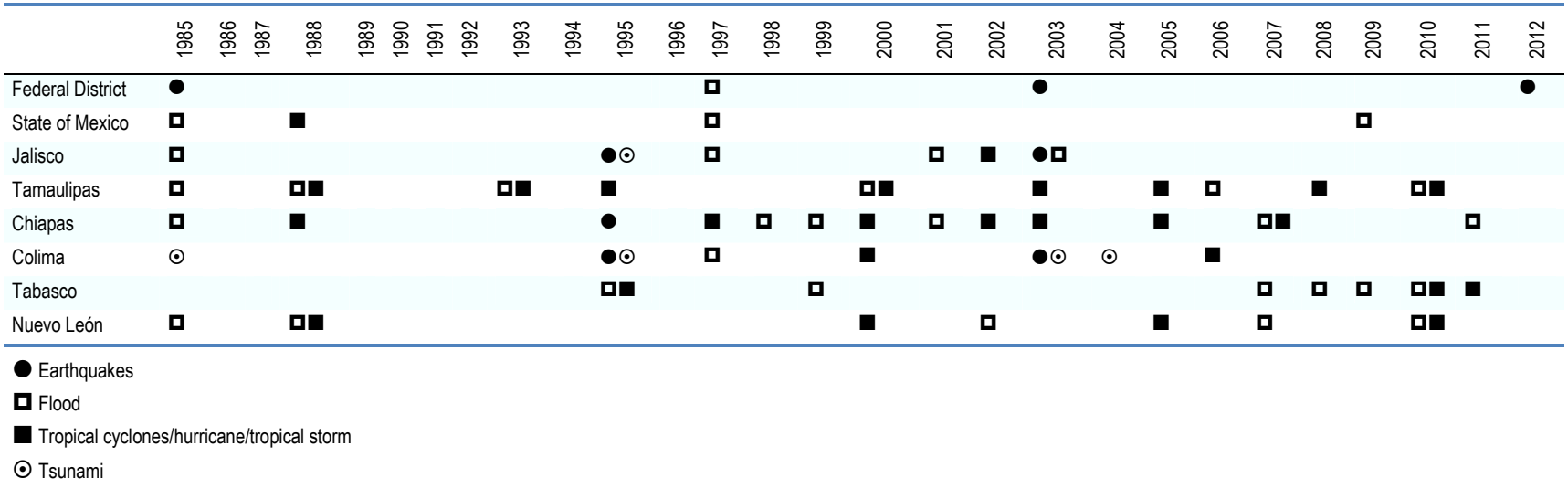
Municipality	State	Population[1]	Population density (inhabitants/km²)	GDP (USD)[2]	GDP per capita (USD)[2]	Human Development Index[3]	Main risks
Cuauhtemoc	Federal District	531 831	16 415	8 072.17	15 636.02	0.8671	Earthquakes and floods
Guadalajara	Jalisco	1 495 182	2 578	14 170.63	8 607.46	0.8258	Floods and hurricanes
Monterrey	Nuevo León	1 135 512	2 099	17 054.06	15 350.23	0.8486	Floods and hurricanes
Motozintla	Chiapas	69 119	88	195.73	3 269.00	0.6985	Floods, rainfall, hurricanes
Nezahualcoyotl	State of Mexico	1 110 565	17 506	N/A	7 373.42	0.8149	Floods and eathquakes
Puerto Vallarta	Jalisco	255 681	373	16 213.39	8 776.90	0.8111	Floods, hurricanes,
Tampico	Tamaulipas	297 554	4 369	2 622.06	8 875.06	0.8202	Floods and hurricanes
Tuxtla Gutierrez	Chiapas	553 374	1 342	3 808.98	8 773.56	0.8159	Flood, rainfall, hurricanes

Notes: 1. Population data for 2010. Information does not include population related to metropolitan areas. INEGI, 2010 Census of Population and Housing. 2. Data for 2000. Data calculated by UNDP. Calculations based on INEGI. XII General Census of Population and Housing, 2000 and National Household Income and Expenditure Survey, 2000. 3. UNDP Data for 2000. N/A: Not available.

Sources: INEGI, National Commission of Population (CONAPO), U.S. Geological Survey, Mexican Senate (Commission for Hydraulic Matters), information gathered from meetings held during peer review missions.

Annex B

Major disruptive events by state



Notes: 1985: Michoacán earthquake (7.8); 1988: Hurricane Gilbert; 1995: Colima earthquake (8.0); 1995: Hurricane Roxanne; 1997: Hurricane Paulina; 2000: Hurricanes Keith and Norman; 2002: Hurricane Kenna; 2003: Colima earthquake (7.6); 2005: Hurricanes Emily and Stan; 2006: Hurricane Lane; 2007: Hurricane Dean; 2008: Hurricane Dolly; 2010: Hurricane Alex; 2012: Guerrero earthquake (7.4). * Main events only related to states visited during the OECD peer review missions.

Source: Data obtained from CENAPRED, "Series Fasciculos"; "Characteristics and Socio-Economical Impact of the Main Disasters Occurred in Mexico"

Annex C

Key federal laws related to civil protection

Federal law	Main provisions
Mexican Constitution (DOF, 1917)	The Mexican Political Constitution (DOF, 1917) grants regulatory powers for civil protection matters to the Congress and the Legislative Assembly of the Federal District. By law, the Mexican Congress has the right to issue regulations in order to set co-ordination bases on civil protection between the federal government, the states, the Federal District and municipalities (Article 73.29-I). Article 122 grants the Legislative Assembly of the Federal District the power to legislate on the subject within its territory as well as on land use. The law also mentions that municipalities are entitled to design, approve and manage municipal urban development micro-zoning and plans; authorise, control and supervise land use; and grant licences and authorisations for buildings (Article 115.V).
General Law of Population (GLP) (DOF, 1974)	Article 3 requires the Ministry of the Interior to create, implement and promote among the governmental bodies, activities focused on co-ordinating emergency response actions between the three levels of government and the private sector in the case of a risk of disaster or an actual disaster.
General Law of Ecological Equilibrium and Environmental Protection (GLEEEP) (DOF, 1988)	The GLEEEP creates faculties to the federal government, the states and the municipalities. The federal government has the power to be involved in preventive and managerial activities related to emergency response based on existent policies and programmes (Article 5). At the same time, it grants the same attribution to the states and the municipalities (Articles 7 and 8), but only related to emergency response activities. It also establishes a co-ordination basis between the federal ministries and the states with the Ministry of Environment and Natural Resources (SEMARNAT) in the risk of environmental damage caused by natural phenomena (Article 14). Section IV is devoted to human settlements, with a specific mandate (Article 23.X) establishing the responsibility of federal, state and municipal authorities to avoid human settlements in risk areas.
General Law for the Prevention and Integral Management of Waste (GLW) (DOF, 2003)	The GLW regulates the provisions of the Mexican Constitution which are related to the protection of the environment in terms of prevention and integral management of waste. It aims at ensuring the population's right to an adequate environment and sustainable development through the prevention and the integral management of dangerous waste. It also provides for co-ordination mechanisms among the federation, the states and the municipalities (Article 1) and mentions principles such as assessment of environmental risks (Article 5.VII) and integral management of waste (Article 5.X). The federation is responsible for establishing and operating, in the frame of the National Civil Protection System (SINAPROC), in co-ordination with states and municipalities, the system for the prevention and control of environmental contingencies and emergencies related to waste management (Article 7.XIII).
Organic Law of the Federal Public Administration (OLFPA) (DOF, 1976)	The OLFPA set a managerial obligation to the Ministry of the Interior related to the implementation of civil protection policies and programmes defined by the executive. This law integrates the concept of a National Civil Protection System together with prevention, recovering, population aid and support in case of disaster. By law, these activities should be concerted together with the private and social sector and the three levels of government on a co-ordinated basis (Article 27).
Law of Civil Responsibility for Nuclear Damages (LND) (DOF, 1974)	The LND aims at regulating civil responsibility for nuclear damages caused by nuclear reactors and the use of nuclear substances and waste (Article 1). In case of accident, the operator is held responsible for nuclear damage (Articles 4 and 5) except if nuclear accidents derive from external events (acts of war, invasion, insurrection or natural disasters) (Article 11). In case of a nuclear accident, the Ministry of the Interior co-ordinates the activities of federal, state and municipal public institutions and the private sector, for assistance, evacuation and safety measure activities in affected areas (Article 29).
Law of Responsibility of Public Servants (LRPS) (DOF 1982)	The LRPS provides for regulations related to the responsibility of civil servants, their obligations, sanctions and authorities responsible for the application of sanctions (Article 1). It lists offence that prejudice fundamental public interests and functioning among which attacks against democratic institutions and the republican government; gross and systemic violations of individual or social right; any breach of the Constitution or federal laws causing serious prejudice to the federation, one or more states; serious omissions and gross and systemic violations of plans, programmes, budgets of the Federal Disctric public administration (Article 7).

Federal law	Main provisions
Law of Planning (LP) (DOF, 1983)	The LP establishes co-ordination parameters for the three levels of government and the federal ministries for the creation of the National Plan of Development (NPD) and any other federal programmes – such as the National Program of Civil Protection (NPCP). This law emphasises the importance of the social consultation and social involvement for drafting, updating and implementing the NDP and the federal programmes.
Law of the Conclusion of Treaties (LCT) (DOF, 1992)	The LCT provides definitions regarding treaties, institutional agreements and the process of concluding treaties. It aims at regulating the conclusion of treaties and international inter-institutional agreements (Article 1). The material scope of inter-institutional agreements is limited to the specific competences of public administrations (Article 2.2). Treaties and inter-institutional agreements are registered by the Secretary of Foreign Relations (Articles 6 and 7).
Law of Foreign Trade (LFT) (DOF, 1993)	The LFT aims at regulating and promoting foreign trade, developing the competitiveness of the economy, encouraging the efficient use of the country's productive resources, integrating the Mexican economy to the international economy and contributing to improving the population's welfare (Article 1). It provides for general regulations of exports and for cases not provided for by the official Mexican norms regarding national safety, public health, plant, animal and ecology health (Article 15.VI); this also applies for exports, exchange and transit of goods (Article 16.VI).
Gederal Law of Transparency and Access to Governmental Public Information (LT) (DOF, 2002)	The LT ensures free access for all people to information possessed by the Union Powers, autonomous institutions, other federal entities (Article 1) and governmental information (Article 2) except confidential or secret information (Articles 7, 13 and 18). It aims at making public management transparent through the dissemination of (Article 4.II) and protection of personal data owned by the institutions (Article 4.III). The law notably provides for a comprehensive list of sanctions (Articles 63 and 64).

Source: Based on information provided by the Mexican Ministry of the Interior (SEGOB), March 2012.

Annex D

SINAPROC: Key federal ministries and organisations

Mexican Development Bank (BANOBRAS)	BANOBRAS is the Mexican Development Bank in charge of promoting and financing infrastructure projects and public services, mainly, through sub-national government lending and project finance. Among other activities, it also acts as trustee of the National Infrastructure Fund, the most important trust of the federal government related to infrastructure. The fund was created to increase national and international private investment in this sector. It also contributes to achieve the goals established in the National Infrastructure Program 2007-2012.
Mexican Petroleum (PEMEX)	Mexican Petroleum (PEMEX) is the state-owned company in charge of managing oil resources and it is one of the main sources of financial resources of the government. PEMEX is in charge of oil pipelines and refineries located on continental land and overseas. Its main objectives within SINAPROC are first to ensure safety within its facilities and continually review of its internal and external emergency plans. Just as CFE and CONAGUA, PEMEX has an early warning system for hurricanes. During an emergency, PEMEX works in co-ordination with its local representatives through a well-established chain of command ensuring a continuous supply of fuel for the continuity of economic activity.
Ministry of Agriculture, Livestock, Rural Development and Food (SAGARPA)	The Ministry of Agriculture, Livestock, Rural Development and Food (SAGARPA) is responsible for designing, leading and supervising the general policy of rural development. It fosters civil protection programmes for prevention, emergency and recovery and for assistance to rural populations in emergency situations. It encourages a culture of prevention with regard to natural phenomena that affect the productive activities of rural populations. It also co-operates in the implementation of prevention measures, notably with the Ministry of Environment and Natural Resources for the construction of small irrigation works, the maintenance of channels and the conservation of agriculture soils. It integrates and manages the Fund for the Attention of Population affected by Climate Contingencies (FAPRACC) and co-ordinates with state and municipal authorities for emergency response. Finally, it conducts damage assessments in zones of agricultural production and ensures that no affected states or municipalities are overlooked in the application process for federal disaster assistance.
Ministry of Communications and Transport (SCT)	The Ministry of Communications and Transport (SCT) is responsible for ensuring and providing the necessary infrastructure for communication services and transport within Mexico's national territory. It conducts training programmes for internal civil protection brigades, performs risk and vulnerability assessments, implements mitigation activities, drafts initial reconstruction plans for recovery, etc. It is responsible for assuring the operability of the communication and transport infrastructure such as highways, airports and ports to guarantee vertical and horizontal co-ordination and communication between the government and population.
Ministry of Environment (SEMARNAT)	The Ministry of Environment and Natural Resources (SEMARNAT) protects, maintains and ensures the conservation of Mexico's environment. It considers prevention as crucial for civil protection activities. This preventive approach is enforced through the implementation of land-use planning policies across the Mexican territory. However, this attribution is limited to federal territory (such as coasts) which is not managed by local governments. SEMARNAT is attributed regulatory enforcement powers allowing it to apply fines or other penalties in case of non-compliance of land-use policies and regulations. It can co-ordinate with local governments for local land-use regulation drafting not managed by the federal government.
Ministry of Finance (SHCP)	The Ministry of Finance (SHCP) is in charge of managing the Mexican federal government's economic policies, finances, taxes, budget, income and public debt, producing statistics and other information on these subjects. Its role within SINAPROC is based primarily on the management and authorisation of resource allocation, first, to FOPREDEN for the implementation of preventive actions and programmes, and second, resource allocation to the states through FONDEN for disaster management and recovery. Similarly, it encourages the use of risk transfer instruments in order to protect the financial resources of the prevention and disaster control mechanisms.
Ministry of Foreign Affairs (SRE)	The Ministry of Foreign Affairs (SRE) is in charge of managing international co-operation activities related to the national civil protection system. Its responsibilities include contacting diplomatic representations, embassies and consulates in the country to report information updates about emergency situations, requesting and managing international assistance, among other activities, in co-ordination with the Ministry of the Interior. Furthermore, through the Mexican Agency for International Development Co-operation (AMEXCID), it maintains close co-operation with the General Co-ordination of Civil Protection establishing a point of contact for the implementation of prevention policies, early warnings and emergency plans with the embassies and diplomatic missions in Mexico.

Ministry of Health (MH)	The Ministry of Health (MH) is in charge of creating and implementing the National Health Program with the objective of providing quality health services to the population. The Mexican Institute of Social Security (IMSS), the State's Employees' Social Security and Social Services Institute (ISSSTE) and the MH provides health services to the population. With the implementation of the "Safe Hospital Program", its role within SINAPROC is crucial for emergency preparedness.
Ministry of Labour and Social Welfare (STPS)	The Ministry of Labour and Social Welfare (STPS) is responsible for the implementation and supervision of labour and social welfare provisions in the Constitution (Article 123) and in the Federal Labour Law. Its role in civil protection is mostly related to prevention; it co-operates to identify companies and public or private sector infrastructures which use hazardous materials and could constitute a risk and it establishes and supervises compliance with prevention norms for medicine, safety and hygiene at work. Along with SEGOB, it designs programmes for raising the population's awareness regarding emergency activities in case of chemical-origin disasters. For emergency response, it promotes to local authorities and companies measures aiming at avoiding socio-organisational problems in the transport of people and highly attended places.
Ministry of National Defense (SEDENA)	The Ministry of National Defence (SEDENA) is in charge of providing support to the population during an emergency mainly through the implementation of its flagship emergency programme named "Plan DN-III", having well-established operational processes for emergency response and a set of regional command centres within the country in order to reduce response times.
Ministry of Navy (SEMAR)	As SEDENA, the Ministry of Navy (SEMAR) is involved in SINAPROC mainly through the implementation of its emergency response "Navy Plan". SEMAR has a meteorological system available to inform both the Navy and merchant ships about any possible risks on the coasts and in Mexican ocean waters. SEMAR is in charge of the operational co-ordination of the National System for Tsunami Alert (SINAT) in co-ordination with SEGOB, the SCT, the UNAM and the Centre of Scientific Research and High Education of Ensenada (CICES). Because of this, SEMAR is mandated to develop a Centre for Tsunami Alert (CAT).
Ministry of Public Education (SEP)	The Ministry of Public Education (SEP) is in charge of creating and implementing educational programmes within the public schools in Mexico. One of its main activities related to SINAPROC is integrating risk and disaster management information in text books provided to students. The SEP co-ordinates with the Institute for Educational Infrastructure (INIFED) for activities related to prevention, mitigation, recovering and/or reconstruction of its infrastructure.
Ministry of Public Safety (SSP)	The Ministry of Public Safety (SSP) is in charge of preserving freedom, order and public peace in the country, and of safeguarding the integrity and rights of the people by preventing the commission of crimes (SSP, 2012). It provides support for the population during emergencies in co-ordination with SEDENA and SEMAR. Due to its technological and ICT capabilities, it also represents strong technical support for the federal government, especially for emergency management purposes.
Ministry of Public Service (SFP)	The Ministry of Public Service (SFP) is in charge of co-ordinating, assessing and supervising the federal government's public exercises of power. Regarding civil protection, it supervises that for public works and related services, institutions and contracting companies comply with the legal provisions for human settlements, urban development and construction. It drafts the internal programme of civil protection for its employees and must promote a civil protection culture. For emergency response activities, it acts in co-ordination with state and municipal authorities. It is also responsible for the supervision of internal and external aid distribution and for the assessment of damages to its infrastructures.
Ministry of Social Development (SEDESOL)	The Ministry of Social Development (SEDESOL) is in charge of poverty reduction and development policies. While the majority of its programmes aim at fostering social inclusion and welfare, SEDESOL also takes part in the prevention and management of natural risks, notably through the support provided to the states for the creation of risk maps and food supply and shelters during an emergency.
Ministry of the Agrarian Reform (SRA)	The Ministry of the Agarian Reform (SRA) is responsible for agrarian reform and agricultural workers according the provisions of Article 27 of the Constitution. Regarding civil protection, the SRA organises the participation of agricultural workers for the prevention or response to natural phenomena and promotes a civil protection culture.
Ministry of the Interior (SEGOB)	The main objective of the Ministry of the Interior (SEGOB) is to maintain and improve the relationship of the Presidency with the Congress, the judiciary and the different levels of government. It is the most important ministry inside SINAPROC as it is in charge of its executive co-ordination trough the General Co-ordination of Civil Protection.
Ministry of Tourism (SECTUR)	The Ministry of Tourism's (SECTUR) main objectives are focused on fostering internal and external tourism in the country due to the importance of this economic activity for Mexico. Its role within SINAPROC focuses on co-ordinating with other ministries such as the SRE for managing and informing international tourists about risks and implementing specific civil protection programmes with the support of the private sector.
National Water Commision (CONAGUA)	CONAGUA is a decentralised body within the Ministry of Environment and Natural Resources (SEMARNAT). It is in charge of the management of water resources within the Mexican territory and hydraulic infrastructure. It is also in charge of providing technical support for damage assessments to the states and municipalities after a disaster. The most important meteorological agency in the country, the National Meteorological Service, is an internal body under the supervision of CONAGUA.

Federal Electricity Commission (CFE)	The Federal Electricity Commission (CFE) is a company created and owned by the Mexican government in charge of generating, distributing and marketing electric energy. One of its main functions within SINAPROC is to ensure the safety of its facilities and in case of emergency, to ensure fast restoration of electric power supply in the affected areas. Similarly, CFE has hurricane and earthquake monitoring centres that allow it to take preventive or emergency response measures in order to ensure uninterrupted electric power supply or its fast restoration, as well as the safety of its employees and the population.
National Institute for Educational Facilities (INIFED)	The National Institute for Educational Facilities (INIFED) is a decentralised public agency of the federal public administration, a legal entity with its own assets and technical and administrative autonomy to meet its objectives, normative capacity for consultation and certification. INIFED is charged with building, equipping, maintaining, rehabilitating, reinforcing, reconstructing, reconverting and habilitating the property and installations destined to the public education of the Federal District, in the states in the case of institutions of a federal nature or, when suited, with state authorities. It co-ordinates activities deriving from the prevention of and attention to damages caused to the physical educational infrastructure by natural disasters and provides training, consulting and technical assistance.
Telecomunicaciones de Mexico (Telecomm-Telegraph)	Telecomunicaciones de Mexico (Telecomm-Telegraph) is a decentralised government agency in charge of providing diverse services such as telegraph and satellite services. Since 1995, with the amendment of Article 28 of the Mexican Constitution, satellite communication is no longer regulated as a strategic area, allowing private investment in the sector. In 1997, 75% of the Mexican satellite system was privatised (at that time, it was operated by Telecomm) granting the concession of the satellites and control centres to the company "Satellites Mexicanos" (SATMEX). In 2010, the Mexican government, through the SCT, acquired three new satellites for the security of the Mexican state (Mexsat 1, 2 and 3). In 2010, the Mexican President announced that the new system would be operated by Telecomm-Telegraph, considering its experience in operating and managing similar systems. Orbiting for the first satellite (Mexsat 1) was expected before the end of 2012.
National Seismological Service (SSN) National Oceanographic Service (NOS)	The National Seismological Service (SSN) and the National Oceanographic Service (NOS) are internal bodies within the Geophysics Institute of the National Autonomous University of Mexico (UNAM). Their main objective is the monitoring of seismic and tsunami activity. They provide strategic information on these hazards to the federal government and determine the main parameters such as the magnitudes and epicentres of earthquakes and the risk of a tsunami.
National Meteorological Service (SMN)	The Mexican National Meteorological Service (SMN) is the national weather organisation responsible for collecting and interpreting data and issuing forecasts, advisories and warning bulletins related to hydrometeorological hazards. It depends on the General Direction of CONAGUA.

Source: Based on information provided by the Mexican Ministry of the Interior (SEGOB), March 2012.

Annex E

Prevention activities: Responsible stakeholders

	Geological	Hydrological	Chemical-technical	Sanitary-ecological	Social-organisational
Airports and auxiliary services	◆	◆		◆	◆
Federal Attorney for Environmental Protection			◆	◆	
Federal Electricity Commission (CFE)	◆	◆	◆	◆	◆
State's Employees' Social Security and Social Services Institute (ISSSTE)	◆	◆	◆	◆	◆
Mexican Federation of Radio Testers	◆	◆	◆		
Mexican Institute of Social Security (IMSS)	◆	◆	◆	◆	◆
Mexican Petroleum Institute			◆		
Mexican Red Cross	◆	◆	◆	◆	
Ministry of the Agrarian Reform (SRA)	◆	◆	◆	◆	
Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA)	◆	◆	◆	◆	
Ministry of Communications and Transport (SCT)	◆	◆	●		●
Ministry of Economy (SE)	◆	◆		◆	
Ministry of Energy	◆		●	◆	
Ministry of Environment and Natural Resources (SEMARNAT)	◆	●	●	●	
Ministry of Finance (SHCP)	◆	◆	◆	◆	◆
Ministry of Foreign Affairs (SRE)	◆	◆	◆	◆	◆
Ministry of Health (MH)	◆	◆	◆	◆	●
Ministry of Labour and Social Welfare (STPS)			●	◆	◆
Ministry of Navy (SEMAR)	◆	◆	◆	◆	◆
Ministry of Public Education (SEP)	◆	◆	◆	◆	◆
Ministry of Public Service (SFP)	●				
Ministry of Public Safety (SSP)	◆	◆	◆	◆	◆
Ministry of Social Develpment (SEDESOL)	●	◆	◆		◆
Ministry of the Interior (SEGOB)	⊙	⊙	⊙	⊙	⊙/●
Ministry of Tourism (SECTUR)	◆	◆	◆	◆	
Ministry of National Defence (SEDENA)	◆	◆	◆	◆	◆
National Association of the Chemical Industry			◆		
National Autonomous University of Mexico (UNAM)	◆	◆	◆	◆	◆
National Center for Prevention of Disasters (CENAPRED)	○	○	○		
National Chamber of the Industry of Radio and Television	◆	◆	◆	◆	

	Geological	Hydrological	Chemical-technical	Sanitary-ecological	Social-organisational
National Chamber of the Industry of Transformation	◆	◆	◆	◆	
National Forestry Commission (CONAFOR)			◆		
National Institute of Ecology (INE)			◆	◆	
National System for Integrated Family Development (DIF)	◆			◆	
National Water Commission (CONAGUA)	◆	●	◆	◆	
Mexican Petroleum (PEMEX)	◆	◆	◆	◆	◆
Republic Attorney-General	◆		◆	◆	
States, municipalities and boroughs	●	●	●	●	●

⊙ Executive co-ordination[1]

● Technical co-ordination[2]

◆ Co-responsability[3]

○ Technical support[4]

No assistance provided when cell is blank.

Notes: 1. Executive co-ordination: in charge of establishing the co-ordination and communication channels between municipalities, states, departments, agencies and institutions involved in risk prevention activities; 2. Technical co-ordination: ministries, agencies, etc. from different levels of government, assume the responsibility to provide guidance, technical knowledge and resources according to its area of expertise to all of the other stakeholders involved in the prevention activities, promoting and integrating planning, operation and evaluation of the performed tasks, in addition to the achievement of the operations and activities within its competence. 3. Technical support: ministries and/or agencies, which, according to their own functions, have both the structure and capacity to provide specific aid or support for decision making specifically for prevention activities. It can also refer to the provision of technical advice during recovery activities to ensure that reconstruction includes prevention needs in order to reduce the probability of recurrent damage. 4. Co-responsability: entities and/or institutions responsible for providing support and human and material resources, in addition to developing their own activities.

Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf*

Annex F

Recovery activities: Responsible stakeholders

	Co-ordination
DICONSA, S.A. de C.V.*	◆
Federal Electricity Commission (CFE)	◆
State's Employees' Social Security and Social Services Institute (ISSSTE)	◆
Mexican Institute of Social Security (IMSS)	◆
Mexican Petroleum (PEMEX)	◆
Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA)	●
Ministry of Communications and Transport (SCT)	◆
Ministry of Economy (SE)	◆
Ministry of Environment and Natural Resources (SEMARNAT)	◆
Ministry of Finance (SHCP)	◆
Ministry of Health (MH)	◆
Ministry of Public Education (SEP)	◆
Ministry of Social Development (SEDESOL)	●
Ministry of the Interior (SEGOB)	⊙
National Centre for Prevention of Disasters (CENAPRED)	○/◆
National System for Integrated Family Development (DIF)	◆
National Water Commission (CONAGUA)	◆
States, municipalities and boroughs	●

⊙ Executive co-ordination[1]

● Technical co-ordination[2]

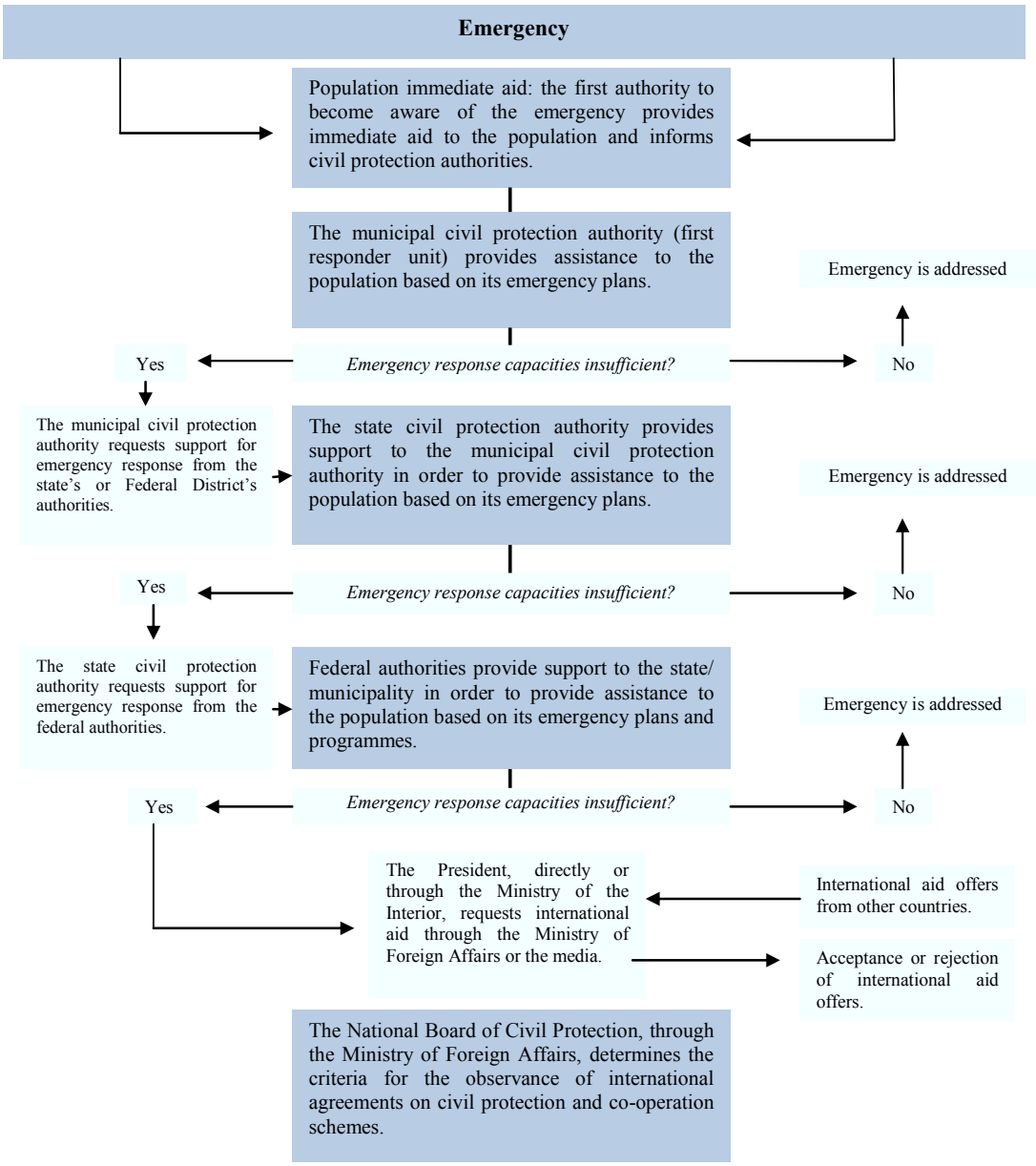
◆ Co-responsability[3]

Notes: * The current version of the SINAPROC's Manual still refers to the National Company of Popular Subsistence (CONASUPO) as part of the system. However, that state-owned company disappeared in 1999, being replaced by DICONSA S.A. de C.V., a mostly governmental shareholding company (information updated by the Ministry of the Interior). 1. Executive co-ordination: in charge of establishing the co-ordination and communication channels between municipalities, states, departments, agencies and institutions involved in risk prevention activities. 2. Technical co-ordination: ministries, agencies, etc. from different levels of government, assume the responsibility to provide guidance, technical knowledge and resources according to its area of expertise to all of the other stakeholders involved in the prevention activities, promoting and integrating planning, operation and the evaluation of the performed tasks, in addition to the achievement of the operations and activities within its competence. 3. Co-responsibility: entities and/or institutions responsible for providing support and human and material resources, in addition to developing their own activities.

Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf.*

Annex G

Process for scaling up emergency response



Source: SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf.*

Annex H

2012 General Law of Civil Protection: Main new provisions

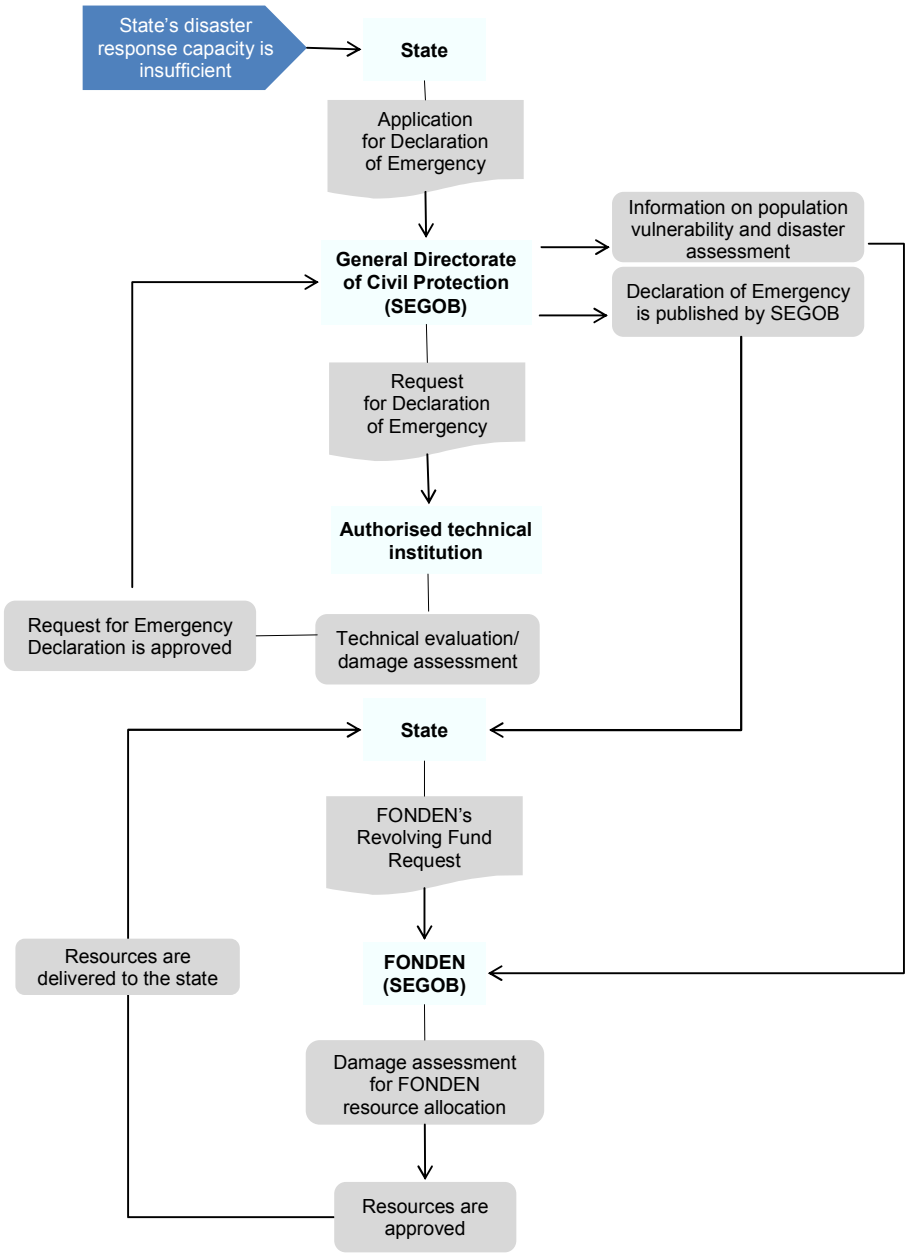
Financial mechanisms	Mandatory use of risk transfer mechanisms	States are required to insure their infrastructure assets (Article 18).
	Special Funds for Rural Sector	The federal government is responsible for establishing aid mechanisms for the rural sector. The federal government should create a special financial reserve intended to provide immediate resources for the Climate Contingencies Response Program (Articles 91-94).
	Creation of the Local Civil Protection Funds (FOPROCI) (mandatory for states)	States are required to establish Local Funds for Civil Protection to improve the knowledge, technical and operational capabilities of local civil protection units (Article 66).
Guidelines	National Development Plan	The National Development Plan should frame the development and objectives of the National Program of Civil Protection (Article 35).
	Holistic risk management	The 2012 law has established Holistic Risk Management (HRM) as its main framework. The HRM considers risk as the object of SINAPROC's work. It considers its causes and evolution of risks, and the driving forces influencing it, setting cross-cutting policies and responsibilities for the different sectors involved in risk management.
	Mandatory co-ordination	The importance of conducting co-ordinated and concerted activities between SINAPROC's stakeholders is enshrined as a mandatory principle (Article 8).
	Mandatory information sharing	Technical information sharing has been defined as mandatory for SINAPROC's stakeholders. If justified, stakeholders should share their information on alert systems, monitoring, forecasts and risk assessments if requested by other stakeholders (Article 16).
	Inter-insitutional committees and scientific advisory commitees	The inter-institutional committees and the scientific advisory committees have been recognised as support mechanisms for risk assessments and authorities' decision making (Article 20).
	Climate change	Climate change and its consequences have been included as a priority for policy making (Article 4).
	Civil service system	The establishment and/or strengthening of the federal and local civil protection civil service system has been identified as a key element to improve the quality of civil protection human resources and human capital (Articles 46 and 47).
	Certification of competences	The National School of Civil Protection will certify the knowledge and skills of public servants related to civil protection supporting the establishment of a professional career service for civil protection in the country.
Risk assessments	National Risk Atlas	The new law has increased the importance of the national and local risk maps. While the 2000 law established the development of a National Risk Atlas as one of the Ministry of the Interior's responsabilities, the new law emphasises the importance of these tools. In addition, the 2012 law recognises the importance of developing risk maps at the local level.
	Local Risk Atlas	
	Use of risk maps for decision making	The national and local risk atlases have to be the reference framework for risk management decision and policy making (Article 19). Article 86 establishes the use of the national and local risk atlases as tools for issuing or denying building permits.
	Risk assessments for construction areas (offense)	Risk assessments are now mandatory for the construction of infrastructure or dwellings. The absence of such an assessment is now considered as an offense. In addition, if any risks are identified, mitigation works should be carry out to limit them (Article 84).
	Mitigation works on risk areas	
	Relocation and mitigation works in risk areas	For human settlements already located in risk areas, authorities should carry out risk assessments in order to determine the implementation of mitigation works, or, if necessary, relocation (Article 87).
	Issuing of land-use permits by public servants (offense)	Public servants issuing land-use permits without the authority to do so are considered as law offenders (Article 90).

Education and capabilities	Risk knowledge as a right of the population	Population at risk has the right to be informed and to participate in risk management activities (Article 41).
	National School of Civil Protection	The National School of Civil Protection has been created as an educational and training system for public servants (Article 49).
	Civil protection included in educational curricula	Civil protection should be included in educational curricula on a mandatory basis. This comprises all levels of education as well as public and private schools (Article 43).
Risk communication	Use of official media	Using official media is one of the Ministry of the Interior's methods of improving the population's knowledge on civil protection (Article 10).
Emergency preparedness	Internal programmes of civil protection	Buildings from the public, private or social sectors are required to establish internal programmes of civil protection and internal units of civil protection (Articles 39 and 40) focused on developing risk management capabilities within society, especially in relation to emergency preparedness.
	Internal units of civil protection	
	Safe Hospital Programme	In addition to the establishment of internal units of civil protection, health services should take into account the guidelines of the Safe Hospital Program in order to ensure health services during an emergency (Article 39).
	Hazardous materials	Private sector companies or individuals engaged in activities related to hazardous materials management should present their internal programmes of civil protection to the authority in charge of this area (Article 79).
	National Centre for Civil Protection Communication and Operation	The National Centre for Civil Protection's Communication and Operation – NCCPCO – (Articles 23 and 24) is intended to act as the system's new communication and co-ordination mechanism. It will be the technical link between SINAPROC's components for preparedness, aid and recovery, supporting efficient decision making.
	Volunteers: National Network of Communitarian Brigades (NNCB)	The NNCB was created to improve co-operation between volunteers and civil protection authorities. It is managed by the Ministry of the Interior, through the CGPC. This network will keep a register of volunteers and will allow authorities to provide training to improve volunteers' capacities and capabilities.
Recovery	Donations management	Donations for relief need to be managed and made transparent (Articles 68-72).
	Continuity of operations	The continuity of operations should be planned and carried out by the private, social and public institutions to ensure things are restored to normal in the shortest possible period.
	Resilient society	Improving the resilience of society is one of the objectives of the civil protection system.

Source: Based on the 2012 General Law of Civil Protection.

Annex I

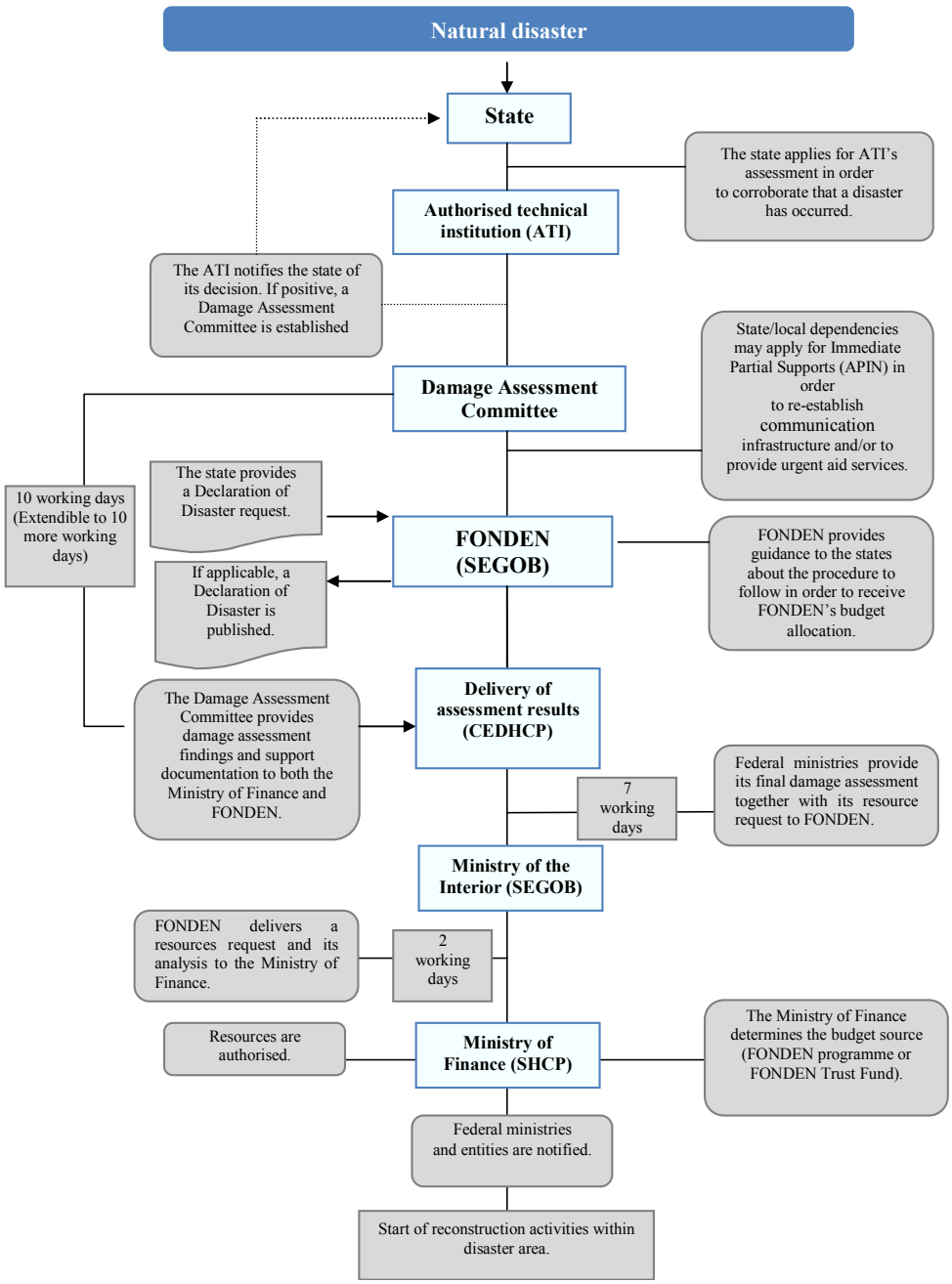
Operational process for accessing the FONDEN Emergency Fund



Source: Based on SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf.*

Annex J

Operational process for accessing the FONDEN Reconstruction Fund



Source: Based on SEGOB (2006), *Organization and Operations Manual of the National Civil Protection System*, *Diario Oficial de la Federación*, 23 October 2006, *www.diputados.gob.mx/LeyesBiblio/regla/n4.pdf.*

Annex K

Agreements for international co-operation

United States	Treaties	– La Paz Agreement on Co-operation for the Protection and Improvement of the Environment in the Border Area (1983)[1] – 14 Sister Cities agreements (Mexico-United States) – Agreement for Scientific and Technical Co-operation (1972) – Agreement on Emergency Management Co-operation in Cases of Natural Disasters and Accidents (2008) – 14 Sister Cities Bi-national Emergency Response Plans[1]
	IBWC[2]	– Joint management of bordering water resources – Joint management of Falcon Dam and Amistad Dam
	EPA[3]	– Border Program 2012 (BP 2012): group on emergency preparedness and response – Sister Cities Program and prevention – Joint Response Team[4] – BP 2012: emergency response group for the 14 Sister Cities – Joint Contingencies and Emergencies Plan for Preparedness and Response to Events Associated with Chemical Hazardous Substances in the Inland Border Area (IBP)
	NOAA[4]	– National Seismological Service (SMN) co-operates with the Pacific Tsunami Warning Center (PTWC) – The Ministry of Navy (SEMAR) co-operates with NOAA to improve its technical capabilities for oceanographic monitoring
	FEMA[5]	– Co-operation forum on policies for seismic disasters – Exercise Practitioner Program and trainings, at federal and state level – Joint emergency operations – Drills
	USCG[6]	– MEXUSPAC/GULF: MEXUS joint contingency plan on pollution events on coastal waters signed between SEMAR and the US Coast Guard
	USGS[7]	– CENAPRED and the National Seismological Service (SMN) have developed technical co-operation activities with the USGS
	IRIS[8]	– National Seismological Service (SMN) has developed technical co-operation activities with IRIS
	BGC[9]	– Discussion table for bordering states governors – Bi-national Emergency Response Strategic Plan, with the possibility of establishing memoranda of understanding for mutual help in case of emergencies
Central America	Belize	– International Boundary and Water Commission (1993) – Treaty of Technical and Scientific Co-operation (1995) – Monitoring of three joint hydro-climate stations
	Guatemala	– International Boundary and Water Commission (1963, renewed and fostered in 1990) – Treaty of Technical and Scientific Co-operation (2001) – Capacity building for monitoring systems – Treaty for Co-operation on Natural Disasters Prevention and Response (1988)
	Mesoamerica project	– Mesoamerica Project, created in 2007. It includes one specific work area devoted to disasters prevention and mitigation – Mesoamerican system of territorial information – Management of financing for disaster risks

Other		– Good Humanitarian Donorship (2011) – Technical co-operation agreements with several countries
International organisations and agencies	ECLAC[10]	– Support provided to CENAPRED for developing a damage assessment methodology. Co-operation has led to yearly assessments of the estimated socio-economic effects of the main disasters that have occurred in Mexico since 1980.
	UNDP[11]	– Integrated risk management of disasters in the south-east of Mexico developed in Campeche, Chiapas, Oaxaca, Quintana Roo, Tabasco, Yucatán (2002-2012). Strengthening of local and institutional capacities for disaster prevention, preparedness, response and recovery. Work in 185 municipalities in the region.
	World Bank	– FONDEN benefited from technical co-operation with the World Bank to issue its first catastrophic bond in 2006, and utilised the World Bank Multi-Cat Programme for the issuance of its Multi-Cat bond in 2009. – The World Bank financed the performance assessment of the SMN carried out by the WMO 5 (MXN 10 billion loan for its implementation)
	UNISDR[12]	– Hyogo Framework for Action (2005) – Programme implemented in the Federal District: Making Cities Resilient: My City is Getting Ready – Safe Municipality and Safe Hospital programmes
	WMO[13]	– Modernisation of the National Meteorological Service for Improved Climate Adaptation (2012-17). – Performance assessment of the SMN's activities and the development of a ten-year strategic plan for improving the SMN.
	UNESCO	– CENAPRED is involved in the International Platform for Reducing Earthquake Disaster (UNESCO-IPRED) which allows members to exchange information and scientific advice
	UN-SPIDER[14]	– National Focal Point. Use of space-based information for risk management
	USAID[15]	– Latin America Disaster Risk Reduction Plan for 2012-14: strengthening early warning systems; increasing capacities for disaster risk reduction in urban settings; developing technical assistance and training – Seismology workshops organised with experts from Central America, Mexico and the United States to foster research – Regional Disaster Assistance Program: technical assistance. Mexico benefits from an active USAID-funded programme for disaster preparedness, response and management – Regional Disaster Assistance Program: aid for the floods in Tobasco in 2007 and 2010
	JICA[16]	– JICA's financial and technical support for CENAPRED's development – Joint activities with CENAPRED: – south-south co-operation with Guatemala and other countries – Training Program for Third-party Countries: – Technology improvement for seismic-resilient popular housing, Taishin Project, El Salvador (2003-07 and 2009-12) – Human resources training and the development of tools for seismic-resilient infrastructures – Technical support to Colombia and Haiti (2012-13) JICA – disaster relief team

Notes: 1. Fourteen Sister City agreements have been signed. Annex II of La Paz Agreement required a Joint Contingency Plan (JCP) along the border, which provided the foundation for the 14 Sister City Bi-national Emergency Response Plans. 2. International Boundary and Water Commission. 3. United States Environmental Protection Agency. 4. National Oceanic and Atmospheric Administration. 5. American Federal Emergency Management Agency. 6. United States Coast Guard. 7. United States Geological Service. 8. Incorporated Research Institutions for Seismology. 9. Border Governors Conference. 10. Economic Commission for Latin America and the Caribbean. 11. United Nations Development Program. 12. United Nations International Strategy for Disaster Reduction. 13. World Meteorological Organization. 14. United Nations Platform for Space-based Information for Disaster Management and Emergency Response. 15. United States Agency for International Development. 16. Japan International Agency for Co-operation.

Source: Based on information provided by the Mexican Ministry of the Interior (SEGOB), March 2012.

Annex L

List of interviewees

During the two peer review missions in which took place in March and May 2012, the review team met with representatives from the following institutions:

Federal level

General Co-ordination of Civil Protection (*Coordinación General de Protección Civil*, CGPC)

General Directorate of Civil Protection (*Dirección General de Protección Civil*, DGPC)

National Centre for Prevention of Disasters (*Centro Nacional para la Prevención de Desastres*, CENAPRED)

General Directorate of the Fund for Natural Disasters (*Dirección General del Fondo de Desastres Naturales*, DGFONDEN)

Ministry of the Interior (*Secretaría de Gobernación*, SEGOB)

Ministry of Foreign Affairs (*Secretaría de Relaciones Exteriores*, SRE)

Ministry of Social Development (*Secretaría de Desarrollo Social*, SEDESOL)

Federal Electricity Commission (*Comisión Federal de Electricidad*, CFE)

Ministry of National Defense (*Secreraría de la Defensa Nacional*, SEDENA)

Ministry of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*, SEMARNAT)

Mexican Petroleum (*Petróleos Mexicanos*, PEMEX)

Ministry of Navy (*Secretaría de Marina*, SEMAR)

Ministry of Tourism (*Secretaría de Turismo*, SECTUR)

Ministry of Communications and Transport (*Secretaría de Comunicaciones y Transportes*, SCT)

Ministry of Public Education (*Secretaría de Educación Pública*, SEP)

National Institute of Education Physical Infrastructure (*Instituto Nacional de la Infraestructura Física Educativa*, INIFED)

Ministry of Finance (*Secretaría de Hacienda y Crédito Público*, SHCP)

Ministry of Public Safety (*Secretaría de Seguridad Pública*, SSP)

National Water Commission (*Comisión Nacional del Agua*, CONAGUA)

State level

Federal District

State of Chiapas

State of Coahuila

State of Colima
State of Jalisco
State of Mexico
State of Nuevo León
State of Tamaulipas
State of Tabasco
Hydrometeorological Council of the State of Nuevo León
Scientific Advisory Committee of the State of Chiapas
Scientific Advisory Committee on Hydrometeorological and Geological Hazards of the State of Jalisco

Municipality level

Cuauhtemoc Borough
Municipality of Guadalajara
Municipality of Monterrey
Municipality of Motozintla
Municipality of Puerto Vallarta
Municipality of Tampico
Municipality of Tuxtla Gutiérrez

Private, scientific and social stakeholders

Centre for Seismic Instrumentation and Record (*Centro de Instrumentación y Registro Sísmico*, CIRES)
Mexican Association of Insurance Institutions (*Asociación Mexicana de Instituciones de Seguros, A.C.*, AMIS)
Mexican Red Cross (*Cruz Roja Mexicana*)
National Meteorological Service (*Servicio Meteorológico Nacional*, SMN)
National Seismological Service (*Servicio Sismológico Nacional*, SSN)
Topos-Tlatelolco Rescue Brigade (*Brigada de Rescate Topos-Tlatelolco*, A.C.)
United Nations Development Program (UNDP)

In addition, the review team would like to thank the following stakeholders for their valuable comments:

Associated Civil Engineers (*Ingenieros Civiles Asociados*, ICA)
Atmospheric Sciences Centre of the National Autonomous University of Mexico
Cabinet Co-ordination of the Presidency of the Republic
Centre for Research and Higher Studies in Social Antropology (*Centro de Investigaciones y Estudios Superiores en Antropologia Social*, CIESAS)
Federal Judiciary Council (*Consejo de la Judicatura Federal*)
Gilberto Association (*Asociación Gilberto de Cancún, A.C.*)
Institute of Geophysics of the National Autonomous University of Mexico

Mexican Airspace Navigation Services (*Servicios a la Navegación en el Espacio Aéreo Mexicano*, SENEAM)

Mexican Geological Service (*Servicio Geológico Mexicano*, SGM)

Mexican Institute of Social Security (*Instituto Mexicano del Seguro Social*, IMSS)

Mexican Institute of Transport (*Instituto Mexicano del Transporte*, IMT)

Mexican Institute of Water Technology (*Instituto Mexicano de Tecnología del Agua*, IMTA)

Ministry of the Agrarian Reform (*Secretaría de la Reforma Agraria*, SRA)

National Autonomous University of Mexico (*Universidad Nacional Autónoma de México*, UNAM)

National Centre of Preventive Programs and Disease Control (*Centro Nacional de Programas Preventivos y Control de Enfermedades*, CENAPRECE)

National Commission for the Development of Indigenous Peoples (*Comision Nacional para el Desarrollo de los Pueblos Indigenas*, CDI)

National Commission for Nuclear Safety and Safeguards (*Comisión Nacional de Seguridad Nuclear y Salvaguardias*, CNSNS)

National Forestry Commission (*Comisión Nacional Forestal*, CONAFOR)

National Housing Commission (*Comisión Nacional de Vivienda*, CONAVI)

National Institute of Ecology (*Instituto Nacional de Ecología*, INE)

National Institute of Social Development (*Instituto Nacional de Desarrollo Social*, INDESOL)

National Institute of Statistitcs and Geography (*Instituto Nacional de Estadística y Geografía*, INEGI)

National System for Integral Family Development (*Sistema Nacional para el Desarrollo Integral de la Familia*, DIF)

Regulatory Commission of Energy (*Comisión Reguladora de Energía*, CRE)

SINAPROC's Scientific Advisory Commitee on Hydrometeorological Hazards

SINAPROC's Scientific Advisory Commitee on Social Sciencies

State of Aguascalientes

State of Campeche

State of Chihuahua

State of Guanajuato

State of Hidalgo

State of Michoacán

State of Morelos

State of Nayarit

State of Puebla

State of Sonora

State of Veracruz

State of Yucatán

State of Zacatecas

State's Employees' Social Security and Social Services Institute (*Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*, ISSSTE)

Annex M

Methodology

This report is the outcome of an OECD peer review of civil protection policies in Mexico, carried out by the OECD Secretariat and a team of three lead peers in co-operation with the Mexican Ministry of the Interior (*Secretaría de Gobernación*, SEGOB) and a representative sample of stakeholders from the Mexican National Civil Protection System (*Sistema Nacional de Protección Civil*, SINAPROC). The peer review follows a well-established mini-Delphi method of data and information collection and applies an analytical framework that has been previously used in peer reviews in France, Italy, Japan, Norway and Sweden. The objective of the review was to take stock of progress made throughout SINAPROC since its establishment in 1986, and to identify areas where policies and practices across the government could further improve civil protection outcomes.

The peer review followed a broad and inclusive participatory process, reflecting inputs from the multiple co-ordinating functions and operational capacities that together compose SINAPROC. A kick-off meeting took place in Mexico on 10 January 2012, to explain the objectives and approach of the peer review to more than 250 SINAPROC stakeholders. Detailed questionnaires were sent to 137 organisations representing federal, state and municipal levels of government as well as the private sector, volunteer organisations and academia. Over 80 questionnaire responses were received, which provided a significant amount of information about how SINAPROC is structured, its objectives, functions and key challenges. On the basis of this information, two fact-finding missions were conducted with three peer reviewers (from Chile, Italy and the United States) who possess operational and policy expertise in the field of civil protection. The first mission in March 2012 involved panel interviews with a broad range of federal authorities and stakeholders. The second mission in May 2012 focused on officials from state and municipal levels of government, the scientific research community and volunteer organisations. In total, 46, formal panel interviews were conducted during the 2 missions, including with 8 states (Chiapas, Coahuila, Colima, Jalisco, Nuevo León, state of Mexico, Tabasco and Tamaulipas) and the Federal District, and 6 municipalities (Guadalajara, Monterrey, Motozintla, Puerto Vallarta, Tampico and Tuxtla Gutiérrez) as well as 1 borough of the Federal District (Delegación Cuauhtemoc).

Preliminary findings and policy recommendations were presented for discussion at a policy dialogue held on 14 May 2012 in Santa Maria de Huatulco, Oaxaca, in which 40 representatives of various organisations in SINAPROC participated. During this meeting, consensus was reached about policy areas where recommendations would be useful. Based on the information collected, the OECD Secretariat carried out its analysis following the criteria presented in, *Emerging Risks in the 21st Century: An Agenda for Action* and *Future Global Shocks*. The analytical criteria include: *i)* the clarity of responsibilities and roles, consistency of practice, effectiveness in achieving goals,

coherence of organisation among SINAPROC's stakeholders; *ii)* the integration of scientific research and modern technologies to support prevention policies and civil protection planning; *iii)* the effectiveness of policy measures and techniques that enable risk reduction; *iv)* the co-operation among the different levels of government and with the private sector, international assistance and volunteer organisations in providing relief services and support to emergency responders; *v)* the transparency, efficiency and effectiveness of the financial instruments for recovery and reconstruction.

The draft report was circulated to all SINAPROC stakeholders for fact-checking, including two rounds of comments over the autumn 2012 and the winter 2012-13. Nearly 300 written comments from 48 stakeholder groups were carefully reviewed and incorporated in the final report. The report's findings were discussed with a broad group of delegates from 28 OECD countries at the 2012 OECD High-Level Risk Forum.

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MEXICO

REVIEW OF THE MEXICAN NATIONAL CIVIL PROTECTION SYSTEM

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