Water and Climate Change in Mexico 2007-2012

Analysis and Future Recommendations

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With the aim of facilitating the in-depth analysis of the catalogue of water and climate change actions in Mexico between 2007 and 2012, it has been placed online, in Spanish only, and can be downloaded from http://www.d4wcc.org.mx/images/documents/Catalogo/catalogo.pdf. Additionally, this document is available to be downloaded, in both English (from http://www.d4wcc.org.mx/images/documentos/Catalogo/wandccmex2007-2012.pdf) and Spanish (from http://www.d4wcc.org.mx/images/documents/Catalogo/ayccmex2007-2012.pdf).

In this publication, the amounts quoted are mainly in Mexican pesos. As a reference, as of December 27, 2012, 10 Mexican pesos were the equivalent of approximately 0.8 US dollars.

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Prologue

Water and climate change in the international context

The world's climate is already changing. According to the Synthesis Report on Climate Change (IPCC, 2007, p. 8), "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level". Although there is still some skepticism on the subject, as well as important efforts to deny the existence of climate change, reduce its importance, or disassociate it from human activities, the proof that we are experiencing a change in our climate as a result of our activities are conclusive, and are appearing with increasing intensity and frequency.

Although changes in the climate are nothing new, and there is evidence that the climate of our planet has shifted significantly at different points of its evolution, mainly due to variations in solar energy and the Earth's reflectivity, it was in the 1960s that scientific evidence started supporting more conclusively the notion that human activities could also have a significant impact on the climate. With the gradual growth in scientific knowledge, it was clarified that the increase in levels of carbon dioxide (CO2) and other greenhouse gases (GHGs) could cause an imbalance in the climate. The IPCC says on the subject that "Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004" and "Most of the global average warming over the past 50 years is *very likely* due to anthropogenic GHG increases" (op. cit., pp. 36 and 72).

It was only towards the end of the 1980s that it was scientifically understood that these changes were already starting to occur. This growing awareness led the WMO and the United Nations Environment Programme (UNEP) to create the Intergovernmental Panel on Climate Change (IPCC) in 1988. Additionally, the United Nations Framework Convention on Climate Change (UNFCCC) was created at the Earth Summit in Rio de Janeiro, Brazil, in 1992, coming into effect two years later in 1994. It currently has 195 Member States, which have met every year since 1995 in the Conference of the Parties (COP) to aim to reach agreement on the best way of tackling the problem of climate change.

Naturally, the UNFCCC's main initial priority was the mitigation of anthropogenic climate change, but as the changes in the world climate started to be observed, adaptation to the adverse effects of these changes became increasingly necessary, especially for developing countries. This growing concern gave rise to the Bali Action Plan, in COP 13 (2007), in which the pillars of response to climate change were defined as long-term cooperation; mitigation; adaptation; technology development and transfer; and funding.

Climate change mitigation is a highly complex and politicized issue due to the recognition of the historical contribution to GHGs by the largest polluters, whereas the obvious need to reduce future global emissions of gases is perceived as a barrier to progress by developing countries, who traditionally have contributed little to the problem, but are being increasingly affected by the impacts of this global phenomenon, as well as having a lower adaptive capacity (UNAM, 2009). On the other hand, the need to adapt to the adverse effects of climate change seems a little less controversial, above all as a consequence of the growing impacts of both extreme events and slow onset processes. Without referring to the causes of the changes in the global climate, it is evident that climate change adaptation is an urgent priority for all, both developed and developing countries.

The technical understanding of the effects of climate change on water resources has increased in recent years. Technical Paper VI on Climate Change and Water (IPCC, 2008) underscored how water is the main medium through which the impacts of climate change will be felt by human and natural systems, be it in terms of extreme events such as droughts or floods, or slow onset events, such as sea-level rise, impacts on water quality, ocean acidification or glacier retreat, among others. At the 4th World Water Forum, held in Mexico City in March 2006, the Risk Management framework theme mainly focused on the reduction of risks from hydro-meteorological disasters, but created a precedent in the water community for considering the different impacts of climate extremes on water resources. In August 2009, the "Stockholm Message from World Water Week to the COP 15" was a coordinated effort from the international water community to raise the level of recognition of the issue of water in the global climate change debate. An international movement was starting to build up on this issue, which generated a high degree of expectation that water could be considered more significantly in COP 15 in Copenhagen. However, in the end it was almost totally absent from the discussions, dominated by the issue of mitigation, and the lack of a binding global agreement on that subject.

In 2010, taking advantage of the preparation and hosting of COP 16 in Mexico, the Conagua took part in the creation of two international bodies that focus on this issue: the Water and Climate Coalition (WCC), the objective of which is to insert water into the formal deliberations under the UNFCCC, and the Alliance for Global Water Adaptation (AGWA), which focuses on adaptation practices. Furthermore, in 2010 the Conagua planned a series of activities on the issue, at the national, regional and global levels, some of which are described in the present document. Through these strategic alliances and its own work, the Conagua was able to use its double role as a Mexican government body and a member of the international water community to try to include water in a more prominent way in the international debate on climate change.

Through these efforts over the last few years, water has been initially inserted in the Nairobi Work Programme (NWP) under the UNFCCC, which focuses on impacts, vulnerability and adaptation to climate change. In this sense, Mexico hosted the first UNFCCC meeting on water and climate change in July 2012, held under the NWP, for which the UNFCCC Secretariat prepared an official technical paper on the issue (UNFCCC, 2011). This is a promising recognition, which demands follow up in the future, in order to confirm this interesting entry point.

Impacts of climate change on water resources in Mexico

Mexico is a country that is naturally vulnerable to changes in the climate: due to its geographic location, in the inter-tropical zone of the Northern Hemisphere, which places two thirds of the country in arid or semi-arid zones while one third is prone to floods; its exposure to tropical cyclones on its three coastal margins; the difference in land relief throughout its territory; and the distribution of its precipitation and differences in runoff in time throughout the year and in space throughout the country. This natural vulnerability however has been exacerbated in recent years. It is estimated that 15% of its territory, 68.2% of its population and 71% of its GDP are currently highly exposed to the direct risk of the adverse effects of climate change (World Bank, quoted in CICC, 2009). This is due both to climatic factors and its "social vulnerability" (land-use planning, urban development, the concentration of productive centers and industry in the northern, arid parts of the country, and inequality in income represented by the Gini coefficient, among other "human" factors), which when combined with the extreme climate conditions, regularly produce disasters that are anything other than "natural" (Landa et al, 2008).

To provide some examples, 2010 was the second rainiest year in Mexico in the last 70, causing extreme floods; at the start of 2011 and in September the same year, atypical frost was experienced, the most serious in the last 55 years; and at the end of 2011 and up to mid-2012, the country suffered its worst drought in the last 70 years. The financial consequences of these extreme conditions are estimated in the billions of dollars; there are no official figures, but different studies place the cost of the damage from the floods, storms and hurricanes in 2010 at around 5.3 billion USD (69 billion pesos, ECLAC, 2010); the cost of the frosts at the beginning of 2011 was estimated at 30 billion pesos in nine states in the agricultural sector alone (UNAM, 2011), while the damage caused by the frosts in September 2011 was estimated at 5 billion pesos in six states (Diario Respuesta, 2011); and finally the losses resulting from the drought in 2011-2012 in the agricultural sector were estimated at 16 billion pesos (USDA, 2012).

Given that the climate has a natural and mutually-dependent relationship with water resources, it may be inferred that one of the best means of adapting to climate change is through the strengthening of integrated water resources management, viewing water as a crosscutting resource that is essential for social wellbeing, economic development and environmental security, as well as a threat for the latter if it reaches extremes of abundance or scarcity. Clearly water should not be dealt with in an isolated manner in adaptation efforts, but holistically with other risk management, ecosystem, and land-use planning processes, among other highly relevant issues. A major hurdle for water-based adaptation to be treated with the due importance is the way in which it is categorized in planning processes, as an "additional" task to be undertaken, especially for developing countries. For this reason the challenge is to "mainstream" water-based adaptation in ongoing development processes, so as to avoid competition between these overlapping processes, and to ensure their long-term sustainability.

In Mexico, where water has been declared at the highest possible level as a "strategic resource… and issue of national security" (COLMEX, 2003, p. 131), the impacts of climate change on this resource are a clear threat to that security. The Conagua's efforts to face the impacts of climate change are in line with the general framework of Mexico's response to this global phenomenon. To coordinate that response, in

2005 the Inter-Ministerial Climate Change Commission (CICC) was created, which currently brings together 11 Ministries and the INEGI, and includes six work groups, focused respectively on adaptation; mitigation; REDD+; greenhouse gases; international negotiations; and the Special Climate Change Program (PECC). Additionally, the federal government produced its National Climate Change Strategy in 2007, and in 2009 the CICC published the PECC, the first iteration of which includes 105 objectives and 294 targets, aligned with the objectives of the 2007-2012 National Development Plan (NDP). The Conagua is responsible for the implementation of 41 of these targets as well as 9 others that it shares with other institutions, meaning that there are 50 targets directly related with water. Similarly, for the first time the 2007-2012 National Water Program (PNH) has a specific objective related with climate change.

Additionally, the National Institute of Ecology and Climate Change (INECC) has promoted the development of State Action Programs to face Climate Change (PEACCs), of which, at the time of going to press, seven had been included. It is worth mentioning that in the PEACCs, one of the requirements in terms of capacity development is that a workshop is carried out on the status of water and climate change. Furthermore, more than 30 pilot municipalities (in the 1st stage, in 2012) and more than 200 municipalities (in the 2nd stage, for 2012-2013) are working on the production of their Municipal Climate Action Plans (PACMUN), with the support of ICLEI-Local Governments for Sustainability, the British Embassy in Mexico, the INECC and the Ministry of the Environment and Natural Resources (SEMARNAT). Among the PACMUN's objectives is to identify water-based vulnerability.

The interaction between these elements of the legal and action framework underlines on the one hand the great interest in Mexico in offering an effective response to the problem, while on the other hand it should be highlighted that there is great inherent complexity in coordinating between such a large number of stakeholders, processes and actions at different levels, with similar purposes and overlapping scopes. Exactly for that purpose, since June 2012 Mexico has had a General Law on Climate Change, which governs the country's action both in mitigation and adaptation. This Law aims to establish the coordination of faculties between the central government, the states and municipalities, as well as the relevant programs, actions and investments, by grouping together the different criteria that have been developed in recent years into a single set of regulations. The Law also foresees the principles of a National Climate Change Policy and the Climate Change Fund, among other tools, and will be followed by by-laws, a strategy, programs and other tools that will facilitate its implementation in the coming years.

Introduction

This document was commissioned by the Conagua due to the growing need to systematize the different actions carried out by the water community in Mexico to face the impacts of climate change. In the majority of cases, these actions have arisen spontaneously in recent years given the needs of each organization and administrative area of the Conagua to incorporate new practices, considerations and modalities in order to carry out as efficiently as possible their daily tasks, faced with the significant uncertainty represented by current climate conditions, and the even greater uncertainty in the future. It is important to highlight that the water community is initiating a collective learning process in this field, although water resources management, by definition, has always been about dealing with changing climate conditions – only not at the same scale.

As a result of this interest from the Conagua, a consultancy was undertaken by the author of this document between October and December 2012, in the framework of the Project to Strengthen Integrated Water Resources Management in Mexico (PREMIA), a joint project between the WMO and the Conagua, described in action 2.3. This consultancy resulted in a catalogue of water and climate change actions in Mexico in the period 2007-2012, as well as this document, which aims to analyze the catalogue as well as selected actions from it, so as to be able to highlight some current trends, challenges and areas of opportunity in the future.

The initial effort to systematize the water and climate change actions from the 2007-2012 period in the catalogue reaped 118 actions; 81 from the Conagua, both centrally and its regional offices, and 37 from other organizations. It should be mentioned that without any doubt this number is only a small sample of what was actually implemented in Mexico on this issue in the aforementioned period, by both governmental and non-governmental organizations, as well as from both water organizations and those from other related disciplines. However, this sample is believed to be relatively representative of the bigger picture, thus allowing an overview of what has been achieved in the period to be drawn up.

The actions in the catalogue were classified and analyzed from two main perspectives: firstly, their **substantive focus**, including adaptation for various purposes and mitigation, or in other words the "what" of the action. In this sense, the same nine categories were used as in the Inventory of Water and Adaptation Actions in the Americas (www.aguaaaa.org); and secondly, through five crosscutting **factors** or approaches, which were the challenges that the actions sought to overcome through their implementation (or the "how"). In both cases, it should be mentioned that one action may consider various focuses and factors in parallel.

The results of the analysis of the substantive focuses of the 118 actions in the catalogue may be found in illustration 2. It should be highlighted that 47 out of the 118 actions (39.8%) were an attempt to solve environmental problems and 44 actions (37.3%) deal with the question of basic services. Additionally, a large share of these actions deal with issues of either the excess of water (floods) or its scarcity (drought), with 42 actions (35.6%) each, confirming up to a certain degree that necessity is the mother of invention, given the conditions that the country has experienced in this period. Finally, relatively few actions were an attempt to tackle urban or rural issues, and even fewer attempted to tackle mitigation, sea-level rise or other issues.

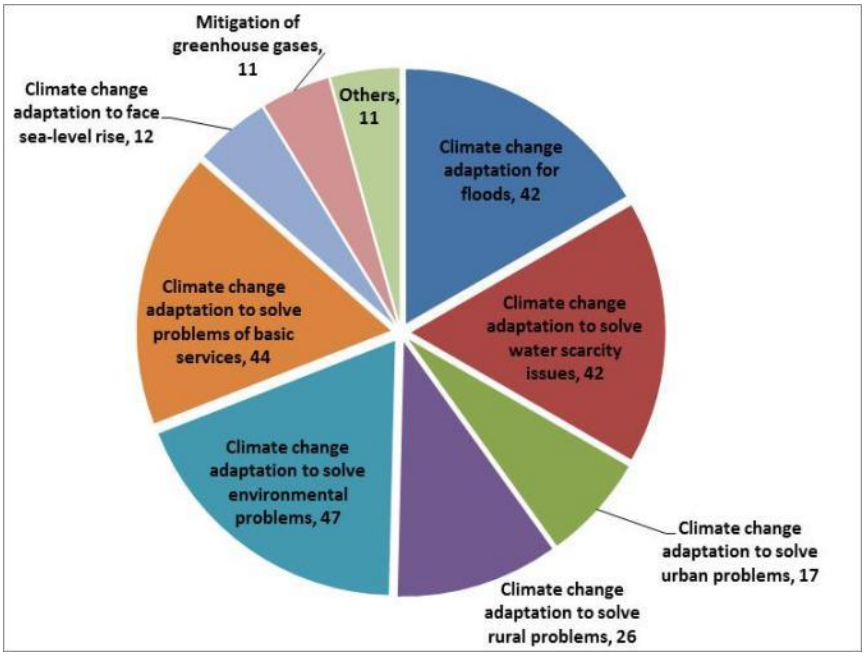


Illustration 2 Substantive focuses of the actions in the catalogue (the number of actions that considered each focus)

To define the five crosscutting factors, some thought was put behind the question "*what needs to be adapted to face the impacts of climate change on water resources?*" The response, like the problem, is complex, containing multiple interwoven and interdependent elements:

- Water management **institutions** will have to be updated, since they were mainly designed to deal with a more stationary set of issues, in social, economic and environmental conditions from another time;
- The water community's **planning and cooperation** practices and processes will have to be adjusted to take into account the new demands imposed by the changing climate, as part of a more holistic vision of the role of water in sustainable development processes;
- The **technical knowledge base** on the impacts of climate change on water will have to be enhanced in order to be able to foresee and interpret more precisely the impacts of climate change on the components of the water cycle in the future, as well as outlining the actions to be carried out to cope with these changes;
- The water community's **financial arrangements** will have to be diversified in order to allow greater flexibility when facing the onset of unexpected occurrences, and so as to be able to relieve the current dependency on funds from the federal government; and
- Better use will have to be made of existing **science** as well as investing in the research and development of new **technologies** to prepare a response that is more adapted to the problem at hand.

The definition of these five inter-related factors was used to classify the actions in the catalogue, as well as serving to define the chapters in this document. It should be highlighted that the majority of the actions in the catalogue (89 actions or 75.4%) sought to improve planning and cooperation efforts; 68 actions (57.6%) aimed to enhance the knowledge base; 59 actions (50.0%) constituted attempts to make better use of appropriate science and technology; and relatively few actions (28 and 27 actions, or 23.7% and 22.9% respectively) set out to foster institutional/regulatory strengthening and/or innovative financial schemes/arrangements (see illustration 3 below).

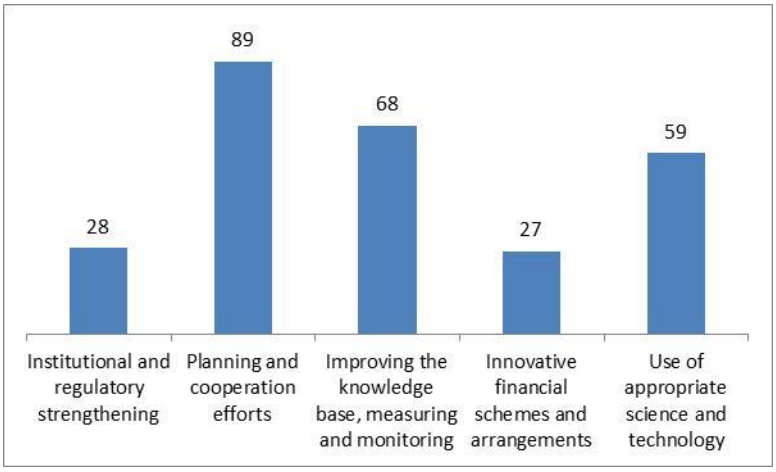


Illustration 3 Focus on the factors that the actions in the catalogue sought to overcome through their implementation

Subsequently, it was considered relevant to cross the information between the aforementioned focuses and factors. This crossover of classifications allows a robust matrix to be established in order to quantify the actions in the catalogue, which reveals in some way a prioritization of the water and climate change actions carried out over the last six years (see illustration 4). This crossover reveals that the most common "cells" are adaptation for floods aiming to improve planning and cooperation efforts and to enhance the knowledge base, measuring and monitoring, as well as adaptation to solve environmental problems through planning and cooperation efforts. On the other hand, there are very few actions on the issue of institutional and regulatory strengthening for mitigation of GHG emissions, for example.

Focuses / Factors	Climate change adaptation for floods	Climate change adaptation to solve water scarcity issues	Climate change adaptation to solve urban problems	Climate change adaptation to solve rural problems	Climate change adaptation to solve environmental problems	Climate change adaptation to solve problems of basic services	Climate change adaptation to face sea-level rise	Mitigation of greenhouse gases	Others
Institutional and regulatory strengthening	10	14	8	11	13	17	7	1	2
Planning and cooperation efforts	32	29	12	19	33	31	9	7	9
Improving the knowledge base, measuring and monitoring	33	22	13	16	28	19	9	4	9
Innovative financial schemes and arrangements	11	12	7	7	16	13	6	8	4
Use of appropriate science and technology	25	17	7	10	24	23	5	7	5

Illustration 4 Crossover between the focuses and factors for the actions in the catalogue (red 10 actions or fewer, yellow is between 11 and 20, and green is above 20).

Another possible means of analysis is whether the actions are an *explicit* effort to solve climate change-related issues, which would not therefore have been carried out without the incidence of this global phenomenon, or on the other hand are what we might identify as actions that would have been implemented with or without climate change, or "business as usual". After analyzing the catalogue, it is estimated that 18 out of the 118 actions, or 15.3%, were explicitly designed to face the problem of climate change, the others being more traditional actions in which, in some cases, some aspects of climate change have been incorporated, or which it is considered that even without including additional climate variables, contribute mainly to the issue of adaptation.

The production of this document was based on the analysis of the catalogue. In order to exemplify in greater detail what courses of action can be taken to fulfill each of the five factors, four actions were extracted from the catalogue, resulting in the twenty actions presented in this document. It is important to clarify that these actions are not necessarily "better" than the other actions in the catalogue, but put together they do constitute a wide range of examples that show in fairly representative fashion the path that the water community has taken in recent years. There are many other interesting actions that could have been included, some of which are briefly mentioned in the introduction to each chapter, but for the purpose of keeping the document relatively concise, only these illustrative examples were used. All the actions can be consulted in detail, in Spanish only, in the catalogue on http://www.d4wcc.org.mx/images/documentos/Catalogo/catalogo.pdf.

Finally, it is interesting to reflect upon the fact that many of the actions presented in this document exemplify at the same time several of the factors and focuses, and therefore could have been included in several chapters. For example, the Modernization of the National Meteorological Service was selected to exemplify its innovative financial aspects, although it also fulfills the characteristics of the other four factors. Perhaps one conclusion that could be drawn from this consideration is that actions that aim to overcome several challenges, in some cases, might have a greater impact. The categorization used for the purpose of this document should therefore be considered as a flexible framework that allows some general trends to be brought forth, rather than a straightjacket.

Illustration 5 Floods in the Valley of Chalco, February 2010, as a result of atypical rainfall

Executive summary and key messages

The analysis of the catalogue clearly reveals how the Mexican water community is already implementing proactive measures, with some degree of urgency, to adapt water resources management to the changes in the global climate, mainly by attempting to overcome the existing gap in sustainable water resources management. In this sense, the water community has made great strides forward in recent years to face this global phenomenon, without having a formal framework to guide their actions. It is evident that a country with an improved water management in the present will be better prepared to face the impacts of climate change in the future, while the same barriers to current progress in integrated water resources management will also affect the ability to foster effective water-based climate change adaptation. To a certain extent, water management has always been an effort to overcome prevalent climate conditions in order to ensure the supply of the resource for different uses. However, this has mushroomed in recent years as a result of the occurrence of more intense and frequent climate conditions, and the corresponding human, economic and social losses.

Climate change adaptation is an ongoing process, in which economic, technological, social, demographic, environmental and governance factors are at play. It should therefore be tackled from a multi-disciplinary and multi-level perspective. It is important to highlight that in the majority of cases, the actions in the catalogue have arisen rather spontaneously and unilaterally, with the corresponding risks that these well-intentioned efforts might be less effective, or might even in extreme cases become "maladaptation". It is still too early to pass any sort of definitive judgment in this respect, but the early signs are promising that the bases are being laid down for an effective water-based climate change adaptation. However, it is also crystal clear that there is a need for a general framework for water-based adaptation that guides and gives greater coherence to the measures being carried out to reduce the risk of maladaptation in the future.

Faced with the uncertainty about the future impacts of climate change, but also with the certainty that the country is currently suffering multi-million dollar losses as a result of extreme hydro-climate events and slow onset processes – losses that are more severe due to the backlog in Mexico regarding development and water – the water community in Mexico seems to be focusing its actions mainly on adapting to the impacts of these extreme events in the short term, before turning to medium- and long-term priorities. As a result, it may be inferred that, as regards water, ***Mexico is adapting to current climate variability, but not yet fully to future climate change***. Proof of this may be drawn from the fact that the actions in the catalogue mainly deal with the gravity of current problems, such as floods, droughts and basic services, which are a consequence of many non-climatic factors (uncontrolled urban growth, overdrafting of groundwater reserves, the saturation of drainage systems, etc.). However, it is also interesting to observe how, by adopting this focus in the present, the adaptation capacity to future shocks is also being proportionately increased, bestowing multiple benefits upon the economic investment currently being made in water-based adaptation measures.

Along these lines, it is worth mentioning that the majority of the actions in the catalogue that accompanied this document may be fully justified with or without the onset of climate change, being what might be called "business-as-usual" actions, which may or may not include the incorporation of some initial considerations of climate change. On the other hand, it is estimated that 15.3% of those actions were specifically designed to improve preparedness to face the impacts of climate change in water resources. In this sense, the path taken by the water community to achieve this adaptation would seem to be clearly defined, and mainly consists of achieving the already established and ongoing

objectives and tools established both nationally and internationally, such as those of the NDP, PNH and PECC, for the former, and the Millennium Development Goals and the Human Right to Drinking Water and Sanitation, for the latter.

As we have already observed, it becomes apparent from the analysis of these actions that there are some areas in which the water community has marked an initial priority, such as measures to face floods and droughts, for obvious reasons, given the frequency and intensity of these extreme phenomena in recent years in Mexico, and environmental issues. However, it is also evident that there are significant opportunities to broaden future actions, in particular in the area of water-based mitigation, be it through wastewater treatment processes or in the agricultural and livestock sector, among others. Mexico's Fifth Communication to the UNFCCC (INECC, 2012) estimates that the agricultural sector contributes 12.3% of GHGs at the national level, and the treatment and elimination of wastewater a further 2.73%, meaning that water is central to at least 15.03% of these emissions, as well as being indirectly involved in other productive and industrial processes, those related with soil use and water transportation. As an example on the latter subject, the Cutzamala system, which supplies water for 11 delegations of the Federal District and 11 municipalities in the State of Mexico, was responsible for using 0.6% of the energy generated in Mexico in 2008 (1.29 TWh), with a cost of 1,844 million pesos (Conagua, 2011b).

This focus on water-based mitigation, or the mutually-dependent relationship between water and energy, is symptomatic of how Mexico has experienced a significant but gradual semantic change in recent years, going from the so-called "hydraulic sector" many moons ago, with its implications of an ever greater construction of water infrastructure to meet demand, to the "water sector", with its connotations of water as a resource, up to current efforts to refer to the "water community", in which water is no longer viewed within the narrow confines of a simple sector, but as a crosscutting resource that is actually managed by many stakeholders from different sectors, not just traditional water managers. It should be mentioned that these three terms were used almost indiscriminately in the entries in the catalogue, although it is the author's recommendation that the "water community" should be increasingly used in the future to frame the far-reaching vision of water in development processes. This semantic change is revealing of the focus that this community is adopting to face climate change, since the main impacts of climate change on water are on the resource itself, which has knock-on effects on many productive sectors which depend upon the quality and quantity of water resources.

The key messages extracted from the analysis of the actions in the catalogue were grouped into the same five factors used for the purpose of this document, and are based on the main trends observed. In each case, some examples of actions employed in the document are provided to illustrate the messages:

Institutional and regulatory strengthening

- **Water management institutions and their governance frameworks** were not designed with the flexibility necessary to be able to face climate change, so they are rightly the starting point of many water-based adaptation efforts (see actions 1.1, 1.2, 1.3, 1.4, 2.3, 2.4, 3.4 and 4.1).
- **There are significant initial efforts to strengthen institutional capacities** on water and climate change, through capacity development schemes, mainly using integrated water resources management as a tool for adaptation, at two levels: broadly, at a basic level; and on specific issues for some technicians, such as the monitoring of hydrological variables, the forecasting of severe impacts from "natural" disasters and the more precise monitoring and control of reservoir levels (actions 1.3, 2.3, 2.4, 3.4 and 4.1).
- A **multi-level and multi-sectoral institutional framework** is starting to take shape in response to the impacts of climate change on water in Mexico, in a more holistic manner with other planning

mechanisms “out of the water box”, both within the three tiers of government and with other relevant stakeholders. In this sense, the water community’s incursion into issues such as REDD+ and the CDM present interesting opportunities to be built upon in the coming years (actions 1.1, 1.2, 1.3, 1.4, 2.4, 3.4, 4.4, 5.1 and 5.2).

Planning and cooperation efforts

- Given the backlog the country still faces regarding water resources, the water community in Mexico is still mainly adapting to **current climate variability**. However, by adapting to this current variability, it is also preparing in the best possible way to face the future impacts of climate change (actions 1.1, 1.4, 2.1, 2.2, 2.3, 3.4, 4.1 and 5.2).
- It is highly important that **joint and coordinated efforts continue** between organizations with different focuses and at different scales, through consultation, implementation and follow up of coherent and multidisciplinary strategies and actions to face the impacts of climate change on water resources, building upon the bases of some of the cooperation schemes that were initiated in the 2007-2012 period (actions 1.1, 2.1, 2.2, 2.3, 2.4, 3.2, 3.4, 4.1 and 4.4).
- The **National Water Resources Climate Change Adaptation Strategy** currently under preparation, which includes proposals to improve water-based adaptation planning, programs, projects and actions, should be part of a more formal focus to tackle the issue of climate change through water resources, and should be incorporated into the national planning system, as a complementary document to the 2013-2018 National Water Program (actions 2.4, 3.1 and 4.2).

Improving the knowledge base, measuring and monitoring

- There is still a **generalized lack of knowledge and awareness** among the water community in Mexico about the impacts of climate change, which the technical studies produced in recent years have attempted to overcome, with a limited degree of success (actions 2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 4.1 and 5.4).
- Although the information on climate change is not currently and will surely never be perfect, this is not preventing **the implementation of proactive actions**, above all so-called “no regrets” actions that can be fully justified with or without the occurrence of climate change (actions 1.1, 3.2, 3.3, 3.4, 4.1 and 5.3).
- The cost of prevention is much lower than the cost of recovery after extreme events, but even so there is still a general trend towards reacting more than preventing. For example, monitoring of current and past climate conditions is readily available, but **flood forecasts are lacking**, which would allow the occurrence of this extreme condition to be foreseen so as to inform decision making at appropriate geographic and time scales (actions 1.3, 3.2, 3.4 and 5.3).

Innovative financial arrangements and schemes

- Important efforts are being made to **diversify the sources of funding** for the implementation of water actions, to lighten the dependence on federal funds, by attempting to gain access to other national and sub-national funds, as well as from the private sector, and making a more efficient use of the available resources (actions 1.1, 1.2, 3.4, 4.1, 4.4 and 5.1).
- The possibility of **attracting international climate change funds** should be explored in greater detail, for the purpose of allowing the scaling up of successful water-based adaptation actions in Mexico (actions 1.1, 4.1, 4.2 and 4.3).

Use of appropriate science and technology

- In general terms we already have at our disposal the majority of the **technology that we need to face the impacts of climate change on water resources**, but it should be used in a more

appropriate way for the problem at hand, instead of metaphorically seeking a problem for the solution available (actions 1.4, 3.1, 5.1, 5.2, 5.3 and 5.4).

- The agricultural and livestock sector and wastewater treatment processes in particular produce large quantities of GHGs, and some initial efforts are being carried out to make use of appropriate options to **reduce the energy footprint** of those processes, which will in turn have a positive impact on their water footprint (actions 5.1 and 5.2).
- As well as structural measures, investments are being made in non-structural measures as alternatives that seek first and foremost to **strengthen the resilience to extreme conditions of ecosystems in the country's most vulnerable localities**, by conserving their basic functioning and endemic vegetation. This natural infrastructure is by definition more flexible and may serve various purposes in parallel (actions 1.1, 3.4, 4.4 and 5.2).

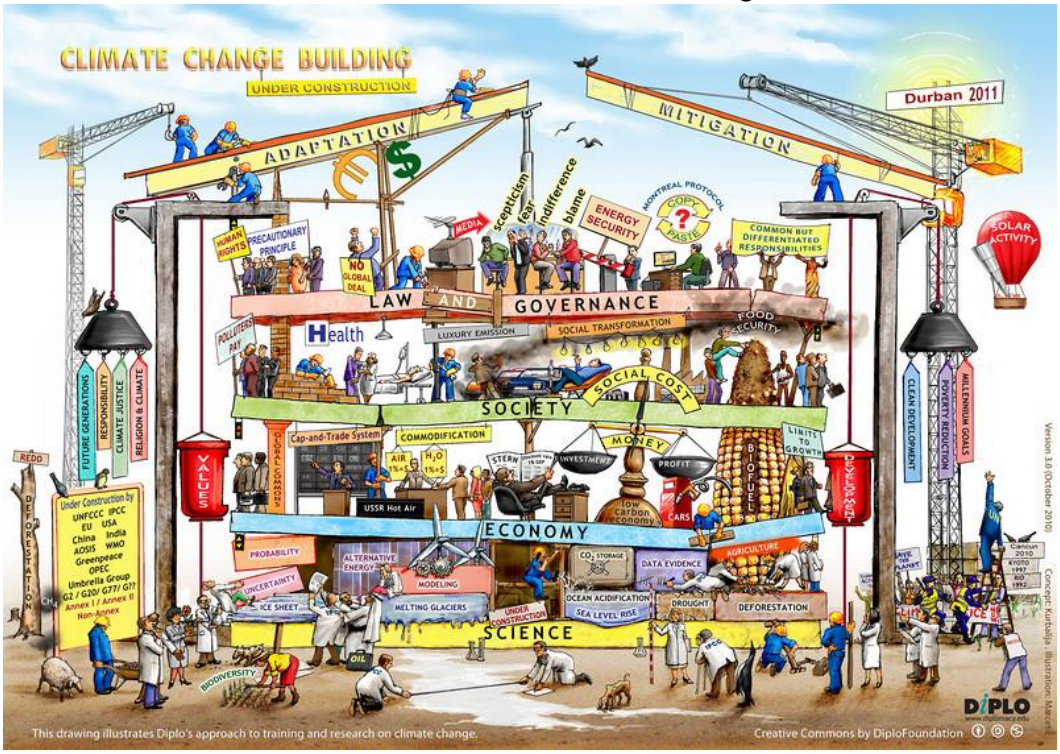
These messages constitute a series of observations based on the existing situation. As a result of these observations, the recommendations to attempt to guide the possible next steps may be found at the end of this document.

1. Institutional and regulatory strengthening

Neither water management institutions nor their regulatory frameworks were designed to have the necessary flexibility and rapidity to face situations of constant and unexpected changes in climate conditions. For decades, the basis for water management has been stationarity, or the historical study of the components of the water cycle (Milly et al, 2008), in particular precipitation, runoff, infiltration and evapotranspiration, which traditionally occur in similar periods of the year and in comparable volumes. Faced with the current changes in these traditional patterns – in both time and space –, it is necessary to have efficient governmental and non-governmental institutions with technical capacity, which foster a more flexible and "adaptable" management of water resources, in coordination with the institutions that manage other natural resources. Indeed, a good inter-institutional coordination will allow appropriate preventative decision making to face these changes in the components of the water cycle, including both structural and non-structural measures.

In this sense, in this chapter four actions are highlighted that respectively aim to constitute a "no regrets" program to ensure water for environmental purposes, associated with the formulation of an Official Mexican Standard (the National Program of Potential Water Reserves for the Environment); a regulatory framework to foster a more efficient use of water nationwide (Water Banks); a strategy that outlines the actions to be implemented before, during and after a drought, to reduce its social, economic and environmental impacts (Guidelines to plan actions against droughts); and the protection of vulnerable populations from floods (the Protection of Population Centers Program).

Other interesting examples extracted from the catalogue are the incorporation of the subject "Climate change and its impact on the hydrological cycle" in training activities under the Water Culture Program; the Program for Drinking Water, Sewerage and Sanitation in Urban Zones (APAZU); the inter-institutional collaboration with ecological regulation in the watershed of the Valley of Mexico; and the course for Conagua civil servants focused on IWRM as a tool to face climate change.



1.1 National Program of Potential Water Reserves for the Environment in Mexico

Since 2010 the Conagua and the Alliance between the World Wildlife Fund (WWF) and the Gonzalo Río Arronte Foundation, I.A.P. has been making joint efforts to establish water reserves that ensure the conservation of Mexico's main ecosystems, as well as the availability of the resource for the present and future generations. In 2010 the criteria were established to determine and prioritize water reserves for the environment. A study was undertaken named "Identification of Potential Water Reserves (PWRs) for the Environment in Mexico", through which 189 management units (basins) were identified with favorable characteristics for their declaration as water reserves, with three levels of feasibility: 19 basins with "very high" feasibility, 54 with "high" feasibility and 116 with "medium" feasibility. 54% of them are within the inland areas of the Mexican territory and 46% in coastal zones. They cover 97 protected areas and 55 Ramsar sites (50% and 41% respectively).

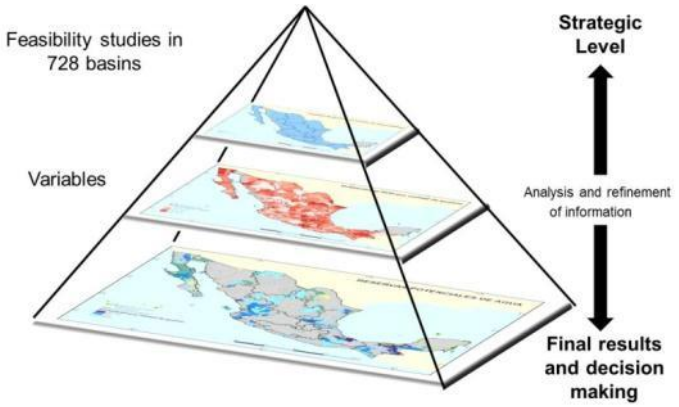


Illustration 6 Procedure to identify the basins with the potential to establish water reserves for the environment in Mexico

1. **Classification of the action's focus:**
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services

2. **How this action helps to face climate change:**

As a climate change adaptation measure, a PWR system is highly relevant since it guarantees the functionality of the water cycle as a source of water and as an input for ecological processes. A reserve represents a volume of water in a management unit, which will have implications for groundwater sources, as a baseline flow or natural discharge, and for surface water sources, as natural runoff within the basin itself and a downstream movement of upstream waters. Longitudinal and crosscutting connectivity is established with the channels for the transportation of water, nutrients, sediments, the migration of species and genetic material, and the dynamic of the ecosystems is regulated, guaranteeing the conservation of biodiversity and its associated goods and services. The establishment of a system of reserves would provide better conditions of resilience in water bodies, in regions and nationwide, which would imply an important climate change adaptation measure.

3. **Other organizations that took part in the action, and how:**

Two other organizations took part in reaching the proposed objectives:

I) WWF Mexico, in the planning, implementation, evaluation and funding of this Program from the start, and

II) The Inter-American Development Bank (IDB), as the other organization that funds this Program.

4. **Classification of the action's scope:**

National

5. Start and end date of the action:

The Program started as an inventory in 2010. In 2011 the book on "Identification of Potential Water Reserves for the Environment in Mexico" was published, and in 2012 the implementation of the technical, legal and cost-benefit studies was initiated to carry out the declarations of water reserves in pilot basins.

6. Approximate cost of the action:

More than 10,000,000 Mexican pesos

7. How the action was financed:

Professional associations and academic institutions/ Intergovernmental institutions: The implementation of this Program is the responsibility of the Conagua, through funding from the IDB implemented by WWF Mexico.

8. Impact/benefit of the action (in environmental, economic and social terms):

A PWR system is highly relevant since:

I) It would guarantee the functionality of the water cycle as a source of water and input for ecological processes,

II) It represents the sustainable limits of the water supply, favoring the principle of water saving and demand management,

III) It guarantees the connectivity throughout the basin and is the foundation for multiple environmental services, such as storage, transportation and supply, improves water quality, and provides a protective buffer against extreme events,

IV) It demands the joint planning and management of groundwater and surface water, especially relevant in areas with low availability, such as the north of the country,

V) It establishes the conservation or controlled release of floods, which will improve the evacuation capacities of the basins in which it is implemented, preventing the invasion of channels and as a result reducing the risks of extreme events, and

VI) It complements the conservation strategy of the country's most important ecosystems and their environmental services: protected areas, Ramsar sites and km^2 of additional basins.

9. Innovations that contributed to the success of the action:

The establishment of a methodology for multi-criteria analysis for the identification of basins or management units with the potential to act as water reserves for the environment, supported by a Geographic Information System (GIS) in which various shapes were analyzed (basins, rivers, irrigation districts, protected areas, Ramsar sites, surface and groundwater prohibition zones, and groundwater availability, among others). This program has also been undertaken in a coordinated manner with public-private participation (Conagua-WWF-IDB).

10. General comments:

This is a national Program, which represents a unique initiative, at least in Latin America. An important point to mention is that, to be able to declare a water reserve for the environment, the volume to be reserved has to be estimated, calculated or determined. In this context, work was undertaken in parallel on the Mexican standard to determine environmental flows (NMX-AA-159-SCFI-2012), which was published in the Official Government Gazette (DOF) on September 20, 2012.

11. Reference document(s) or website for more information:

http://sigagis.conagua.gob.mx/RESERVAS%20POTENCIALES%20DE%20AGUA%20PARA%20EL%20MEDIO%20AMBIENTE/. This page is a GIS visualizer in which a link can also be found to download the document in question.

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1.2 Water Banks

Water Banks are part of the Conagua, being immersed in the Integral Service Centers. There are 13 Water Banks in the headquarters of the River Basin Organizations (RBOs) and 20 support offices in each of the Conagua's Local Offices. Their functions are to provide guidance on the technical and hydrological characteristics of the region under their responsibility; provide consultancy regarding the regulations applicable for the process of transmission of water rights; speed up and manage the process from start to finish; and publish and disseminate announcements for the transmission or acquisition of water rights. The advantages that they represent for users are having access to privileged information for appropriate decision making, as well as having an integrated consultancy service free of charge regarding the transmission of rights, and the simplification of the process, framed by legality and transparency.

1. **Classification of the action's focus:**
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve environmental problems

2. **How this action helps to face climate change:**

One of the functions of the Water Banks is to promote efficient reallocations of water to the most productive uses, which contribute to the sustainable development of water resources. Additionally, they provide integral consultancy to users on the technical and hydrological aspects of the region, contributing to the creation of a culture of the rational use of the resource.

3. **Classification of the action's scope:**

National

4. **Start and end date of the action:**

Their conceptualization started in 2007, and the first Water Bank was inaugurated in December 2008. In 2009 five further Banks were established; in 2010 the seven remaining Water Banks were concluded as well as three support offices in the Local Offices; in 2011 support offices were opened in the 17

remaining Local Offices. The Water Banks have gradually evolved, improving and broadening the scope of their services, since they initiated as information centers on water resources and as facilitators of the process of transmitting rights; additionally they currently carry out the integral attention to processes in their three modalities, including the integration of the dossier, the respective ruling and resolution, notification, entitlement and registration requests in the Public Registry of Water Rights. Work is currently ongoing on their consolidation.

5. Approximate cost of the action:

1,000,000 to 5,000,000 Mexican pesos

6. Percentage of this cost directly assigned to infrastructure and to social questions:

Infrastructure 80% - Social 20%

7. How the action was financed:

Governments and governmental authorities: the economic, human and material resources used were the Conagua's own resources.

8. Impact/benefit of the action (in environmental, economic and social terms):

The Water Banks provide integral advice free of charge to water users regarding the transmission of rights, meaning that the users do not have to contract intermediaries; they provide legal security and certainty in rights transmission operations, guiding users if necessary to fill out the forms; as much as possible the resolution times are reduced; they analyze and, if required, advertise the requests of supply and demand for water rights from users through the Water Banks' web page. The great challenge facing the Water Banks is the gathering and analysis of information on the behavior of the rights transmission market, so as to design public policies on the management of the resource, which represent the best social, economic and environmental benefits for the hydrological-administrative region in question.

9. Innovations that contributed to the success of the action:

The Water Banks were conceptualized from the beginning as public bodies due to the legal nature of the nation's water resources. They were established based on an analytical process both of international experiences related with the market of water rights, and the legal and administrative framework in Mexico, reviewing the behavior of rights transmissions and their relationship with key elements of water policy. Furthermore, coordination and support was achieved with different areas of the Conagua to develop support tools and make them available to the Water Banks; similarly permanent capacity development has been provided.

10. General comments:

It should be highlighted that the Water Banks were considered within the national planning system, in the guiding documents for the 2007-2012 period: the NDP, in its Guiding Theme 4 "Environmental Sustainability"; the Sector-wide Environment and Natural Resources Program as part of its "Blue Agenda"; and the PNH within its Objective 3 "Promote Integrated and Sustainable Management of Water in Basins and Aquifers". Similarly, it should be mentioned that the target established for the last government administration was to have two Water Banks in operation, however given the relevance and importance of these bodies, as well as the acceptance by the users of the nation's water resources, the implementation was continued at the national level.

11. Reference document(s) or website for more information:

Water Banks in Mexico. Conagua, July 2012. Web page : www.conagua.gob.mx/bancosdelagua.

Contact details:
Suraya Juliet Padua Díaz. Deputy Department of Regulation of Rights Transmission and Water Banks, in the Conagua's Deputy Director General's Office for Water Management; suraya.padua@conagua.gob.mx; (+52 55) 5174-4000 exts: 1752 and 1753.

1.3 Guidelines to plan actions against droughts

In the guidelines developed by the Conagua and proposed to the 26 River Basin Councils (RBCs) that cover the whole country, actions are included –as illustrative examples, rather than as a strait jacket – that could be developed before, during and after a drought. Inherent characteristics for the set of actions are also suggested; for example:

- They should promote stakeholder participation;
- They should achieve this participation through transparency, reliability, equity, diversity of options and support; and
- There should be a continuous improvement (by evaluating, incorporating experiences and fostering research of best practices).

A significant organization will be required in the RBCs to be able to act in a coordinated manner during a drought. They will have to define the action stages, in a traffic lights system according to the severity of the emergency; the criteria for the start and end of each stage; and the percentage of reductions needed to achieve the targets at each stage. It will be fundamental to carry out far-reaching actions such as land-use planning, the effective control in villages of the growth of demands as compared to the supply that is available to them; and continual promotion of the involvement of society-at-large to avoid the excessive use and the lack of efficiency.

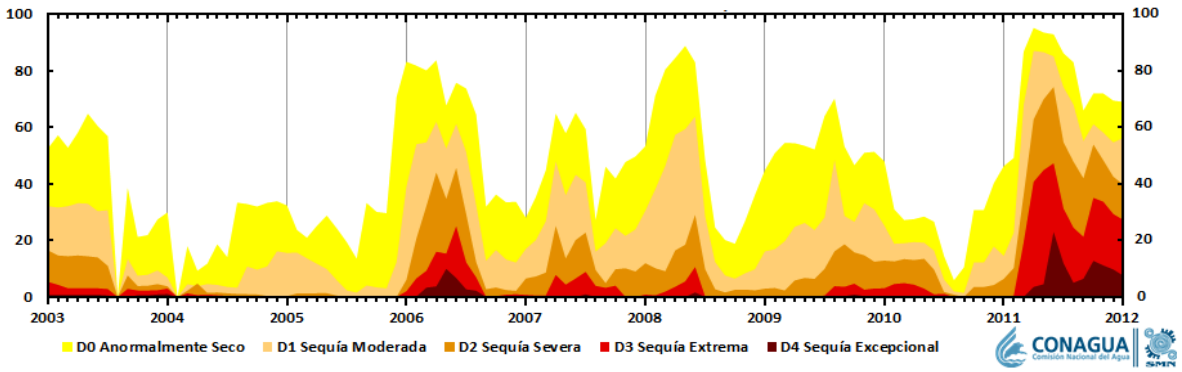

Illustration 7 Status of drought in Mexico, 2003-2012

1. **Classification of the action's focus:**

Climate change adaptation to solve water scarcity issues

2. **How this action helps to face climate change:**

The project contributes to reducing the vulnerability of the country's entire population because it provides a framework which fosters the design and potentially the implementation by its representatives in the 26 RBCs of coordinated actions to face current droughts, and the more severe ones that could occur with climate change.

3. **Other organizations that took part in the action, and how:**

The 26 RBCs are expected to participate. These Councils include representatives of authorities from the three tiers of government and the different uses of water, so the design and implementation of actions

will be carried out with the approval of the government and society-at-large, to ensure broad participation against droughts.

4. **Classification of the action's scope:**

National and sub-national

5. **Start and end date of the action:**

The proposal was formalized in the DOF on November 22, 2012. It is expected to be disseminated and implemented as soon as possible through the design and agreement on the planning of preventative actions by the 26 RBCs in their respective territories. It is hoped that the planning in each Council could be progressively improved; it will therefore not have an end date.

6. **Impact/benefit of the action (in environmental, economic and social terms):**

The timely and coordinated actions (planned in advance) against droughts aim to reduce the extent of the damage, and to ensure that the rhythm of productive activities is reduced as little as possible. And environmentally, the efficient use of water prior to the emergency will avoid there being an excessive drop in volumes of water during the emergency to be able to divert them towards urgent uses of human activities.

7. **Innovations that contributed to the success of the action:**

Planning, the comprehensive nature and participation.

8. **General comments:**

Each region has its particularities; its inhabitants and authorities have their own social dynamics and experience their own problems. It is hoped that they themselves will generate their own actions and their action committees; for this purpose, they will have the technical support of the Conagua. The cost of putting into practice both the design and the implementation will vary and cannot be quantified by the Conagua at this stage; nor is it possible to estimate the proportion of the cost that will be assigned to infrastructure or other actions. However, in all likelihood the cost will be less than that of merely reacting during a clear drought with evident and growing damage. The guidelines were designed based on the planning of urban uses against droughts developed in California (USA), with the leadership of the agencies that provide water services; which is one of very few examples of drought prevention worldwide; although the guidelines for Mexico contemplate all uses, and the leadership will be with the RBCs.

9. **Reference document(s) or website for more information:**

http://www.dof.gob.mx/nota_detalle.php?codigo=5278695&fecha=22/11/2012

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1.4 Protection of Population Centers Program

Objective: Prevent risks and respond to the effects caused by floods in population centers.

Aimed at: The public-at-large, RBOs, Local Offices, state and municipal governments.

Examples of actions that are supported: Carrying out feasibility studies, final plan sets and infrastructure construction (protection berms, channeling, rectifications, open-air tunneling, marginal protections, cleaning and desilting of channels, flood-control dams and early warning systems, among others).

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve urban problems

2. **How this action helps to face climate change:**

This Program is aligned with the current climate mobility and dynamics in favor of the protection of rivers and therefore of the population. It acts as an adaptation measure because it studies, builds and plans protection infrastructure works for population centers to avoid floods, which will increase as a result of climate change. The implementation of this Program nationwide is related with Objective 3.2.3 of the PECC, 2007-2012 NDP and the 2007-2012 PNH.

3. **Classification of the action's scope:**

National

4. **Start and end date of the action:**

In 1995 this Program was moved to the Department of River Protection Infrastructure and Rainfed Districts.

5. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

6. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 30% - Social 70%

7. **How the action was financed:**

Governments and governmental authorities: 100% federal resources from the Conagua.

8. **Impact/benefit of the action (in environmental, economic and social terms):**

All the feasibility studies drawn up under this Program allow flood scenarios to be viewed through three fundamental perspectives:

- **Technical Feasibility Studies:** These studies allow flood scenarios and/or factors to be analyzed through the design of three alternatives for the construction of infrastructure works to protect the rivers proposed in the studies, with the aim of analyzing which is the most viable option in economic and technical terms. In this way the planning horizon is broadened and the flood curves can be clearly viewed through different return periods of the flood. It even allows infrastructure works to be designed with return periods of up to 1000 years.
- **Environmental Feasibility Studies:** These studies allow the current status of the environmental system to be viewed in the sites where the construction of infrastructure works is carried out to protect population centers. They serve as background information to analyze the historical situation of the presence and outbreak of floods over time and their relationship with the depletion of natural resources and environmental depredation. These studies also serve as the technical background to draw up the Manifestation of Environmental Impact (MEI), in order to comply with the General Law of Ecological Balance and Environmental Protection (LGEEPA) based on articles 28 and 5 of that Law's By-Laws. The MEI also allows the environmental

scenarios to be viewed based on the technical alternatives described in the aforementioned study, which allows environmental protection to be favored and sustainability to be promoted.

- **Legal Feasibility Studies:** They allow the current legal situation of the project to be analyzed, as well as the soil use and the right of way permits, and ensures that the development of the project is legally in line with the regulations in force in Mexico, which indirectly fosters social justice in the population benefited by the infrastructure works to protect population centers.

9. Innovations that contributed to the success of the action:

The setting up of the "Management System for Hydro-Agricultural Infrastructure Processes" in the Deputy Director General's Office for Hydro-Agricultural Infrastructure, administered by the Department of River Protection Infrastructure and Rainfed Districts, allows the standardization and control of administrative and management processes for budgetary resources, through an online information system available for public consultation.

It includes all the planning, budgetary, contracting, implementation follow-up and investment project closing activities, intended for the operation, conservation, maintenance and administration of the federal hydro-agricultural infrastructure in the country's Technified Rainfed Districts (TRDs), as well as the Inventory of Infrastructure Works to Protect Population Centers.

It would be of great importance to include the PCP Program's central alignment around climate change in this system, for this information site to be the forerunner of a national system of floods and protection of population centers, for public consultation and early warning systems as well as a central digital archive of the first adaptation measures in terms of infrastructure to protect population centers.

10. Reference document(s) or website for more information:

http://sgh.conagua.gob.mx/

Contact details:

Alejandra Escalante Paredes. Deputy Department for Special Projects in the Department of River Protection Infrastructure and Rainfed Districts, in the Conagua's Deputy Director General's Office for Hydro-Agricultural Infrastructure; alejandra.escalante@conagua.gob.mx; (+52 55) 5174 4000, exts 1207 and 1208.

Illustration 8 "El Macayo" Control Structure (PHIT)

2. Planning and cooperation efforts

The growing impact of climate change on water resources implies the need not only to upscale actions which seek to ensure the sustainability of water resources, but also to increase the coordination between water managers at different scales, seeking synergies and mutual benefits in their planning processes, be it in terms of sharing information or financial resources. Additionally, this coordination should ensure a more holistic and multi-sectoral focus with other relevant planning processes to tackle the issue "out of the water box", and should be based on the most updated information on the impacts of this phenomenon. At the same time as it constitutes a threat, climate change also provides an opportunity to enhance collective cooperation efforts between water stakeholders and those in other disciplines related with water resources, which should be the objective with or without climate change.

The four actions highlighted in this chapter respectively show an example of regional cooperation to increase the technical understanding on water and climate change (the Regional Policy Dialog on Water and Climate Change Adaptation in the Americas), a platform for the inclusion of water in the global debate on climate change (the Dialogs for Water and Climate Change, or D4WCC), the support of an international organization for climate change mainstreaming and technical studies (the Project to Strengthen Integrated Water Resources Management in Mexico, or PREMIA), and the development of policies for water-based adaptation in Mexico (the Policy Development Program for Climate Change Adaptation in the Water Sector).

Other highly interesting examples taken from the catalogue that accompany this document include the National Water Resources Climate Change Adaptation Strategy; the Tabasco Integral Water Plan (PHIT); the natural resources management plans in the Michoacán State Basin Commissions; Shared Management of the Pixquiac River Basin by SENDAS, A.C.; and the Program of Actions and Projects for Water Sustainability in the State of Guerrero. The planning efforts undertaken around the 2030 Water Agenda should also be mentioned, both nationally and at the regional level, which in both cases took into account the future impacts of climate change on water resources.

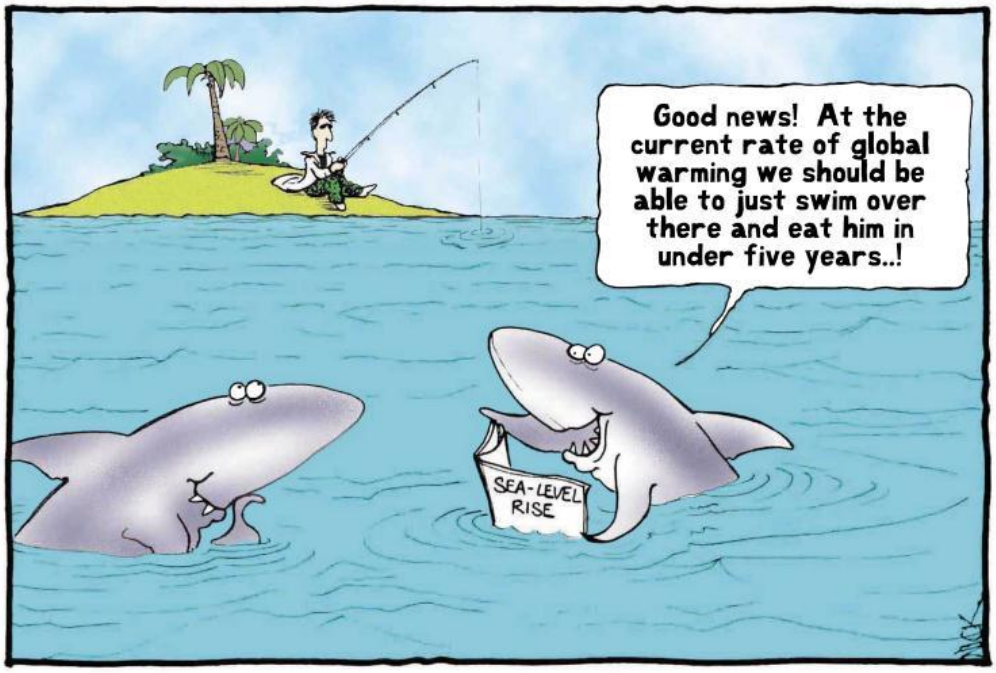


Illustration 9 The importance of planning appropriately to be able to adapt to climate change

2.1 Regional Policy Dialog (RPD) on Water and Climate Change Adaptation in the Americas

The RPD is a multi-stakeholder platform with 21 members coordinated by the Conagua, who work with a shared vision towards common goals regarding water-based climate change adaptation in the Americas. It has fostered the formulation of nine public policy recommendations on this subject, which have been presented and fine-tuned through a series of relevant events, including COP 16, the 6th World Water Forum and Rio+20. The RPD has defined and pursued two targets, related with the drawing up an inventory of water and climate change adaptation actions in the Americas (www.aguaaaa.org) and stimulating the specific inclusion of water in national and local climate change adaptation plans between 2009, 2012 and 2015, and aims to continue working towards both targets in the coming years. Additionally, within the framework of the RPD, the Prize for Water and Adaptation Actions is organized every three years.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve urban problems
   - Climate change adaptation to solve rural problems
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services
   - Climate change adaptation to face sea-level rise
   - Other: A cooperation platform to deal with water-based adaptation in the political-technical domain

2. **How this action helps to face climate change:**

The RPD seeks to achieve the following objectives:

- Socially construct a reflexive and multi-stakeholder platform in the Americas to develop a common and coherent position regarding the importance of water-based climate change adaptation and mitigation.
- Raise awareness on this issue amongst the public-at-large, water and other experts and decision makers, through events, technical publications and media campaigns.
- Foster the exchange of best practices and social learning processes.
- Consolidate a network of cooperation and political action to influence the theme's mainstreaming process.

3. **Other organizations that took part in the action, and how:**

The members of the RPD, who collectively take part in its actions, are the following: American Society of Civil Engineers (ASCE), Central American Commission for Environment and Development (CCAD), Conference of Ibero-American Water Directors (CODIA), Conservation International (CI), FEMSA Foundation, Freshwater Action Network for Central America (FANCA), Freshwater Action Network for Mexico (FANMEX), Global Water Partnership (GWP), Environment Secretariat of the State of São Paulo (SMA), IDB, International Union for the Conservation of Nature (IUCN), National Water Agency of Brazil (ANA), Mexican Institute of Water Technology (IMTA), National Water Commission of Mexico (Conagua), National Water Ministry of Ecuador (SENAGUA), The Nature Conservancy (TNC), United Nations Human

Settlements Programme (UN-Habitat), Water Advisory Council (CCA), Water Center for Latin America and the Caribbean at the Tecnológico de Monterrey, World Bank (WB), and WWF.

4. Classification of the action's scope:

Regional (in the Americas)

5. Start and end date of the action:

It started in June 2010, and continues to date.

6. Approximate cost of the action:

5,000,000 to 10,000,000 Mexican pesos

7. Percentage of this cost directly assigned to infrastructure and to social questions:

Infrastructure 0% - Social 100%

8. How the action was financed:

Intergovernmental institutions / Governments and governmental authorities / Companies and utilities / Civil society organizations and water user associations / Professional associations and academic institutions: The funding comes from the RDP's members, mainly the Conagua, IDB, FEMSA Foundation, the Water Center for Latin America and the Caribbean and the SMA. The other members have mainly contributed in kind, with their technical expertise and/or political support.

9. Impact/benefit of the action (in environmental, economic and social terms):

The impacts of the RPD have been multiple and far-reaching, and include the following:

- It has raised awareness among different stakeholders both within and outside the water community;
- It has supported the inclusion of the impacts of climate change on water resources in national and local deliberations in the countries of the region;
- It has facilitated the collaboration on joint projects and actions between different organizations, such as for example the program on water reserves for the environment, through collective funding and implementation (see 1.1);
- It has provided a platform for some of the members of the RPD to commit to carrying out actions in the future, such as the water funds, for which various members of the RPD have assigned 27 million USD to create 32 new funds (see 4.4); and
- It has allowed the winner of the Prize for Water and Adaptation Actions, CHF International, to implement its winning activity, water harvesting, at a greater scale in Honduras, through 50,000 USD in seed money.

10. Innovations that contributed to the success of the action:

The RPD in itself is an innovation, seeking to change the paradigm around water management, by fostering a collective thought process among water managers "outside the water box", and broadening this consideration with those in charge of the issues of climate change, the environment, sustainable development and urban planning, among other relevant issues. Furthermore, the RPD has innovated as regards its organization, since it does not have a set structure or formal operating procedures, but by defining a collective vision – another innovation – the latter has not been necessary. Its leadership has come from a government agency, a rare occurrence that is relevant for its success, given the predominant role of national governments in the search for sustainable solutions to environmental,

social and economic problems and in the international debate on these issues. Finally, it has innovated as regards its long-term vision, encapsulated in its two targets.

11. Reference document(s) or website for more information:

www.waterclimatechange.org

Contact details:

Colin Herron, External Consultant and RPD Coordinator, on behalf of the International Cooperation Department in the Conagua's Deputy Director General's Office for Planning; colin.anthony.herron@gmail.com.

2.2 Dialogs for Water and Climate Change (D4WCC)

As part of the strategy developed by the Conagua in order to insert water resources in the global climate change debate, and initially in the framework of the UNFCCC's 16th Conference of the Parties (COP 16), held in Cancun, Mexico in 2010, a series of relevant partners came together to give shape to the D4WCC with the purpose of shedding a new light on the importance of water resources management for climate change adaptation. Over time and through different events, the D4WCC have been strengthened as a process that seeks to bring together the sustainable development community and the sectors and stakeholders interested in strengthening water resources management as a measure to effectively adapt to the impacts of climate change.

1. Classification of the action's focus:

- Climate change adaptation for floods
- Climate change adaptation to solve water scarcity issues
- Climate change adaptation to solve urban problems
- Climate change adaptation to solve rural problems
- Climate change adaptation to solve environmental problems
- Climate change adaptation to solve problems of basic services
- Climate change adaptation to face sea-level rise

2. How this action helps to face climate change:

The D4WCC have aimed to constitute a political platform to insert water into the UNFCCC debate, with the purpose of opening up a range of possibilities for crosscutting interaction between the water and climate change communities, among others, which traditionally act in their own narrow processes. It has been an effort to raise awareness and increase the technical understanding on this issue by harmonizing the vision of the water community, and sharing it with other communities which are central to sustainable development. Within the UNFCCC, the D4WCC have facilitated the insertion of water under the Nairobi Work Programme (NWP), leading to the production of a technical paper by the UNFCCC secretariat, and the holding of a first technical workshop on water and climate change in Mexico City in July 2012.

3. Other organizations that took part in the action, and how:

There are a number of partners that have contributed to the D4WCC, its apogee being in the first edition at COP 16, which had 612 participants and the active support of the organizations whose logos are shown below. This participation has taken different forms, from the technical consultancy from the WB (see 2.4) and UN-HABITAT, the convening of sessions and other joint activities (UN-Water, WB and the Water Resources Group, among others), sharing of technical experiences (AGWA, Water Resources Group), funding (FEMSA Foundation, WB and Grupo Modelo), political support (the Water and Climate

Coalition and the CODIA) and communication and outreach (Water Advisory Council and The Water Channel).

Illustration 10 Partners in the organization of the D4WCC

4. Classification of the action's scope:

International

5. Start and end date of the action:

The D4WCC started during the preparation of COP 16, held in November and December 2010, and continue to date.

6. Approximate cost of the action:

5,000,000 to 10,000,000 Mexican pesos

7. Percentage of this cost directly assigned to infrastructure and to social questions:

Infrastructure 0% - Social 100%

8. How the action was financed:

Intergovernmental institutions / Governments and governmental authorities / Companies and utilities / Civil society organizations and water user associations / Professional associations and academic institutions

9. Impact/benefit of the action (in environmental, economic and social terms):

The D4WCC have raised the level of technical understanding within the international water community on the issue, and have had a great impact in Mexico in terms of the knock-on effect on the number and quality of actions that seek to fully integrate the impact of climate change on water, both in the federal government and among other relevant stakeholders. Additionally they have led to an increased international recognition of the work of the Conagua, as the main organizer and instigator of the D4WCC. As a political platform, the benefits in environmental, economic and social terms have been rather

indirect, since the benefits that it is hoped to achieve are long-term, in terms of improving adaptation to future climate events and processes.

10. Innovations that contributed to the success of the action:

As is the case for the RPD (see 2.1), the importance of the leadership role of a governmental agency has been fundamental for the success of the D4WCC, due to its far-reaching influence and its role both within and outside the formal UNFCCC process, as well as the support of partners of different types (governments, non-governmental organizations, private sector, intergovernmental institutions and academia). Traditionally this type of processes is led by international organizations, who lobby national governments from the outside. Additionally, the harmonization of the vision of many organizations on a key question for the future work of all of them has been fundamental. Finally, the D4WCC's long-term vision has been essential, as an effort that started through an event before turning into a process that the Mexican federal government has continued to promote, through the Conagua.

11. Reference document(s) or website for more information:

www.d4wcc.org.mx

Contact details:

Colin Herron, External Consultant and Coordinator of the D4WCC, on behalf of the International Cooperation Department in the Conagua's Deputy Director General's Office for Planning; colin.anthony.herron@gmail.com.

2.3 Project to Strengthen Integrated Water Resources Management in Mexico (PREMIA)

Since 2006, the WMO has provided technical assistance, capacity development and technology transfer to the Conagua through the implementation of the PREMIA project. During the 2006-2012 period, activities were implemented for a total value of $8.8 million USD, and were developed in different thematic areas, with the participation of around 300 national and international experts as well as WMO staff. A great variety of activities have resulted in tangible benefits for Integrated Water Resources Management (IWRM) in Mexico, as well as for the adaptation of the water sector to climate change; for example, this document and six of the 20 actions presented in it have received financial and technical support through the PREMIA. Recently the continuation of this collaboration has been agreed upon, through the preparation and implementation of the project to Strengthen the Water Sector to face Climate Change (FORAGUACC), which initially considers the following components:

I) Institutional strengthening and capacity development;
II) Development of the Mexican Hydrological Service (MHS); and
III) Development of products and services for adaptation and mitigation in the water sector to face climate change.

1. Classification of the action's focus:

- Climate change adaptation for floods
- Climate change adaptation to solve water scarcity issues
- Climate change adaptation to solve urban problems
- Climate change adaptation to solve rural problems
- Climate change adaptation to solve environmental problems
- Climate change adaptation to solve problems of basic services
- Climate change adaptation to face sea-level rise
- Mitigation of greenhouse gases

2. **How this action helps to face climate change:**

The PREMIA has provided technical consultancy to support the Conagua in its efforts to increase the efficiency of its response to climate change. Some of the most relevant activities for this document include:

I) The diagnosis and development plan of the National Meteorological Service (NMS), which were picked up as the basis for the design of the Modernization Project of the NMS (see 4.1), to be implemented with the financial and technical support of the WB;

II) The General Guidelines for the Formulation and Implementation of the National Water Resources Climate Change Adaptation Strategy;

III) The support for the planning and holding of the second edition of the D4WCC (see 2.2);

IV) The development and implementation of the course for Conagua civil servants on IWRM as a climate change adaptation measure;

V) The diagnosis and strategic plan for the development of the MHS;

VI) As well as various information, management and warning systems for water resources management and the protection of the population from extreme phenomena, in different regions of the country.

3. **Other organizations that took part in the action, and how:**

As part of the Technical Cooperation Agreement with the WMO, and taking advantage of projects and programs within the WMO, as well as its Technical Commissions, the participation of experts from other related agencies was also made possible, such as the case of the State Meteorology Agency (AEMET) and the Center for Hydrographic Studies of the Center for Studies and Experimentation in Public Works (CEDEX) from Spain, which have collaborated in the development of activities for the diagnosis and integration of development plans, both for the NMS and the MHS.

4. **Classification of the action's scope:**

International, transboundary and national

5. **Start and end date of the action:**

The PREMIA was agreed in 2005, and was implemented according to a 2007-2012 plan. Recently the general principles of the 2013-2018 plan were agreed.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 0% - Social 100%

8. **How the action was financed:**

Intergovernmental institutions / Governments and governmental authorities: The funds are from the Conagua, and the WMO receives them for the purpose of contracting the consultants from its network.

9. **Impact/benefit of the action (in environmental, economic and social terms):**

The different technical assistance, capacity development and technology transfer activities developed have contributed to the creation and strengthening of capacities among the staff in the different areas of the Conagua that take part, in order to improve water resources management and to be in better conditions to face and adapt to the impacts of climate change. An evaluation report on the impacts of

the PREMIA is currently being prepared, which should shed more light on the benefits of the project as such. The actions in the PREMIA are aligned with five of the eight objectives, 25 strategies and 23 indicators of the 2007-2012 PNH, all of which have been successfully completed.

10. Innovations that contributed to the success of the action:

The PREMIA has facilitated the participation of international experts for short-term missions with specific purposes, which otherwise would have been complicated if not impossible to organize directly through the Conagua. The PREMIA, the only direct cooperation scheme between the WMO and a member country, counts on the support of a Project Office in Mexico for that purpose, which oversees the cooperation activities between both institutions, supporting in particular the consultancies carried out as part of the PREMIA.

11. Reference document(s) or website for more information:

Due to their diverse nature, the studies are not centralized in a single location, but are available upon request from the WMO Project Office in Mexico.

Contact details:

José Alfredo Garza, WMO Project Office in Mexico; jgarza@wmo.int; (+52 55) 5174-4867 / 4868

Illustration 11 *Jagüey* for water catchment

2.4 Policy Development Program for Climate Change Adaptation in the Water Sector

Within the framework of the strategic alliance between Mexico and the WB, a loan for 450 million USD was formalized for the development of public policies aiming to support the Mexican government's efforts to foster climate change adaptation in the water sector, in which SEMARNAT and the Conagua took part. This alliance sought the sharing of knowledge and global experience, technical consultancy services and innovative financial mechanisms to support Mexico's efforts towards its national climate change strategy, which is central to the country's development agenda. As regards the technical assistance program in the framework of the Development Policy Loan (DPL) on Water and Climate Change, the following themes were supported: The Conagua's efforts aiming to create a long-term vision for the water sector – Vision 2030; Strengthening the Water Sector's Financing System; Water Resources Management and Climate Change Adaptation at the Basin Level; Implementation of the Strategic Plan for the Modernization of the NMS (see 4.1); and Mainstreaming Climate Change Adaptation in the Water Sector.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods

- Climate change adaptation to solve water scarcity issues
- Climate change adaptation to solve urban problems
- Climate change adaptation to solve rural problems
- Climate change adaptation to solve environmental problems
- Climate change adaptation to solve problems of basic services
- Climate change adaptation to face sea-level rise

2. **How this action helps to face climate change:**

The DPL incorporated sectoral policy guidelines, such as water resources conservation and efficiency in water and energy management, present in several of the programs, standards and initiatives managed by the Conagua. Special emphasis was placed on actions in the water sector that contribute to the PECC, through the strengthening of the water sector's regulatory framework and the issuing of standards and incentives in the Conagua's operative regulations, such as the MX and NOM standards elaborated through the joint action of different institutions, under the leadership of the Conagua, and the incorporation of incentives related with the issue of climate change in the operative rules of the federalized programs under the Conagua's responsibility.

3. **Other organizations that took part in the action, and how:**

SEMARNAT's participation focused on the framework of climate change policies associated with adaptation in the water sector, especially the PECC and the Fourth Communication to the UNFCCC, which attributes the same relevance to mitigation and adaptation strategies. Additionally, the Conagua implemented the development of a regulatory framework and financial mechanisms to formalize climate change adaptation in the water sector; identifying a series of standards and programs that incorporate elements of climate change adaptation, including the improvement of efficiency and integrated management of the resource. Furthermore, since 2009 the Conagua has included incentives in its federal programs based on concepts of water reuse (conservation) and prioritization of geographic areas with high social marginalization.

4. **Classification of the action's scope:**

National and sub-national

5. **Start and end date of the action:**

It started with the signing of the DPL in July 2010, and will come to a close with the closing mission in January 2013.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 30% - Social 70%

8. **How the action was financed:**

Intergovernmental institutions (WB)

9. **Impact/benefit of the action (in environmental, economic and social terms):**

This Program allowed an educational platform to be created in order to disseminate the issue of climate change in the Conagua, follow up on the 2030 Vision of water and the planning activities that it implies, the strengthening of the tasks of measuring the quantity and quality of water in Mexico and the

production of a climate change adaptation strategy in the water sector; similarly, the technical assistance from specialists was harnessed to improve the institutional framework for the implementation of policies to face climate change in the sector and the growing incorporation of climate change adaptation perspectives in water utilities, users and consumers, actions that were made possible through the DPL, on which follow up was guided by a Policy Matrix that reflected the objectives and targets of the PNH and the PECC and was the guiding instrument to monitor progress of the policies supported by this operation.

10. **Innovations that contributed to the success of the action:**

The support and technical assistance from the WB, as well as the involvement of different areas of the Conagua in the issue of climate change.

11. **General comments:**

This project has helped to change the mentality of the Conagua's civil servants by generating awareness about the implications of climate change for water resources management; as well as the positioning of the Conagua as a key player in the dialogue on climate change at the national and international levels. In this sense, through the D4WCC (see 2.2), the Conagua has positioned itself as a global leader in the issue of water-based climate change adaptation. The implementation of the DPL has also had positive effects in other areas, having a direct influence on the conception and development of other projects with the WB, particularly the development of the Project to Modernize the NMS (see 4.1) which is currently in an initial phase. Additionally, through the DPL a consultancy was funded on the Water Financing System (WFS), the results of which generated consensus on its definition and scopes, as well as developing a set of initiatives on new schemes for the funding of hydro-agricultural projects and for emergency attention in the case of disasters caused by extreme hydro-meteorological events.

12. **Reference document(s) or website for more information:**

http://web.worldbank.org/external/projects/main?enableDHL=TRUE&hlPK=2810751&menuPK=2805091&pagePK=64283627&piPK=64624214&theSitePK=2748767&Projectid=P120134

Contact details:

Noé Adolfo Salazar Ramírez, Project Leader, Deputy Department for the Management and Evaluation of Projects with External Credit, in the International Cooperation Department of the Conagua's Deputy Director General's Office for Planning; noe.salazar@conagua.gob.mx; (+52 55) 5174 4000, ext. 1764 and 4412.

3. Improving the knowledge base, measuring and monitoring

Information on climate change and water by definition includes a high degree of uncertainty, since it is based on forecasts derived from possible scenarios of emissions and their consequent impacts on the different components of the water cycle. Between the most optimistic and pessimistic scenario, the range of possibilities is extensive. Even so it is essential to improve as much as possible the precision of the monitoring of current climate and hydrological conditions, as well as the forecasting of future conditions. That information should be shared and made available to experts in different water-related disciplines, and at different scales. Furthermore, it is essential that this does not remain an academic exercise, but should serve to inform decision making on prevention measures that reduce the damage and losses. Finally, it is clear that the information on climate change is not currently and will surely never be perfect, but this should not prevent the implementation of proactive "no regrets" or "low regrets" actions that strengthen the resilience of the most vulnerable communities, as well as preventative actions, which have a highly favorable cost-benefit ratio. It should be mentioned that these actions can be fully justified with or without the occurrence of climate change.

The four actions highlighted in this chapter include an effort to foresee the impacts of climate change on water resources at a more localized scale (Studies to characterize the regions of the country according to climate change), a regional platform that has improved the sharing of current information on drought (North American Drought Monitor), an action to measure the country's vulnerability through water resources (Atlas of Water Vulnerability to Climate Change) and an information tool to systematize experiences among 30 local communities in the state of Guerrero (Shared Water for Everyone).

Other interesting actions in the catalogue include the shared hydro-climate monitoring networks in the basin of the Valley of Mexico; the National Inventory of Wetlands at a 1:250,000 scale; the Documentary Center on Water Studies in Tabasco; the hydrological forecasts through the model known as River Forecast System; and the production by WWF Mexico of the document "Mexico's Water Footprint in the Context of North America".

Illustration 12 When is the best moment to face the impacts of climate change?

3.1 Studies to characterize the regions of the country according to climate change

This is a pioneering study in which diagnoses have been elaborated for each of the country's 13 RBOs, including general aspects and conditions and climate trends, water management and expected changes in the hydrological dynamic, as well as the most outstanding conditions of vulnerability in each of the country's 13 Hydrological-Administrative Regions (HARs). Similarly, analyses were produced of general scenarios and expected impacts under conditions of climate change by HAR, and some guidance was outlined aiming to reduce the vulnerability and enhance climate change adaptation for each RBO and at the national level.

1. **Classification of the action's focus:**

Other: Climate change adaptation through IWRM at the national level.

2. **How this action helps to face climate change:**

This study was based on the information and general knowledge on each of the country's HARs, which it systematized and analyzed under a vision of climate change adaptation, the final objective of which focused on the definition of general actions for adaptation in the water sector at the national level.

3. **Other organizations that took part in the action, and how:**

Under the leadership of the Conagua, the study was produced with the participation of a group of meteorologists, climate change and water management specialists, under the coordination of Dr. Rosalva Landa. Support and technical follow up was provided by the NMS and funding from the WMO through its Project Office in Mexico, in the collaboration framework of the PREMIA and MoMet projects.

4. **Classification of the action's scope:**

National and sub-national

5. **Start and end date of the action:**

The project started in October 2011 and finished in December 2012.

6. **Approximate cost of the action:**

100,000 to 500,000 Mexican pesos

7. **How the action was financed:**

Intergovernmental institutions / Governments and governmental authorities: Funds from the PREMIA project

8. **Impact/benefit of the action (in environmental, economic and social terms):**

The impact will be reflected by the information base on the more general conditions and courses of action, which could be included in medium- and long-term water planning processes, to face the expected impacts of climate change in the water sector at the national level. The results may also provide input to the National Water Resources Climate Change Adaptation Strategy.

9. **Innovations that contributed to the success of the action:**

Meteorological information from the NMS and the IMTA was taken into account to leave an analytical precedent on this issue.

Contact details:

Dr. Rosalva Landa, an independent consultant specialized in IWRM, socio-environmental analysis and climate change strategies, leader of the study and coordinator of the group of consultants; rosalba.landa@gmail.com; 044 55 2748 1283.

3.2 North American Drought Monitor (NADM)

The North American Drought Monitor is a cooperation effort between experts from Canada, Mexico and the United States of America, which initiated in April 2002, as part of a broader project, the main objective of which is the monitoring of extreme climate events on the territory of the three countries.

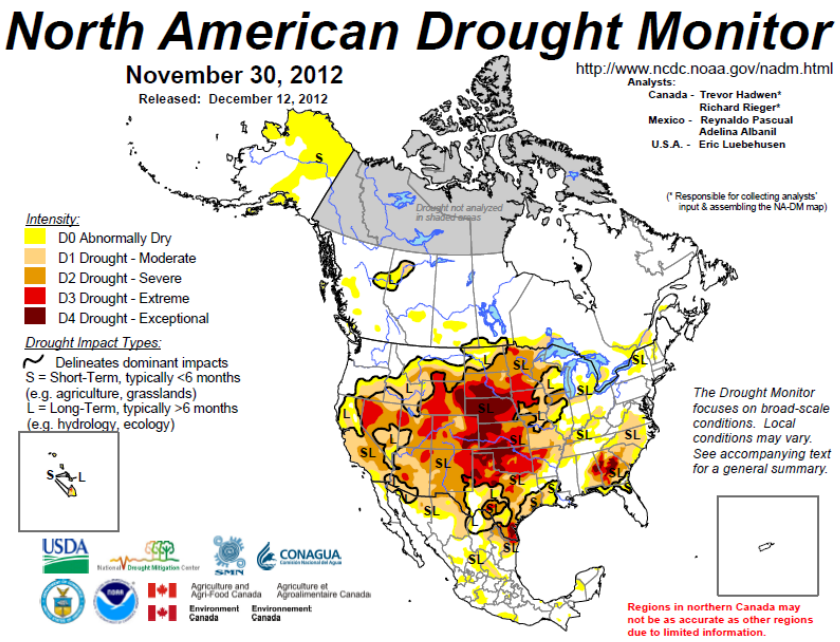


Illustration 13 North American Drought Monitor, November 30, 2012

1. **Classification of the action's focus:**

Climate change adaptation to solve water scarcity issues

2. **How this action helps to face climate change:**

The effects of climate change will not be bound within national borders, so adopting a regional approach will allow this phenomenon to be more effectively monitored over time. It is almost redundant to mention that drought in itself is not merely a consequence of climate change, but of many climatic, hydrological and human-related factors (excessive irrigation, deforestation, erosion, etc.). However, it is expected that the intensity and frequency of droughts will increase in the future as a result of climate change, so having an effective mechanism for following its progression will constitute a vital tool to proactively limit its impact.

3. **Other organizations that took part in the action, and how:**

Agro-Food and Fishing Information Service (SIAP)

4. **Classification of the action's scope:**

International

5. **Start and end date of the action:**

Since June 2003, drought maps of Mexico and North America have been made available.

6. **Innovations that contributed to the success of the action:**

The development in the NMS of the Standardized Precipitation Index (SPI) and analysis of other indices, which allow the level of the drought impact to be appreciated in space and time.

7. **Reference document(s) or website for more information:**

http://smn.cna.gob.mx/index.php?option=com_content&view=article&id=236&Itemid=74

Contact details:

Brenda Liliana Bello Jiménez. Head of Department for Analysis and Quality Control of Climate Registers. Deputy Department of Medium- and Long-Term Forecasts. Department of Meteorology and Climatology. General Coordination of the NMS; brenda.bello@conagua.gob.mx.

3.3 Atlas of Water Vulnerability to Climate Change in Mexico

As a result of the scientific production in the IMTA of the series titled "Effects of Climate Change on Mexico's Water Resources", in 2010 the Atlas of Water Vulnerability to Climate Change in Mexico was published, the third installment of the series regarding this phenomenon. The study focuses on evaluating the impact of climate change in six main sectors: social vulnerability; anomalies in precipitation and maximum, minimum and mean temperatures included in climate scenarios; the rainy season and tropical cyclones; surface water; irrigated agriculture; and water quality. Some of these studies were structured based on the generation of climate scenarios with a greater resolution than that proposed by the IPCC in its fourth assessment report. This allowed the effects of climate change on the national territory to be analyzed and appreciated with greater precision than was previously possible, considering variations in temperature and precipitation. Furthermore, through the Official Mexican Standard 011, the runoff was determined from these precipitation anomalies, with the objective of pinpointing where the availability of water resources would be reduced and to what extent. The vulnerability in the issue of water quality as a result of climate change was also evaluated in three representative basins in Mexico, and a social vulnerability index was generated for all municipalities in Mexico.

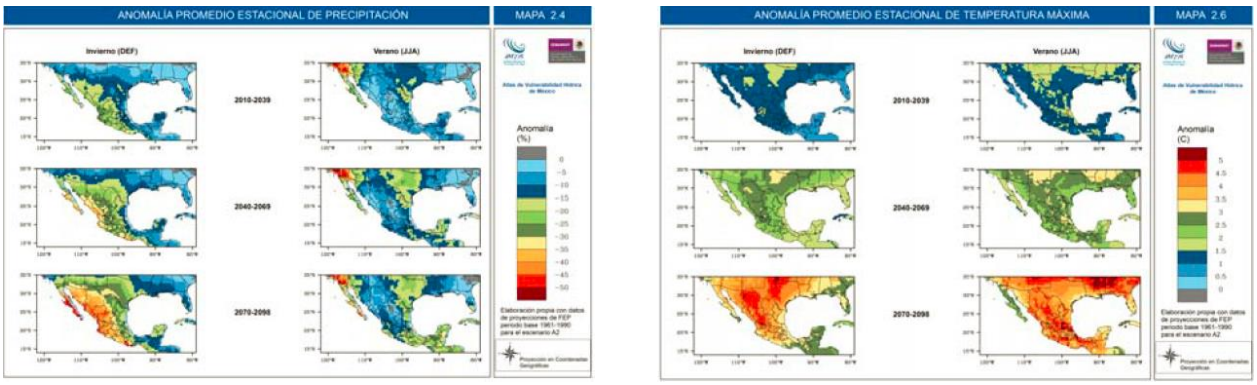


Illustration 14 Mean seasonal anomaly of precipitation and maximum temperature, projected for Mexico

1. **Classification of the action's focus:**

- Climate change adaptation for floods
- Climate change adaptation to solve water scarcity issues
- Climate change adaptation to solve rural problems
- Climate change adaptation to solve environmental problems

- Climate change adaptation to solve problems of basic services

2. **How this action helps to face climate change:**

This document, which adds to the literature generated and accumulated on climate change in Mexico, rather than showing a catastrophic vision, is an invitation to reflect upon the need to take measures to reduce Mexico's vulnerability and confront the threats related with climate change as appropriately as possible. Tackling this phenomenon from the perspective of vulnerability allows us to understand and explain the causes and symptoms of "natural" disasters, decrease the negative consequences on social organization, and establish an operative baseline for the design of social policies, for prevention and adaptation in Mexico to this enormous challenge. Through this publication, SEMARNAT is looking to continue with its analytical activities to disseminate social knowledge, strengthen and support better-informed decision making to mitigate the effects that the country will surely face.

3. **Classification of the action's scope:**

National

4. **Start and end date of the action:**

It started in 2010

5. **Approximate cost of the action**

1,000,000 to 5,000,000 Mexican pesos

6. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 0% - Social 100%

7. **How the action was financed:**

Governments and governmental authorities (the funds came from the IMTA's own budget)

8. **Impact/benefit of the action (in environmental, economic and social terms):**

The Atlas constitutes an important tool to increase the knowledge base on the future impacts of climate change in the water sector, and is intended to inform the definition of public policies on climate change, providing input to other thought processes on this subject. In this sense, the Atlas aims to reduce the impacts of future extreme hydro-meteorological events and slow onset processes, in environmental, economic and social terms, by identifying some of the potentially most vulnerable geographical areas, population groups and productive sectors to this phenomenon.

9. **Innovations that contributed to the success of the action:**

The Atlas proposes a holistic vision of the elements that constitute water vulnerability, from social aspects, precipitation and temperature, the rainy season and tropical cyclones, surface water, irrigation and water quality.

10. **Reference document(s) or website for more information:**

http://www.imta.gob.mx; http://pncs.imta.gob.mx

Contact details:

Dr. Carlos Patiño Gómez, Deputy Coordinator for Integrated Water Management, Hydrology Coordination, IMTA; carlos_patino@tlaloc.imta.mx; (+52 777) 329-3600 ext. 512

3.4 Shared Water for Everyone

The project is implemented as part of the Integrated Regional Project that the Group of Environmental Studies, AC (GEA) carries out in the state of Guerrero. It is developed by the GEA's Peasant Natural Resources Management Program, and some 30 communities in the Central-Mountain region. Its objectives are:

- To strengthen the capacities of families, communities and organizations so that they can affirm the control of their territories and natural resources and make better and more informed decisions about their management.
- To promote processes that guarantee good, sufficient and sustainable water and food in the micro-basins.
- To identify and consolidate relevant resources and practices to increase resilience and community-based and regional adaptation to prevalent environmental and social changes.

1. **Classification of the action's focus:**
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve rural problems
   - Climate change adaptation to solve problems of basic services

2. **How this action helps to face climate change:**

One of the main tenets of this project is working on capacity development from peasant to peasant, in order to guarantee their self-supply of water in quantity and quality, among other natural resources, as well as maintaining the environmental services provided by their territories to the region, in a co-management scheme, with shared responsibility. The integral management of water and natural resources linked to the territory should be highlighted, which has allowed soils to be recovered, fertility to be improved and additional income to be generated through the production of mescal. The project aims to identify and consolidate relevant resources and practices to increase community and regional resilience and adaptation to the environmental and social changes of our time. The management of natural resources by the local communities is by definition more adaptable, and facilitates decision making that is closer to the reality of the impacts of these changes on water resources.

3. **Other organizations that took part in the action, and how:**

In addition to GEA and the 30 communities in question, the financial support for this project has come from the Ford Foundation, the National Indigenous Institute, the National Forestry Commission (Conafor) and the Gonzalo Río Arronte Foundation. Alternativas y Procesos de Participación Social AC, the Red de Aprendizaje, Intercambio y la Sistematización de Experiencias hacia la Sustentabilidad (RAISES) and the Mexican Civil Council for Sustainable Forestry (CCMSS) have also supported it with consultancy.

4. **Classification of the action's scope:**

Sub-national

5. **Start and end date of the action:**

It started in 2001 in a single community, with a donation from the then National Indigenous Institute and the Ford Foundation, and in later years was extended with the contribution of Conafor. The generous contribution of the Gonzalo Río Arronte Foundation, which started in September 2005, is allowing the experience and the accumulated organization to be consolidated and translated into actions with a greater scale and regional impact in the four tributary catchments of the Balsas River that currently cover the area of work.

6. **How the action was financed:**

Governments and governmental authorities / Companies and utilities / Civil society organizations and water user associations / Professional associations and academic institutions: The GEA is the project's main implementer, with the 30 communities in question, while the funds have come from the Ford Foundation, the now defunct National Indigenous Institute, Conafor and the Gonzalo Río Arronte Foundation.

7. **Impact/benefit of the action (in environmental, economic and social terms):**

Among the main achievements, the following should be mentioned:

- Work in 69 micro-basins.
- 1,509 small soil and water restoration and conservation works completed and with maintenance in 30 communities. A map of the works completed up to the end of 2010 can be found on www.gea-ac.org.
- 61 Water Committees set up in 21 communities, renewed in each of them after different periods, with the participation of 183 people in total.
- 10 peasant promoters trained.
- 16 communities with sustainable micro-basin management plans in operation.
- 13 agreements between two or more communities to jointly restore shared micro-basins.
- 152 community assemblies, with the participation of around seven thousand people.
- 13 regional watershed management workshops, with 120-150 participants per workshop.
- 186 training activities (workshops and courses on planning, administration, use of cartography, use of GPS receptors and other equipment, soil and water restoration and conservation techniques), with more than three thousand participants, including the members of the Water Committees.
- 10 regional exchanges from peasant to peasant.
- 26 visits from groups of peasants from other regions of Mexico and other parts of the world, and from students at all levels.
- Connections with the National Autonomous University of Mexico (UNAM), the Autonomous University of Guerrero and other academic institutions.

8. **Innovations that contributed to the success of the action:**

The methodology developed places people in the center, recognizing that in these marginalized regions, the owners of the territory and the water users have always solved problems related with meeting their families' supply needs. This methodology is built upon the existing institutions in the communities, above all the Water Committees, the General Assembly and the local Authorities. Each community micro-basin plan is proposed by the Water Committee and subsequently discussed and ratified by the corresponding Assembly. Courses in watershed management and economic resources are offered; the construction of the infrastructure is accompanied and exchanges of experiences are fostered, with visits from community to community, creating spaces for self-evaluation. The signing of agreements confers formality and clearly establishes the rights and obligations of each group. The ceremony in which the infrastructure is handed over to the community is the means of legitimizing them with the local population.

9. **General comments:**

The project seeks to strengthen local capacities, by fostering consideration, exchange, information, creativity and organization in the communities as some of the elements that make up the basic tenets in the search for solutions for the main problems. By consolidating their capacities, community

organizations and institutions and peasant families ensure the control over their territories and advance towards the sustainable management of their natural resources.

10. Reference document(s) or website for more information:

GEA web page: www.geaac.org,
2005-2010 Executive Summary: http://geaac.org/images/stories/Aguacompartidainformeejecutivo.pdf,
Video: Oxtoyahualco: a village recovering wasted water,
Video: Shared Water for Everyone: a community water management project,
Video: Shared Water for Everyone: activities for community water management.

Contact details:

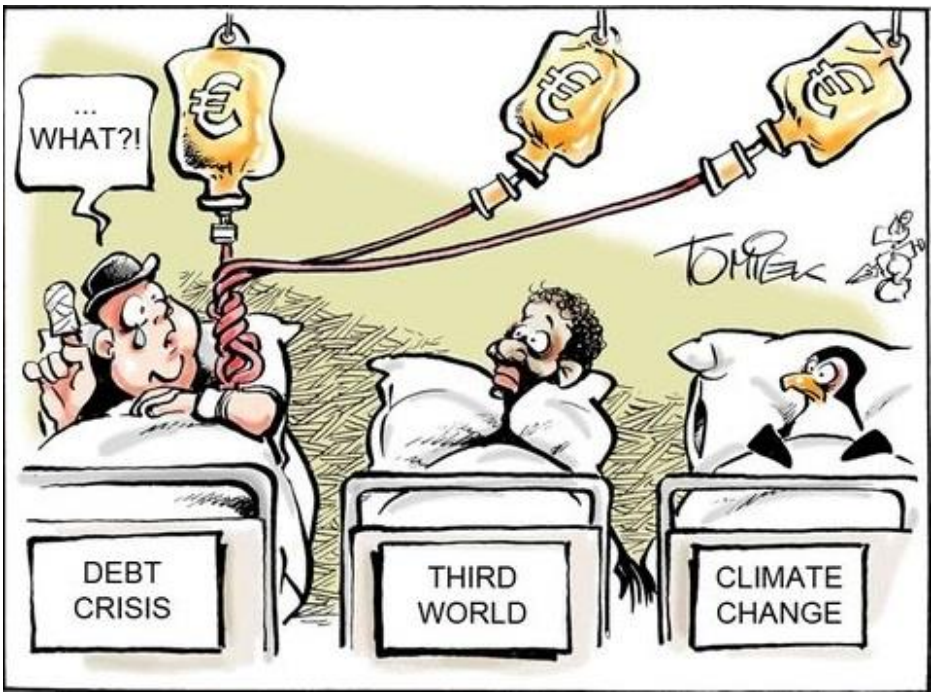
Catarina Illsley Granich, Coordinator of the Peasant Natural Resources Management program, Group of Environmental Studies, gea@laneta.apc.org, (+52 55) 5617 9027 and (+52 55) 5619 2892.

4. Innovative financial schemes and arrangements

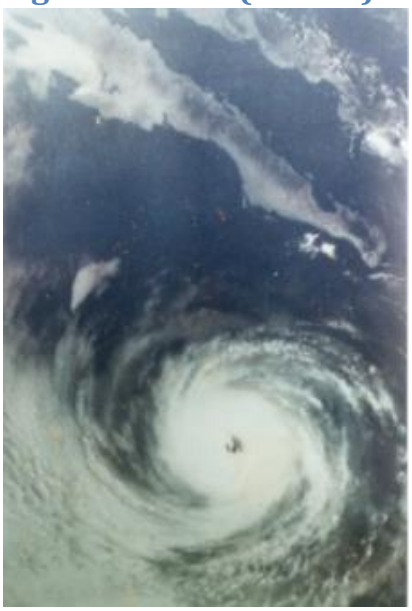
A recent report from the World Bank estimated that 75% of the investment in water in developing countries comes from public resources (WB, 2012b). The analysis of the actions in the catalogue of actions would seem to support in general terms that dependency on federal funds for the particular case of Mexico, since it is estimated that 79 of the 118 actions (66.9%) were mainly financed by federal funds. In Mexico, although in the period 2007-2012 the levels of public federal investment in water were doubled from the previous administration, and were tripled compared to the administration before that, these figures are still not comparable with the existing investment needs for water, with or without considering climate change adaptation. Consequently, the need to diversify the sources of funding for water actions is evident, with an emphasis on preventative actions, and from sub-national, national and international sources, in addition to the resources of the private sector, and efforts to foster a more efficient use of existing economic resources.

In this chapter four interesting examples are presented: a necessary action to face climate change that was implemented through a blend of resources from different intergovernmental organizations with a federal contribution (the Modernization of the National Meteorological Service); two studies of the existing international funding sources that could be used to finance water-based actions against climate change in Mexico; the setting up of the National Implementing Entity of the Climate Change Adaptation Fund in Mexico; and finally Water Funds, a successful scheme of payment for environmental services.

Finally, it is interesting to take note of some other relevant initiatives from the catalogue, such as the Sectoral Conagua-CONACYT Fund and the Special Program on Science and Technology (PECyT); the investment programs destined for the construction of WWTPs and other sanitation systems in the Michoacán Local Office; the Sustainability Parameter in the Mexico-EUA Water Infrastructure Program; and the RPD's Prize for Water and Adaptation Actions, which supported the winning activity with 50,000 dollars of seed funds. Initiative 38 of the 2030 Water Agenda is also worth mentioning, since its purpose is the creation of the Contingency Fund for Climate Change Adaptation.



4.1 Modernization Program of the National Meteorological Service (MoMet)



Based on an institutional diagnosis and proposed strategic plan for the NMS carried out by the WMO in 2010, the WB is loaning 105 million dollars for the modernization of the NMS, over a 6-year period. The WMO diagnosis mentions "institutional development and the operational structure of the NMS, meteorological observation networks, databases and information systems, the development of meteorological products and services, the development of infrastructure for climate and climate change-related issues, and the evaluation of its socio-economic benefits" among its priorities (WMO, 2010), issues that were picked up on by the WB in the four components of its support. The WMO supported the program with additional studies in 2011 and 2012, such as the Framework for Environmental Management for the MoMet. This federal program is thus supported by the technical and financial contributions of these international organizations, as well as a 66 million dollar counterpart from the federal government.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve urban problems
   - Climate change adaptation to solve rural problems
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services
   - Climate change adaptation to face sea-level rise
   - Other: Improvement of the monitoring system of components of the water cycle

2. **How this action helps to face climate change:**

Each of the aforementioned objectives will allow the NMS to provide climate services that will be essential for decision making at appropriate scales and in different sectors on the measures that should be adopted to face the occurrence of both extreme hydro-meteorological and slow onset events. The MoMet is a federal government program that receives significant technical and financial support from the WMO and the WB, within the framework of their respective collaboration schemes with the Conagua. There are numerous examples of extreme events around the world and the consequent economic losses they have engendered, which could have been prevented if enhanced monitoring and forecast infrastructure had been available. The program seeks to bolster both the physical infrastructure and the human resources within the NMS, at the national and regional level, which is considered a financial investment, since WB previous projects such as the PROMMA and PATME have yielded positive financial results (WB, 2012c).

3. **Other organizations that took part in the action, and how:**

The WMO and the WB have provided important financial and technical support for this Program. Furthermore, the implementation of component four, the Development of Regional Climate Capacity, will be mainly achieved through the Conagua's RBOs.

4. **Classification of the action's scope:**

National and sub-national

5. **Start and end date of the action:**

The WMO diagnosis, which was undertaken with the support of Spain's State Meteorology Agency, was carried out in 2009-2010. The WB's support is currently due to come to an end in December 2017.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 40% - Social 60%

8. **How the action was financed:**

Intergovernmental institutions / Governments and governmental authorities (WMO, WB, Conagua)

9. **Impact/benefit of the action (in environmental, economic and social terms):**

The impact up to now has been limited, since the initial diagnosis and other studies have been carried out by the WMO but the implementation of the support program with the WB is still yet to start. Subsequently, the impact will be important in environmental, economic and social terms, especially as regards the possibility of limiting the losses from future extreme hydro-meteorological and slow onset events.

10. **Innovations that contributed to the success of the action:**

The financial arrangements, which helped to complement the domestic economic resources with international funds, as well as the technical-financial cooperation between the two international organizations through the Conagua, are the program's two main innovations.

11. **Reference document(s) or website for more information:**

http://smn.cna.gob.mx/

Contact details:

MAP Elias Alberto Freig Delgado, Mexico's NMS; elias.freig@conagua.gob.mx

4.2 Studies on funding for water-based climate change mitigation and adaptation

This action includes the following two studies, carried out within the framework of the PREMIA:

a. Specialized Technical Assistance in Funding Issues for the Analysis and Consultancy on the Use of Funds for Climate Change Mitigation and Adaptation (2011)
b. Specialized Technical Assistance for the Production of the Financing Component of the National Water Resources Climate Change Adaptation Strategy (2012)

Through both studies, technical assistance, capacity development and technology transfer were provided to strengthen and consolidate actions implemented within the framework of the Mexican water sector's planning and funding, as well as supporting the development of the Water Financing System (WFS). Technical assistance activities were included to support water resources planning, as well as for the analysis and implementation of financial schemes, identification of sources of funding and development of financial and technical mechanisms that favor the development of the water sector. Similarly, actions were developed for the diagnosis and improvement of the WFS, as well as for the analysis and

determination of public policies on water aiming to support the economic-financial sustainability of the sector. Finally, sources of funding were identified and technical mechanisms were suggested to foster the development of the water sector.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve environmental problems
   - Mitigation of greenhouse gases

2. **How this action helps to face climate change:**

Both consultancies propose strategies and a map of available schemes to finance projects in the water sector in Mexico, which will help to adapt to and mitigate the effects of climate change. These schemes include the UNFCCC framework, multilaterals, bilaterals and Mexican funds. Faced with the multiplication of international funding schemes for climate change measures, and the high cost of the recommended measures for water, it is appropriate to investigate which schemes can be used for water projects, as input for a robust financial strategy. The following diagram outlines in general terms the main schemes that are potentially available, which are the subject of a more detailed study within the framework of the second consultancy, which aims to serve as input to the National Water Resources Climate Change Adaptation Strategy.

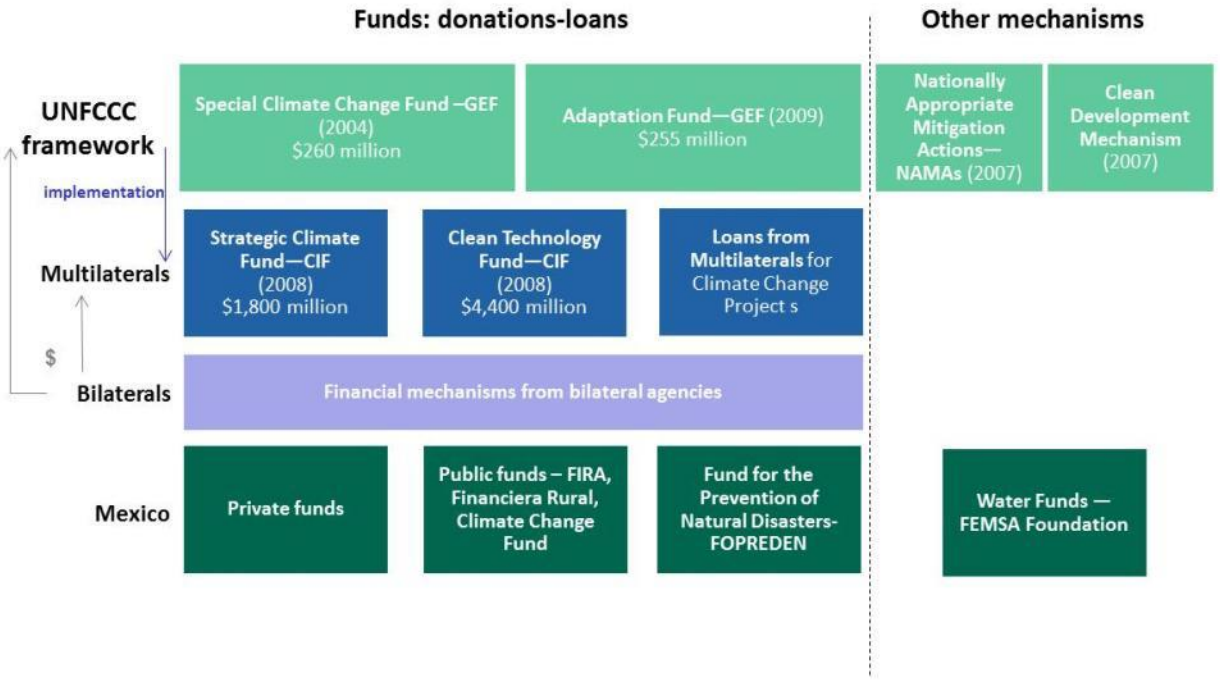


Illustration 15 Mechanisms to fund the response to climate change for the water community in Mexico

3. **Classification of the action's scope:**

International and national

4. **Start and end date of the action:**

The first of the two studies was undertaken from September to December 2011. The second one is still currently being carried out at the time of going to press.

5. **Approximate cost of the action:**

500,000 to 1,000,000 Mexican pesos

6. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 0% - Social 100%

7. **How the action was financed:**

Intergovernmental institutions / Governments and governmental authorities: Funds from the PREMIA project.

8. **Impact/benefit of the action (in environmental, economic and social terms):**

The funding study, in which the funds were identified which the Conagua can get access to in order to fund projects in the sector, working for climate change mitigation and adaptation, is now moving to the second stage with the consultancy on financing the sector-wide climate change adaptation strategy. As the project has not yet been implemented, the concrete impacts or benefits are still unknown. However, it is hoped that it will greatly benefit the environment and the population of Mexico. The projects subsequently implemented under this climate change parameter could also serve as an example to implement similar strategies in developing countries.

9. **Reference document(s) or website for more information:**

Report "Specialized Technical Assistance in Funding Issues for the Analysis and Consultancy on the Use of Funds for Climate Change Mitigation and Adaptation"

Contact details:

Nils Janson, Castalia Advisors; Nils.Janson@castalia-advisors.com; +1 (703) 408-3802

4.3 National Implementing Entity of the Climate Change Adaptation Fund in Mexico

The National Implementing Entity (NIE) of the Climate Change Adaptation Fund in Mexico is a body responsible for overseeing the projects financed through the Adaptation Fund (AF), and for administering the funds received from the AF. It is a mechanism to finance concrete climate change adaptation projects and programs in vulnerable areas.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve water scarcity issues
   - Climate change adaptation to solve urban problems
   - Climate change adaptation to solve rural problems
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services
   - Climate change adaptation to face sea-level rise

2. **How this action helps to face climate change:**

This Climate Change Adaptation Fund stimulates the development of climate change adaptation projects or programs, which put forward adaptation solutions at the community, regional and/or national levels,

and should have one or more collective objectives, with clearly defined concrete products and results as regards their scope, space and time.

3. **Other organizations that took part in the action, and how:**

The Climate Change Adaptation Fund takes part in this action, by financing and evaluating the projects and programs presented to it by the NIE, subject to its analysis criteria. The Designated National Authority also takes part, supervising the participation of the country in the AF, validating the projects to be submitted for funding, and is the spokes organization with the Secretariat of the AF.

4. **Classification of the action's scope:**

National and sub-national

5. **Start and end date of the action:**

In March 2012, the Climate Change Adaptation Fund accredited the IMTA as the NIE. From that date onwards, the Entity was organized through the creation of its Executive Coordination and the formation of the National Technical Committee. Similarly, it produced its Operating Procedures and issued its first Open Call for Offers for the presentation of project proposals to be submitted for their funding from the Climate Change Adaptation Fund, a process that is still ongoing. During the first semester of 2013 the first climate change adaptation project and/or program proposals will be sent off.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 50% - Social 50%

8. **How the action was financed:**

Other: Climate Change Adaptation Fund.

9. **Impact/benefit of the action (in environmental, economic and social terms):**

Since the process is in the project and/or program proposal design phase, and they have not yet been presented to the AF, it is still premature to evaluate the impacts/benefits of this program.

10. **Innovations that contributed to the success of the action:**

The project in itself is an innovation, since it is a means of harnessing international funding for climate change adaptation projects in Mexico.

11. **Reference document(s) or website for more information:**

http://enimexico.imta.gob.mx

Contact details:

Víctor J. Bourguett Ortiz; Coordinator for Professional and Institutional Development, IMTA; vbourgue@tlaloc.imta.mx; (+52 777) 329-3600 Ext. 100.

4.4 Water funds

Innovative mechanism of large-scale conservation based on the payment for environmental services in which the investments of downstream users are used to preserve water sources and improve the

relationship of the upstream communities with their ecosystems. The aim is to create and capitalize at least 32 Funds in Latin American and Caribbean countries.

1. **Classification of the action's focus:**
   - Climate change adaptation to solve urban problems
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services

2. **How this action helps to face climate change:**

Water sources are protected to preserve nature at the same time as ensuring the economy and wellbeing of the users by reinvesting the money in conservation efforts such as reforestation activities, ecotourism and monitoring of water flows.

3. **Other organizations that took part in the action, and how:**

TNC, the IDB and the Global Environment Facility (GEF) contributed with the funding and planning. There are other local organizations from different countries that take part in the implementation; in the case of Mexico, the Chiapas Water Seed Fund (*Fondo Semilla de Agua*) has the support of the Government, Conagua and the el Triunfo Conservation Fund, among others.

4. **Classification of the action's scope:**

International

5. **Start and end date of the action:**

June 2011

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 20% - Social 80%

8. **How the action was financed:**

Intergovernmental institutions / Governments and governmental authorities / Companies and utilities / Other: The Funds are managed through a Regional Alliance, made up of TNC, the IDB, FEMSA Foundation and the GEF with 27 million dollars. Furthermore, they attract voluntary contributions from major downstream users of the resource, such as aqueducts, hydropower or other industries, according to each local context. In the case of the Chiapas Water Seed Fund, the members of the Alliance take part, as well as the Government, Conagua, and the el Triunfo Conservation Fund, among others.

9. **Impact/benefit of the action (in environmental, economic and social terms):**

Through 27 million USD, the aim is to create, implement and capitalize at least 32 Water Funds in countries like Ecuador, Colombia, Mexico, Peru and Brazil, among others in the region. The target is to be able to conserve more than 3 million hectares of basins and benefit 50 million people within a five-year timeframe. The existing Funds are helping to conserve more than 1.3 million hectares in Latin America and the Caribbean as well as bringing benefits to their communities.

10. **Innovations that contributed to the success of the action:**

The reasons for the success are that the Funds are based on science, are inclusive, self-sustained and integral.

11. **General comments:**

There is currently a Water Fund consolidated in Ecuador and 10 others have been created and are operating in Brazil, Colombia, Ecuador and Peru. A further 21 Funds are already in the design phase, in Ecuador, Peru, Mexico, Colombia, Brazil, Costa Rica, Dominican Republic, Bolivia and Chile.

12. **Reference document(s) or website for more information:**

http://www.guardian.co.uk/sustainable-business/trust-funds-water-conservation-increased-supply
http://www.nature.org/ourinitiatives/regions/latinamerica/water-funds-of-south-america.xml
Annual Report 2011 FEMSA Foundation

Contact details:

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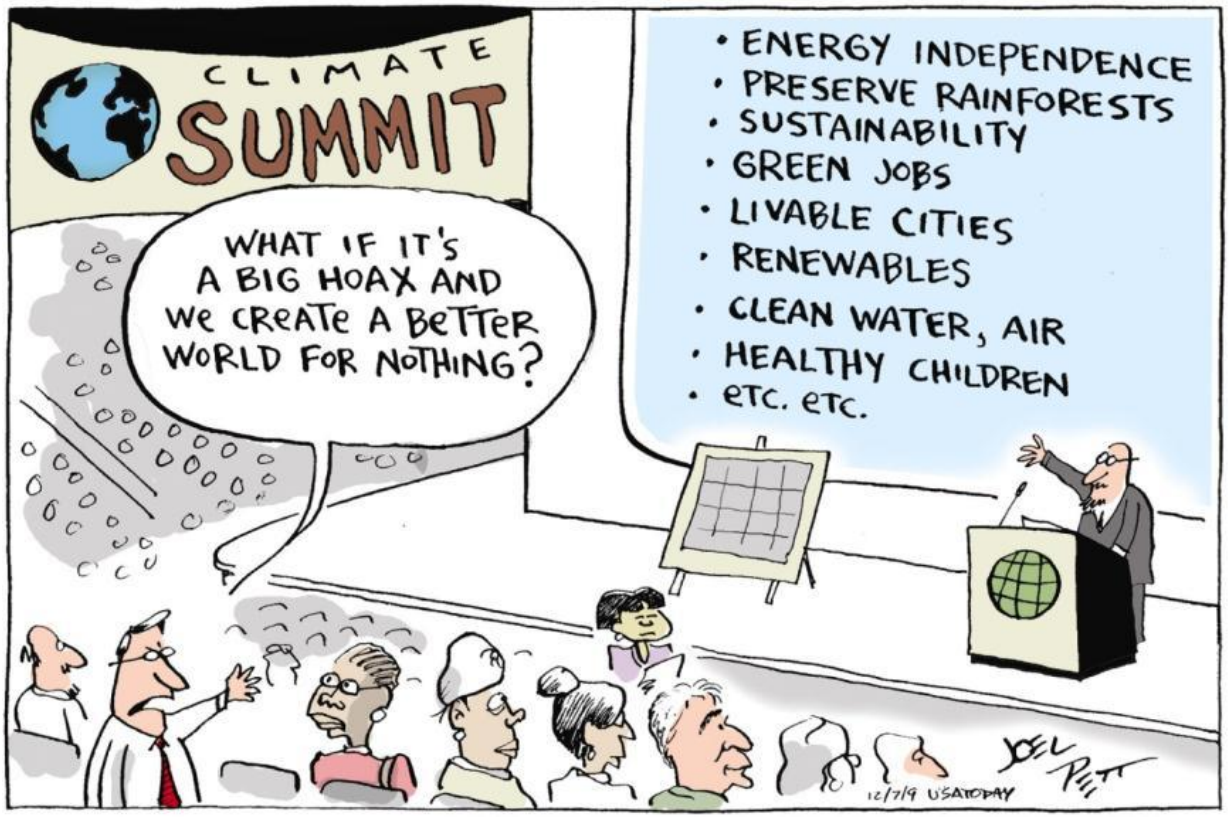
5. Use of appropriate science and technology

The response in water resources management to climate change does not necessarily require the development of new technologies, but the use of appropriate science and technology for the problem at hand. In this sense, it is fundamental that detailed studies are carried out before defining the solution to be implemented, and that when faced with already known problems, serious thought is given to what would be the most adapted solution, which will not necessarily be the most common or traditional. A good solution in the wrong context could lead to maladaptation, so it is important to avoid, figuratively speaking, that if one only has a hammer, one deals with everything as if it were a nail.

As examples in this chapter, we focus on four actions that seek to make use of appropriate science and technology for the problem at hand. First through the mitigation of GHGs while improving water quality and environmental health by registering the Atotonilco Wastewater Treatment Plant in the Clean Development Mechanism (CDM); hydrological-environmental restoration of upper-mid watersheds and Water Management and Soil Preservation, both included in the Rainfed Infrastructure Program K132, as a natural response to climate change; the evacuation of excess water in times of heavy precipitation, through the construction of the Eastern Drainage Tunnel; and the downscaling of climate information through the Statistical Regionalization of CMIP5 models for Mexico.

Other examples of relevant actions that appear in the catalogue include the recovery of reject water from systems in processing plants by Green Giant; the reduction in water-based GHGs through the strategy for energy efficiency in the drinking water, drainage and sanitation sector; the Pilot Project of Infiltration with Treated Wastewater in the Aquifer of the Palmas Valley, Baja California; the "Neutralízate" Program and launch of the voluntary market for forest carbon in Mexico through Pronatura Mexico; and the development of Eco techniques in the State of Mexico by FEMSA Foundation.



5.1 Registering the Atotonilco Wastewater Treatment Plant in the Clean Development Mechanism (CDM)

Historically Mexico City's wastewater has been discharged into the Mezquital Valley, without suitable treatment. 29% of the wastewater discharged into this Valley decomposes anaerobically in the Endhó dam, producing GHG emissions (mainly methane). With the construction of the Atotonilco Wastewater Treatment Plant (WWTP), Mexico City's wastewater will be treated in an aerobic system, while the sludge generated will be treated in an anaerobic digester with biogas recovery for the cogeneration of electricity. With this scheme, the reduction in equivalent carbon dioxide will be 359,880 tCO2eq per year, which may be accredited with the CDM so as to generate Certified Emission Reductions for their commercialization in carbon markets, generating an economic benefit for the country.

1. **Classification of the action's focus:**
   - Climate change adaptation to solve environmental problems
   - Mitigation of greenhouse gases

2. **How this action helps to face climate change:**

With this project, the first of its kind in the country, a reduction will be made in GHG emissions due to the appropriate management and treatment of wastewater, and furthermore the emissions associated with the plant's energy consumption will also be reduced, since with the use of the biogas as energy through cogeneration, the emissions will be transformed through the burning of fuel in order to generate electricity and heat necessary for the operation of the plant. Under this scheme, the aim is for around 70% of the plant's energy needs to be met through the combustion of the gas produced in the plant.

3. **Other organizations that took part in the action, and how:**

The companies Ingenieros Civiles Asociados (ICA), Impulsora de Desarrollo y Empleo de Latinoamérica (Ideal), Promotora del Desarrollo de América Latina, S.A. de C.V, Controladora de Operaciones de Infraestructura, Atletec, Acciona Agua, Desarrollo y Construcciones Urbanas and Green Gas Pioneer Crossing Energy y LCC, will provide the wastewater treatment services in the Valley of Mexico for 25 years, which includes the production of the final plan set, construction, electro-mechanic installation, tests, operation, conservation and maintenance of the WWTP. The service provided by the companies will also include the removal and final disposal of the sludge and biosolids generated in the WWTP, as well as the construction of a cogeneration plant; under the pluriannual modality with a fixed price and the investment of public resources and participation of partially recoverable private investment. Under this scheme, the federal government contributed 45.89% of the resources as non-recoverable funds, against 54.11% from private investment.

4. **Classification of the action's scope:**

Sub-national

5. **Start and end date of the action:**

The tender for the plant was published in 2009, and the construction started in 2010. The plant should be operational in 2013. The concession contract will finish in 2033.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 90% - Social 10%

8. **How the action was financed:**

Governments and governmental authorities / Companies and utilities

9. **Impact/benefit of the action (in environmental, economic and social terms):**

With the use of the gases generated by the plant to produce 70% of its energy needs, 359,880 tCO2eq will not be released into the atmosphere per year, additionally saving 190 million pesos every year in energy. Additionally, it is hoped to receive through the CDM up to 1.8 million dollars per year over a decade. The plant itself will treat up to 35,000 liters per second of the Valley of Mexico's wastewater, from its population of more than 20 million people. It will thus improve the environmental conditions of the Mezquital Valley in Hidalgo, benefitting more than 700,000 inhabitants in the area, generating 14,000 jobs (4,000 directly and 10,000 indirectly), and guaranteeing the availability of quality water for agricultural irrigation in the Irrigation Districts 03 Tula, 100 Alfajayucan and 112 Ajacuba.

10. **Innovations that contributed to the success of the action:**

The financial scheme used for the construction of the plant allows the co-financing of the federal government and private initiative over a period of 25 years. As regards the use of the gases generated as a source of energy, which in itself is an innovative aspect, the registration of this system in the CDM is the first of its kind in the country.

11. **Reference document(s) or website for more information:**

http://www.conagua.gob.mx/Sustainabilityhidricadelvalledemexico/ptaratotonilco.aspx

Contact details:

Emmanuel Gómez Morales, Department of Transboundary Watersheds in the Conagua's Deputy Director General's Office for Drinking Water, Drainage and Sanitation; emmanuel.gomez@conagua.gob.mx; (+52 55) 5174 4000, ext. 1412.

5.2 Rainfed Infrastructure Program K132, with Hydrological-Environmental Watershed Restoration and Water Management and Soil Preservation

This Program has the aim of increasing agricultural production, through the creation of new Drainage Units or TRDs, with the construction of federal hydraulic infrastructure, consisting of drainage, paths, crossing and control structures and construction of berms in rainfed areas where necessary. In parallel with the K132 Program, two fundamental sub-programs are developed to compensate the environmental system, which have the function of acting as climate change adaptation measures.

The first is the "**Hydrological-Environmental Restoration of upper-mid watersheds**", which was conceived as a series of planned actions to prevent, mitigate, control and correct the effects generated

by erosion, runoff, and the production of sediments within a basin. It is an adaptation measure to high-intensity hydro-meteorological phenomena that will occur with greater frequency in the basins of Mexico's humid tropics. Furthermore, the hydrological-environmental restoration of watersheds provides an ideal framework to integrate co-financing mechanisms as part of the REDD+ scheme.

The second is called "**Water Management and Soil Preservation (MAPS)**". This program considers two main focuses: increasing the infiltration capacity of water into the soil to reduce surface runoff and loss of soil, as well as conserving residual humidity and increasing the level of organic matter in soils to raise their productivity. The areas of the humid and sub-humid tropics in which MAPS applies provide the highest potential to meet the growing demand for food in the coming decades in Mexico, and at the same time are areas with a high potential for carbon capture through a mechanism of payment for environmental services, which is ideal to accelerate the national market of carbon bonds and generate at the same time a powerful platform that would allow Mexico to take part in the Green Market.

1. **Classification of the action's focus:**
   - Climate change adaptation to solve rural problems
   - Climate change adaptation to solve environmental problems
   - Mitigation of greenhouse gases

2. **How this action helps to face climate change:**

Hydrological-Environmental Restoration

Within the Conservation and Rehabilitation Program in Rainfed Districts, these actions favor environmental systems in an integral way in the upper parts of watersheds, avoiding soil erosion. These actions are undertaken mainly in the basins of Tabasco, Chiapas and Michoacán, accumulating an investment of 200 million pesos for 2012.

Water Management and Soil Preservation

These actions provide an appropriate tool for the integration of protection measures in conserved areas (forests) and others at risk from degradation, as well as those areas that will undergo rehabilitation to decrease the rate of environmental degradation.

The two actions act as a measure that compensates for climate change through deforestation and degradation, since together these two phenomena and anthropocentric environmental impacts are in second place worldwide in order of importance among the main causes that contribute to the imbalance in the global climate system, the two together producing around 20% of the world's GHG emissions.

Similarly the actions described in the previous paragraph contribute at the same time to an indirect procedure of mitigation of carbon emissions, meaning that the program is suitable to be integrated into the REDD+ system. Additionally, payment for environmental services is an economic tool that promotes conservation activities. In this sense the Department of River Protection Infrastructure and Rainfed Districts through the K132 Program will promote the payment for environmental services with the objective of increasing the coverage of restored zones.

This program also proposes to strengthen its promotion through indicators that show climate change mitigation through the natural absorption of carbon as a result of the performance of the restored zones and the environmental efficiency of these services, improving ecosystems and preserving the hydrological-environmental network as a key resource to contribute to sustainability in Mexico.

Illustration 16 Restored watersheds store water, reduce the speed of water flows and favor infiltration

3. **Classification of the action's scope:**

National

4. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

5. **Percentage of this cost directly assigned to infrastructure and to social questions**

Infrastructure 50% - Social 50%

6. **How the action was financed:**

Governments and governmental authorities (resources of the Conagua)

7. **Impact/benefit of the action (in environmental, economic and social terms):**

Environmental Impact: Selecting the priority micro-basins in which to intervene for the implementation of soil and water conservation practices.

Social Impact: These actions serve to produce the biophysical and socio-economic diagnosis of the upper-mid watershed, as well as favoring the development of processes linked with awareness raising, social organization and self-management by local stakeholders, contributing to provide incentives for social organization for a common good with water through the creation of the Technical Management Committee for Water and Soil Preservation.

Economic Impact: Through the functioning of the MAPS and Hydrological-Environmental Restoration, economic benefits can be provided as incentives through a system of payment distribution within REDD+ as well as the involvement of the local community interested in protecting its water resources and ecosystems.

8. **Innovations that contributed to the success of the action:**

The setting up of the "Hydro-Agricultural Infrastructure Processes Management System", already mentioned in action 1.4, is one of the main innovations.

9. **General comments:**

It is recommended to work on a National System of Carbon Bonds with the objective of measuring the performance and exchanging the capture of carbon equivalent through different programs linked or

aligned with mitigation and/or adaptation measures, as is the case of the Conservation and Rehabilitation of Rainfed Areas Program, and in this way establish a national strategy to ensure the quantifying of a green economy based on the reduction of carbon equivalent.

10. **Reference document(s) or website for more information:**

http://sgh.conagua.gob.mx/

Contact details:

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5.3 Construction of the Eastern Drainage Tunnel

In order to increase the drainage capacity in the metropolitan area, the Eastern Drainage Tunnel (TEO) is under construction, as one of the central works of the Sustainable Water Program in the Valley of Mexico basin. It will allow the deficit in the rainwater evacuation capacity to be complemented during rainfall, as well as the alternate maintenance of the deep drainage during the dry season, since a failure in the Central Drainage Tunnel could have catastrophic consequences, affecting the social order, the economy, public services, public health, security and the environment. It consists of a tunnel with a length of 62 kilometers and a diameter of 7 meters, with a capacity to conduct 150 cubic meters per second and 25 construction ports. The TEO will work through gravity and will receive the wastewater and rainwater coming from the tunnels "Interceptor Oriente" and "Interceptor Río de los Remedios", the flows from which come together in what is known as the TEO's Port 0, its point of origin.

1. **Classification of the action's focus:**
   - Climate change adaptation for floods
   - Climate change adaptation to solve environmental problems
   - Climate change adaptation to solve problems of basic services

2. **How this action helps to face climate change:**

The TEO, together with the complementary drainage works included and constructed according to the Water Sustainability Program in the Valley of Mexico, including the extension to the regulation capacity, will facilitate a better management of the runoff generated by the changes in precipitation and its distribution in time and space, highlighting the timely management of atypical rainfall by having a redundant emission system during the dry season (the Central Drainage Tunnel and TEO) which will allow the alternate maintenance without risks of floods.

3. **Other organizations that took part in the action, and how:**

Apart from the Conagua, as the technical coordinator of the projects, the Governments of the Federal District (Mexico City) and the State of Mexico are directly involved, as stakeholders in the management of drainage and as trustees in the 1928 Trust Fund in which the resources are concentrated from the bulk water duties for the improvement of the water sector and its infrastructure.

4. **Classification of the action's scope:**

Sub-national

5. **Start and end date of the action:**

Started on November 18, 2008 and its termination is programmed for June 2015.

6. **Approximate cost of the action:**

More than 10,000,000 Mexican pesos

7. **Percentage of this cost directly assigned to infrastructure and to social questions:**

Infrastructure 90% - Social 10%

8. **How the action was financed:**

Governments and governmental authorities / Other: 32.3% with resources from the 1928 Trust Fund and 67.7% with federal resources. The resources from the Trust Fund come from the contributions from the payment for bulk water from the Governments of the State of Mexico and the Federal District to the Federation.

9. **Impact/benefit of the action (in environmental, economic and social terms):**

As well as the increase in the rainwater and wastewater evacuation capacity to 150 m^3/s from the Valley of Mexico, and the flexibility for the system's operation and maintenance, the TEO will bring with it environmental benefits as a closed conduit that will feed into the Atotonilco WWTP for the treatment of a flow of up to 35 m^3/s, avoiding high investments for emergency relief, which year after year are needed due to floods, avoiding flood-related damage to material assets, housing and infrastructure, and contributing to avoiding diseases caused by floods with wastewater.

In the case of a major flood that might generate an obstruction or failure in the Central Drainage, the floods could cover a surface of more than 217 km^2, or over 10% of the current urban area, with more than five meters of water above the level of the Benito Juárez international airport. That possible situation would paralyze political and economic activities not only in the city but the country in general and will be avoided by the TEO. The following will thus be avoided: possible repairs or rehabilitation of runways and buildings in the international airport in Mexico City; repair or rehabilitation of the Metro Collective Transport System; repair or rehabilitation of energy substations; and repair or rehabilitation of affected highways. It should be mentioned that the population of the Federal District and the State of Mexico within the Valley of Mexico contribute over 30% of the national GDP, so it is to be expected that if floods occur in an area that could cover nine delegations of the Federal District and four municipalities of the State of Mexico, there would be considerable negative impacts on the country's economic activity.

10. **Innovations that contributed to the success of the action:**

The implementation of the 1928 Trust Fund facilitates an important source of funding that allowed the resources obtained from bulk water duties to be earmarked for the improvement of the water sector and its infrastructure. Furthermore, through the coordination mechanisms set up, the consultation and

agreements between the different entities that take part in the planning and construction of hydraulic works in the Valley of Mexico has been expedited.

11. **General comments:**

It is important to provide continuity to the hydraulic infrastructure plans within the Valley of Mexico, overseeing their compliance in time, form and according to budgets. Before the 2013 dry season, the first stage of the TEO should conclude, allowing a first increase in the evacuation capacity of up to 40 m^3/s, with the support of the El Caracol Pumping Plant, already finished; in 2015 the construction of the whole of the tunnel should be concluded to reach the project's 150 m^3/s. Furthermore follow up should be made to the complementary actions according to the plans in force, among others, the extension of the piping capacity from Río Tula, the project for which is currently being developed.

12. **Reference document(s) or website for more information:**

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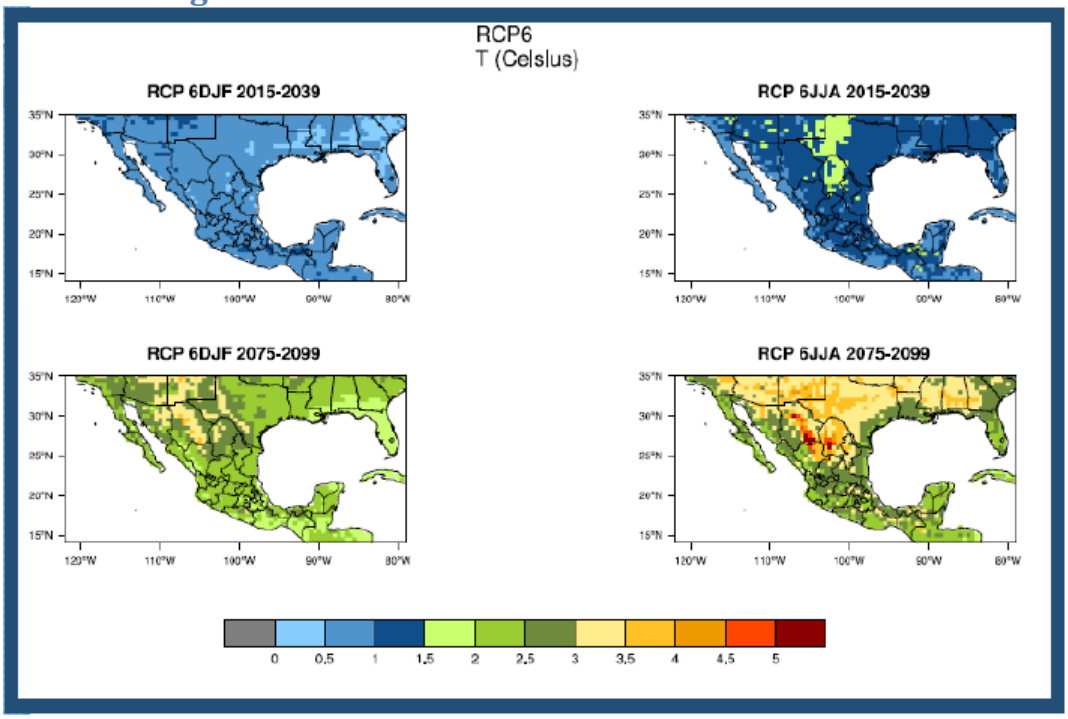
5.4 Statistical Regionalization of CMIP5 models for Mexico



The work consists of obtaining the projections for temperature and precipitation change through the implementation of the method known as Reliability Ensemble Averaging or REA (Giorgi & Mearns, 2002; Montero et al. 2010) with modifications in iterations and the inclusion of the range of uncertainty, in the new models of the IPCC's Coupled Model Intercomparison Project Phase 5 for Mexico and Central America in the time periods from 2015-2039 and 2075-2099. This is in line with the work of the Expert Modeling Group coordinated by the INECC.

1. **Classification of the action's focus:**

- Climate change adaptation to solve water scarcity issues
- Climate change adaptation to solve urban problems
- Climate change adaptation to solve rural problems
- Other: Adaptation in availability of water as a result of increases in mean surface temperature.

2. How this action helps to face climate change:

Due to the uncertainties associated with general circulation models, including the scenarios developed by the IPCC, new models have been released with new scenarios as part of their improvement. As a result, determining the projections in temperature and precipitation change for Mexico by downscaling will inform the direction of the country's adaptation strategies. The range of uncertainty for projections of change will have an influence upon their reliability.

3. Classification of the action's scope:

International, national and sub-national

4. Start and end date of the action:

The project initiated in January 2012, and the first stage has now been completed.

5. Percentage of this cost directly assigned to infrastructure and to social questions:

Infrastructure 50% - Social 50%

6. How the action was financed:

Governments and governmental authorities

7. Impact/benefit of the action (in environmental, economic and social terms):

The impact is at the national level, however the regionalization provides an idea at a 50km x 50km scale of the possible future changes that will occur in precipitation and temperature throughout the country, important factors in hydrological studies for water management and administration.

8. Innovations that contributed to the success of the action:

Use of the programming language ncl (The NCAR Command Language (Version 6.0.0) [Software] (2012). Boulder, Colorado: UCAR/NCAR/CISL/VETS. http://dx.doi.org/10.5065/D6WD3XH5. For the handling of netCDF data. Knowledge of vcdat (http://cdat.sf.net) and ncview (http://meteora.ucsd.edu/~pierce/ncview_home_page.html) viewing programs.

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Recommendations and next steps

The careful analysis of the catalogue compiled as part of the consultancy that also led to this document reveals a series of valuable orientations for the future of water management in Mexico, in a context of climate change. Below are the main recommendations derived from this analysis and the observations put forth in the executive summary, structured around the five factors that should be overcome in order to face this issue, which were also the basis for this document.

The **institutions** at different levels in charge of water management in Mexico should continue their efforts to mainstream and enhance the capacity of response to climate change, in a more coordinated way with other water stakeholders and those from other related disciplines (agriculture, energy, etc.). The creation or empowerment of a crosscutting area in the Conagua is further recommended in order to spearhead this issue and thus ensure good coordination inside the institution, with other agencies from the three tiers of government, international organizations, civil society, academia and the private sector. Thus a more efficient use of existing financial resources would be fostered, competition would be avoided between actions with similar purposes, as well as improving the results of the actions carried out, which is particularly relevant in the context of the current international financial crisis. This is an essential task to face the impending challenges, rather than merely depending upon the good will of those in charge, since continuing to act along the same lines previously employed in water management is no longer viable; as many have observed, “stationarity is dead” (Milly et al, 2008).

In order to be able to provide a coherent collective framework for the **planning** of the different actions undertaken in Mexico on water and climate change, which as we have observed, in the 2007-2012 period occurred in a relatively autonomous manner, there is an obvious need for a robust national strategy, which permeates through to sub-national planning, complemented by a framework for action on this issue, both of which should be fully articulated with the PNH for the 2013-2018 period, but with a much longer-term vision. This vision of water-based climate change adaptation should not dramatically change every six years with the changes of administration, but reviewing the progress made every six years is considered highly relevant in order to be able to effectively revise the action plan for the administration, if necessary. The strategy might have its own targets and indicators, which could in turn be related with the targets and indicators in the PNH, NDP and the PECC. This strategy could result in the identification of substantive and geographical priority areas of action, a streamlining of existing financial and human resources and harnessing of additional resources, and the proposal of a more appropriate institutional framework.

On the issue of **increasing the knowledge base**, precise data is currently available on the impacts of previous and present droughts and floods, through relatively sophisticated monitoring systems, but no drought forecast system currently exists that might inform preventative decision making on this phenomenon. A financial investment in that sense would clearly generate significant savings, above all in the agricultural and livestock sector, as well as that cost being significantly lower than subsequently facing the losses and damages due to being unprepared for these extreme events. Furthermore, in parallel to producing more reliable information on the future impacts of climate change on the components of the water cycle, “no regrets” actions should already be undertaken, which with or without climate change can be justified, as well as “low regrets” actions which are considered to be economically viable as compared to the cost of retrofitting infrastructure in the future. The latter in particular should be linked with the information generated on different hydrological and climatic variables, to ensure appropriate decision making on priority areas of action.

As regards **funding**, investments specifically in water and climate change will undeniably have a high cost, which it will not be possible to cover solely through federal resources, so it will be essential to make a more rational use of federal resources by reviewing subsidies for water, energy and agriculture, and complement those federal resources with those from the private sector and sub-national and international funds, including those mentioned in section 4.2 of this document. In the current construction of infrastructure works, the incorporation of climate change variables is not contemplated, meaning that construction is taking place based on past statistics, despite the fact that, in the words of the Secretary General of the WMO, "the past is no longer a good indicator of the future" (Reuters, 2009). For this reason, it is recommended that, in the areas of Mexico that have traditionally had greater precipitation, the still to-be-built water infrastructure should contemplate an additional safety margin of capacity which would allow it to face future peaks in precipitation; the cost of this "additionality" being potentially covered by international climate change funds. This would clearly be more cost-effective than adjusting the existing infrastructure at a later date, and a more easily and objectively measurable cost-benefit ratio could be established, for the purpose of justifying the investment.

One of the main challenges from the **scientific and technical** perspective in the future is finding the best blend between artificial infrastructure and so-called "natural infrastructure", which is by definition more flexible and can serve various purposes, offering a viable alternative in some cases, especially to face the challenges imposed by climate change. Additionally, the development and the generalized use of clean technologies in water systems will have a great benefit in terms of both adaptation and mitigation efforts, by reducing both their water and energy footprint, so it is highly recommended to investigate the financial mechanisms that might support the generalization of these technologies, which in many cases already exist and only need to be upscaled. Furthermore, technological development must be matched with demand-management options, such as the planting of less water-intensive crops, financial mechanisms to incentivize the efficient use of water in industry and agriculture, and so on. Finally, it is highly relevant to review options to reuse treated water, especially to replace first-use water, so as to relieve the existing pressure on water resources.

To conclude, as regards this systematization exercise on the actions undertaken by different stakeholders in Mexico on water and climate change, unfortunately not all the actions that have been carried out in this period were included in the catalogue, and could not therefore be duly analyzed, for two main reasons: firstly, as a consequence of the political climate in which it took place (during a change of government and of administration); and secondly, like any effort that is only just beginning, there is initial slow movement followed by faster pickup, which is likely to occur once the catalogue and document have been published. However, it is considered that this exercise is highly relevant and useful for planning purposes and as a means of exchanging experiences at different levels, especially if it feeds into an overriding process to upscale the national response to this global phenomenon. It is thus recommended to institutionalize it as a regular exercise, perhaps annually, that would allow the measurement – and perhaps stimulation – of progress in this vital area for Mexico's sustainable development in the coming years.

Bibliography and references

Cámara de Diputados. *Ley General de Cambio Climático*. Mexico City, 2012. http://www.diputados.gob.mx/LeyesBiblio/pdf/LGCC.pdf

Carabias, J. and Landa, R., with the collaboration of Collado, J. and Martínez P. *Agua, Medio Ambiente y Sociedad. Hacia la Gestión Integral de los Recursos Hídricos en México.* Mexico City, 2005. http://www.bibliotecavirtual.info/recursos/agua_medio_ambiente_y_sociedad.pdf

CICC. *Adaptación al Cambio Climático en México: Visión, Elementos y Criterios para la Toma de Decisiones*. Mexico City, 2012. http://books.google.com.mx/books?id=JGZDAQw60MMC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

CICC. *Política Nacional sobre Cambio Climático*. http://www.changeclimatico.gob.mx/index.php/politica-nacional-sobre-change-climatico.html (consulted on 11/12/2012)

CICC. *Programa Especial de Cambio Climático 2009-2012.* Mexico City, 2009. http://www.semarnat.gob.mx/programas/Documents/PECC_DOF.pdf

COLMEX. *Agua para las Américas en el Siglo XXI*. Mexico City, 2003. http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=957968

Conagua, World Bank. *Orientaciones Generales para la Formulación e Implementación de la Estrategia Nacional de Recursos Hídricos relativa a la Adaptación al Cambio Climático*. Mexico City, 2010. http://cuencavalledemexico.com/wp-content/uploads/2010/08/Estrategia-RhyCC-V1_E_231110.pdf

Conagua. *Dialogs for Water and Climate Change: Call to Action*. Mexico City, 2010. http://www.d4wcc.org.mx/images/documentos/call_to_action.pdf

Conagua. *Agenda del Agua 2030*. Mexico City, 2011ª. http://www.conagua.gob.mx/CONAGUA07/Temas/AgendadelAgua2030.pdf

Conagua. *Estadísticas del Agua in México 2011*. Mexico City, 2011b. http://www.conagua.gob.mx/CONAGUA07/Publicaciones/Publicaciones/SGP-1-11-EAM2011.PDF

Conagua. *Gaceta de Administración del Agua edición 2012*. Mexico City, 2012. http://www.cmic.org/comisiones/sectoriales/infrastructurehidraulica/publicaciones_conagua/Pdf/publicaciones/2012%20PDF/SGAA-10-12.pdf

Conde, Cecilia. *Cambio Climático y Género* (presentation during the 2011 National Congress of Climate Change Research). http://www.pincc.unam.mx/congresonacional2011/presentaciones_congreso/Martes%2018/6.%20Taller%20de%20Genero%20y%20CC/Conde%20Cecilia.ppt

Diario Respuesta. *Dejan heladas daños millonarios en 6 estados*. http://www.diariorespuesta.com.mx/septiembre2011/index.php?view=article&catid=96%3Anacional&id=6639%3Adejan-heladas-danos-millonarios-en-6-estados&tmpl=component&print=1&page=&option=com_content&Itemid=276 (consulted on December 29, 2012)

ECLAC. *Desastres y Desarrollo: El impacto en 2010*. Santiago de Chile, 2010. http://www.cepal.org/desastres/noticias/noticias/2/42102/Desastres2010_WEB.pdf

FAO. *How to Mainstream Climate Change Adaptation and Mitigation into Agriculture Policies*. Rome, 2009. http://www.fao.org/docs/up/easypol/778/mainstream_clim_change_adaptation_agric_policies_slides_077en.pdf

FEMSA Foundation. *Annual Report 2011*. Monterrey, 2011. http://files.shareholder.com/downloads/FEMSA/2245813067x0x571887/08B91506-ACE5-497B-B71F-885B2A7E08E2/FEMSA_Foundation_-_Annual_Report_2011.pdf

Germanwatch. *Loss & Damage*. Berlin, 2012. https://germanwatch.org/fr/download/6674.pdf

Green Growth. *About Green Growth*. http://www.greengrowth.org/?q=static-page/sat-10012011-1104/about-green-growth (consulted on December 29, 2012)

Greenpeace. *México ante el cambio climático: Evidencias, impactos, vulnerabilidad y adaptación.* Mexico City, 2010. http://www.greenpeace.org/mexico/Global/mexico/report/2010/6/vulnerability-mexico.pdf

GWP. *What is IWRM?* http://www.gwp.org/The-Challenge/What-is-IWRM/ (consulted on 29/12/2012)

ICLEI. *Vulnerabilidad y Adaptación al Cambio Climático*. Mexico City, 2012. http://www.iclei.org.mx/web/uploads/assets//Presentaciones_Tijuana/V_A_1_CONCEPTOS_Y_GUIA_-_TIJUANA.pdf

IMTA. *Atlas de Vulnerabilidad Hídrica en México ante el cambio climático*. Jiutepec, Mor, 2010. http://www.atl.org.mx/atlas-vulnerability-hidrica-cc/

INECC. *Fifth National Communication to the United Nations Framework Convention on Climate Change*. Mexico City, 2012. http://www2.ine.gob.mx/publicaciones/download/685.pdf

IPCC. *Climate Change 2001. Synthesis Report. Glossary of Terms*. Geneva, 2001. http://www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf

IPCC. *Climate Change 2007: Synthesis Report*. Geneva, 2007. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

IPCC. *Technical Report number VI on Climate Change and Water*. Geneva, 2008. http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf

ISDR. *Countering Disasters, Targeting Vulnerability*. Geneva, 2001. http://www.unisdr.org/files/4033_kit2001english1.pdf

IUCN. *REDD-plus explained*. http://www.iucn.org/about/work/programmes/forest/fp_our_work/fp_our_work_thematic/redd/redd_plus_explained/ (consulted on December 29, 2012).

Landa, R., Magaña, V, Neri, C. *Agua y clima: elementos para la adaptación al cambio climático*. Mexico City, 2008. http://es.scribd.com/doc/50280007/Agua-y-clima-elementos-para-la-adaptacion-al-cambio-climatico-9789688178874

Martínez Austria, P. *Effects of climate change on Mexico's water resources*. Jiutepec, Mor, 2007. http://www.atl.org.mx/images/docs/cambioinglescompleto.pdf

Milly, P.C.D, Betancourt, J, Falkenmark, M, Hirsch, R.M., Kundzewicz, Z.E., Lettenmaier, D. P., Stouffer, R.J. *Stationarity Is Dead: Whither Water Management?* Climate Science, 2008. http://wwwpaztcn.wr.usgs.gov/julio_pdf/milly_et_al.pdf

OECD. *Hacer posible la reforma de la gestión del agua en México*. Diagnóstico y Propuestas. Paris, 2012. http://www.oecd.org/gov/regional-policy/Hacer%20Posible%20Reforma%20Agua_Mexico_Jan18.pdf

Regional Policy Dialog (RPD) on Water and Climate Change Adaptation in the Americas. *Water and Climate Change in the Americas: Solutions from the Regional Policy Dialog*. Mexico City, 2012. http://www.aguacambioclimatico.org/fotos/evento_elemento/0WCC_RPD.pdf

Reuters. *History can no longer guide farmers, investors-U.N*. 2009. http://www.reuters.com/article/2009/08/26/idUSLQ96330 (consulted on December 29, 2012)

Third World Network. *Briefing Paper on Loss and Damage*. Bangkok, 2012. http://unfccc.int/files/adaptation/cancun_adaptation_framework/loss_and_damage/application/pdf/loss_and_damage_bp3_asia_and_eastern_europe_regional_expert_meeting_slow_onset_events.pdf

UNAM. *La Economía del Cambio Climático en México. Síntesis.* Mexico City, 2009. http://www.eclac.org/ddsah/noticias/paginas/2/35382/Sintesis2009.pdf

UNAM. *Por las heladas, México requiere importar tres millones de toneladas de alimentos*. http://www.agua.unam.mx/noticias/2011/unam/not_unam_febrero27_2.html (consulted on December 30, 2012)

UNFCCC. *Kyoto Protocol*. http://unfccc.int/resource/docs/convkp/kpeng.pdf. Kyoto, 1998.

UNFCCC. *Water and climate change impacts and adaptation strategies. Technical paper*. Bonn, 2011. http://unfccc.int/documentation/documents/advanced_search/items/6911.php ¿priref=600006592#beg

USDA. *Global Agricultural Information Network*. Washington D.C., 2012. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Mexico%20City_Mexico_3-30-2012.pdf

WMO. *Proyecto de Modernización del Servicio Meteorológico Nacional de México*. Geneva, 2010. http://smn.cna.gob.mx/modernizacion/modernizacionSMN.pdf

World Bank. *Adaptation Guidance Notes – Key Words and Definitions*. http://climatechange.worldbank.org/content/adaptation-guidance-notes-key-words-and-definitions

World Bank. *Adapting to Climate Change: Assessing the World Bank Group Experience, Phase III*. Washington, 2012a. http://ieg.worldbankgroup.org/content/dam/ieg/climate_change3/cc3_full_eval.pdf

World Bank. *Investing in Water Infrastructure: Capital, Operations and Maintenance*. Washington, D.C., 2012b. http://water.worldbank.org/sites/water.worldbank.org/files/publication/water-investing-water-infrastructure-capital-operations-maintenance.pdf

World Bank. *Project Appraisal Document on a Proposed Loan for the Modernization of the National Meteorological Service for Improved Climate Change Adaptation Project*. Washington, D.C., 2012c. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/04/30/000350881_20120430093034/Rendered/PDF/679710PAD0P12600Offcial0Use0Only090.pdf

World Resources Institute. *Ready or Not*. Washington, D.C., 2012. http://pdf.wri.org/ready_or_not.pdf

World Water Assessment Programme. WWDR3: *Water in a Changing World*. Paris, 2009. http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/wwdr3-2009/downloads-wwdr3/

Annexes

Glossary and definition of terms

Clean Development Mechanism (CDM): Procedure established in the Kyoto Protocol whereby developed countries may finance GHG emission mitigation projects within developing countries, and in exchange will receive Certified Emission Reductions applicable to achieve their own reduction commitments (UNFCCC, 1998).

Climate change adaptation: "…Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2001).

Climate change: "A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use." "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (IPCC, 2001).

Current climate variability: Refers to the changes in the climate registered in recent years, especially as regards the increase in extreme events such as droughts and floods, beyond the uncertainty about whether the changes in the climate are of anthropogenic or natural origin (RPD, 2012).

Environmental flows: Refer to the regime of water supplied within a river, wetland or coastal zone to maintain ecosystems and the benefits they provide to populations (RPD, 2012).

Green growth: "A policy focus… that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development" (Green Growth).

Integrated Water Resources Management (IWRM): "A process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment" (GWP).

Local climate change scenarios: Refers to local projections of global climate change scenarios, drawn up by the IPCC, to establish the adaptation and mitigation measures necessary to reach long-term goals, beyond the certainties and uncertainties of the models in their global and local projections (RPD, 2012).

Low regrets: Options "where moderate levels of investment increase the capacity to cope with future climate risks. Typically, these involve over-specifying components in new builds or refurbishment projects. For instance, installing larger diameter drains at the time of construction or refurbishment is likely to be a relatively low-cost option compared to having to increase specification at a later date due to increases in rainfall intensity" (World Bank).

Maladaptation: "Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead" (IPCC, 2001).

Mainstreaming: "Refers to the incorporation of climate change considerations into established or on-going development programs, policies or management strategies, rather than developing adaptation and mitigation initiatives separately" (FAO, 2009).

Mitigation: "An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC, 2001).

"No regrets": Actions that reduce the vulnerability to possible future extreme water phenomena, but which are justified even without the climate change scenario occurring (RPD, 2012).

Public policy: The attempt to determine and structure the rational basis for action or non-action faced with issues considered public. Dye (1992) stated that it is "whatever governments choose to do or not to do, for what reason and with what effect". Lasswell (1950) referred to public policy as supposing the idea of the public as a dimension of human activity regulated by governmental action (RPD, 2012).

REDD+: The initials of **R**eduction of **E**missions from **D**eforestation and forest **D**egradation. "The objective of REDD is to support activities that enable reductions in CO2 emissions that are caused by deforestation and forest degradation" (IUCN).

Resilience: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change" (IPCC, 2007).

Risk: A result of the expected impact, the probability of its occurrence and vulnerability (RPD, 2012).

Slow-onset events: Considers events such as "sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity and desertification" (Third World Network, 2012).

Threat: Probability that an event will occur in a given space and time, with sufficient intensity to produce damage (ICLEI, 2012).

Vulnerability: "A status resulting from human action or from an inherent situation such as poverty. It describes the degree to which a society is threatened by the impact of natural hazards. The degree of vulnerability depends on the condition of human settlements and their infrastructure, the way in which public policy and administration are engaged in disaster management, the level of information and education available about hazards and how to deal with them, among other aspects" (ISDR).

Water box: Describes the realm in which water management takes place. The 3rd United Nations World Water Development Report (WWAP, 2009) highlights that decisions determining water resources use are not made by water managers alone. Getting out of the "Water Box" means to strengthen the interaction in the decision-making process between resource managers and government, civil society and business – the actors determining the socio-economic context in which water is managed (RPD, 2012).

Abbreviations and acronyms

Acronym	Full name
AA2030	2030 Water Agenda
AF	Adaptation Fund
ANEAS	Mexican National Association of Water and Sanitation Utilities
CDM	Clean Development Mechanism
CMIP5	Coupled Model Intercomparison Project Phase 5
COLMEX	El Colegio de México
Conafor	(Mexico's) National Forestry Commission
Conagua	(Mexico's) National Water Commission
COP	Conference of the Parties
CPT	Climate Prediction Tool
D4WCC	Dialogs for Water and Climate Change
DOF	Official Government Gazette
DPL	Development Policy Loan
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
ENA	National Adaptation Strategy
FAO	Food and Agriculture Organization (of the United Nations)
GDP	Gross Domestic Product
GHG	Greenhouse gases
GIABA	Department of Engineering and Binational Water Issues (of the Conagua)
GIS	Geographical Information System
GIZ	German International Development Cooperation Agency
GWP	Global Water Partnership
HAR	Hydrological-Administrative Region
IDB	Inter-American Development Bank
IMTA	Mexican Institute of Water Technology
INECC	National Institute of Ecology and Climate Change
INEGI	(Mexican) National Institute of Statistics and Geography
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
IWRM	Integrated Water Resources Management
MDG	Millennium Development Goals
MHS	Mexican Hydrological Service
MEI	Manifestation of Environmental Impact
MoMet	Modernization Program of the National Meteorological Service
NADM	North American Drought Monitor
NDP	(Mexico's) National Development Plan
NIE	National Implementing Entity (of the Adaptation Fund)
NMS	National Meteorological Service
NOM	Official Mexican Standard
NWP	Nairobi Work Programme
OECD	Organisation for Economic Co-operation and Development
PACMUN	Municipal Climate Action Plan
PATME	Technical Assistance Program to Improve Efficiency in the Water Supply and Sanitation Sector
PEACC	State Action Program to face Climate Change
PECC	Special Climate Change Program
PHIT	Integrated Water Plan of Tabasco
PNH	(Mexico's) National Water Program

PREMIA	Project to Strengthen Integrated Water Resources Management in Mexico
PROMMA	Modernization of Water Resources Management Programme
PWR	Potential Water Reserves for the environment
RBO	River Basin Organization
REDD+	Reduce Emissions from Deforestation and forest Degradation
RPD	Regional Policy Dialog on Water and Climate Change Adaptation in the Americas
SBSTA	Subsidiary Body for Scientific and Technological Advice
SEMARNAT	(Mexico's) Ministry for the Environment and Natural Resources
SIAP	Agro-Food and Fishing Information Service
tCO2eq	Tons of equivalent carbon dioxide
TEO	Eastern Drainage Tunnel
TRD	Technified Rainfed Districts
UNAM	National Autonomous University of Mexico
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
USDA	United States Department of Agriculture
WB	World Bank
WFS	Water Financing System
WMO	World Meteorological Organization (of the UN)
WWAP	World Water Assessment Programme
WWF	World Wildlife Fund
WWTP	Wastewater treatment plant