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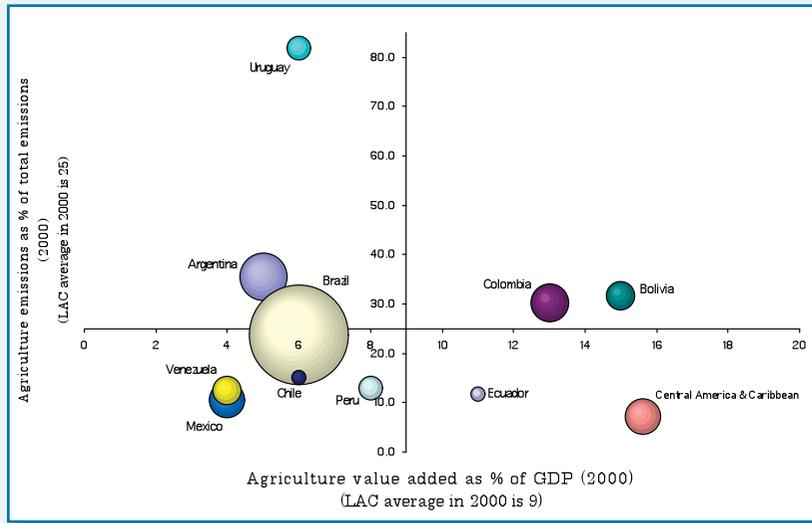
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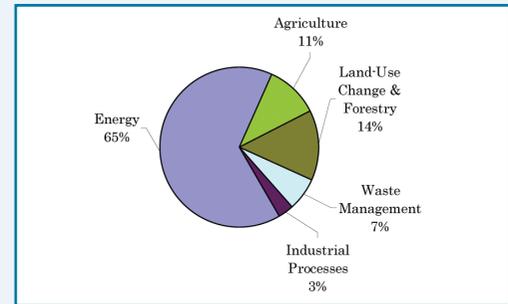
Country Note on Climate Change Aspects in Agriculture

This Country Note briefly summarizes information relevant to both climate change and agriculture in Mexico, with focus on policy developments (including action plans and programs) and institutional make-up.

Contribution of agriculture (without LUCF) to the economy and to emissions in LAC countries
(size of bubble in MTCO₂ of LUCF emissions; axes cross at LAC average)

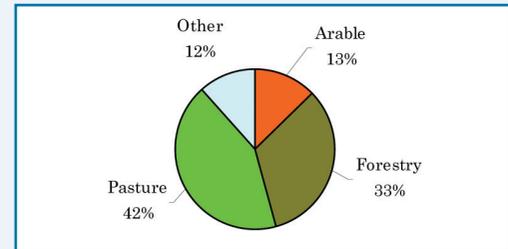


Percent of GHG emissions in CO₂ equivalent, by sector (2000)



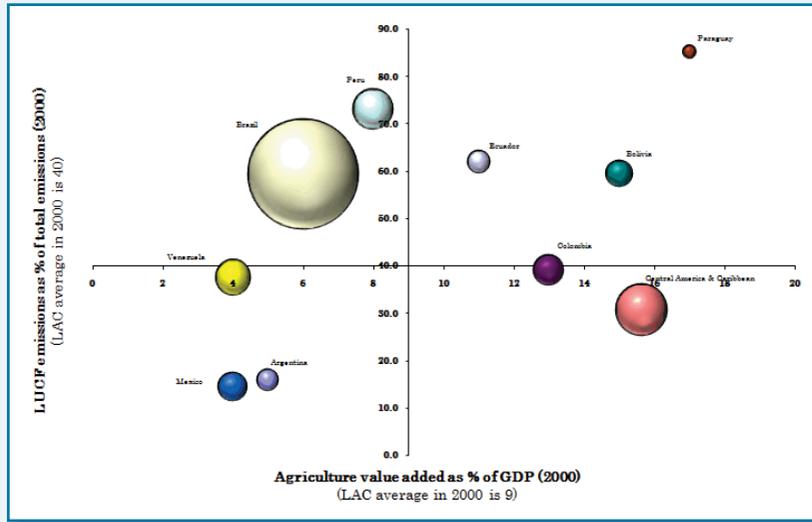
Source: World Resources Institute <http://cait.wri.org>

Land use (2005)

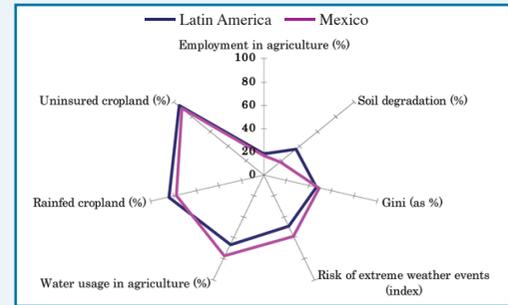


Source: World Development Indicators

Contribution of agriculture to the economy and of LUCF to emissions in LAC countries
(size of bubble in MTCO₂ of LUCF emissions; axes cross at LAC average)



Vulnerability Indicators



Note: In the first bubble graph, the total emissions for Uruguay do not account for the positive effects of LUCF (i.e. afforestation efforts). If they are considered, agriculture represents 222% of total emissions. Because of afforestation efforts in Uruguay and Chile, land use change and forestry (LUCF) is not a net contributor to emissions; hence the countries do not appear in the second bubble graph, but are considered in the calculation of the average in the vertical axis.

Note: Employment in agriculture (% of total employment)*; Rainfed cropland (% of total cropland)*; Gini*; Water usage in agriculture (% of total annual fresh water withdrawals)*; Uninsured cropland (% of total cultivated land area)**; Soil degradation (% of total land)***; Risk of extreme weather events (index; annual average 1997-2006)****

Sources: *World Development Indicators 2007, 2000-2007 average; **IADB, IICA, 2002/2003 figures; ***FAO AGL 2005¹; ****Germanwatch

¹ <http://www.fao.org/landandwater/agll/glasod/glasodmaps.jsp?country=MEX&search=Display+map+%21>

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Summary

Mexico is the only developing country to have submitted three national communications to the United Nations Framework Convention on Climate Change (UNFCCC), indicating strong commitment by the government for addressing climate change across sectors. Agriculture contributes little, in relative terms, to total GHG emissions and the emission reduction potential in the sector is small and primarily focused on methane reduction, though more diversified carbon trading opportunities can be pursued. Agriculture is highly vulnerable to weather extremes, in particular in the Northern parts of the country, where water scarcity is an issue, or the Southern parts of the country, where tropical storms cause extensive damage to crop and livestock production. Reducing vulnerability to climate change is of utmost importance in the agricultural sector in Mexico, considering the role the sector plays in food security and livelihoods of rural populations.

Working definitions

Agriculture is defined as a managed system of crops, livestock, soil management, forest resources (productive use, goods & services) and water resources (irrigation), including land use and land use change. **Climate change** encompasses both **mitigation** and adaptation activities within the agricultural sector. On the mitigation side, the focus is on the potential to reduce green house gas emissions by the different sub-sectors. On the **adaptation** side, the focus is on the potential to build resilience to climate and to increase the adaptive capacity through sustainable management of agriculture and other complementary factors (e.g. financial instruments). There is no specific **time frame** used in the country notes. An effort was made to collect the most recent available information on country indicators and policy matters.

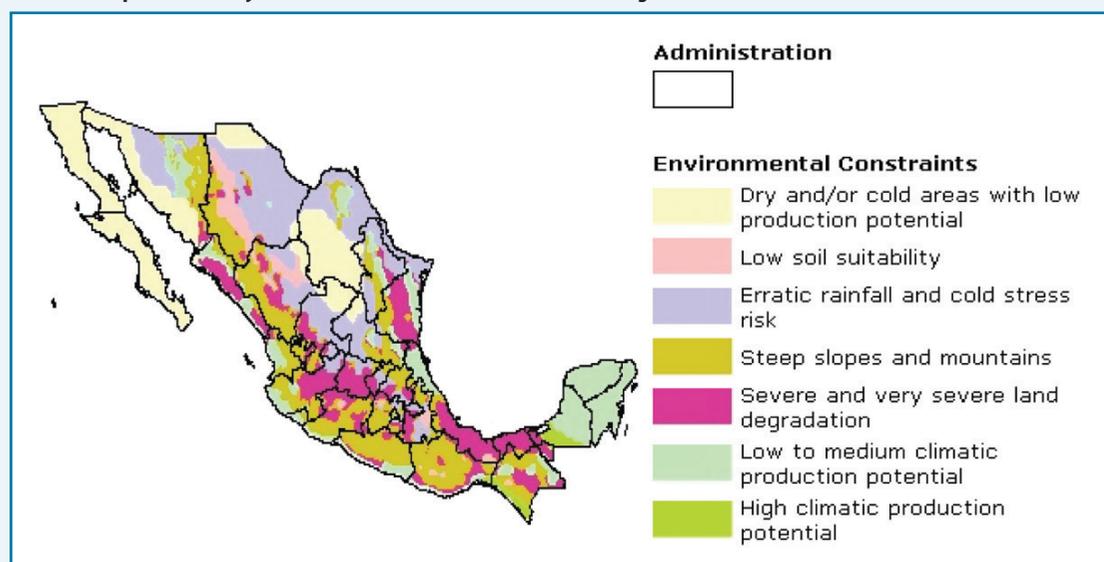
Acknowledgments:

This *Country Note* was produced by a World Bank team of specialists (in agriculture, forestry, social development, risk and knowledge management) from the Latin America and the Caribbean region and other units of the World Bank. The team is very grateful for all the comments and suggestions received from the focal points on climate change and agriculture in many of the countries.

1. The Climate Context

The baseline map provides a visual characterization of Mexico's agricultural potential given current environmental constraints and their regional distribution. Around 55% of Mexico's land is used for agriculture (42% for pasture and 13% for cultivation), with forestry occupying 33% of the land in the country (WDI, 2005).

Baseline map: Current Major Environmental Constraints related to Agricultural Potential



Source: FAO **Note:** For more maps on Mexico and agricultural resources, go to <http://www.fao.org/countryprofiles/maps.asp?iso3=MEX&lang=en>

1.1. Country Projections

According to the Third National Communication the following climatic changes with relevance to the agricultural sector can be expected in Mexico:

- a) **increases in temperature** – by 2020 projected temperature increases in the winter (December-February) are between 0 and 2.5°C and in the summer (June – August) are in the range of 0.9 and 2.2°C². It is very probable that by the year 2050 the climate in Mexico will become warmer by 2 to 4°C especially in the Central and Northern parts of the country.
- b) **reduction in precipitation** – the rainfall will decrease by up to 15% in the Central part and by less than 5% in the area of the Gulf of Mexico, mainly between January and May; by 2020 projected precipitation fluctuations will be in the range of -7 to +12% (December-February) and -8 to +12% (June-August)³.
- c) **increased frequency and intensity of extreme weather events** – the number of severe storms and the intensity of periods of severe drought will also increase; the sea water temperature will increase between 1 and 2°C leading to stronger and more intense tropical hurricanes in the Caribbean Sea, the Gulf of Mexico and the Mexican portion of the Pacific Ocean, with an increase of 6% in wind intensity and an increase in precipitation of 16% within a radius of 100 km from the center of the hurricane; the cold fronts may become less frequent.

The **Global Climate Risk Index**⁴, constructed for a period between 1997 and 2006 and covering both human and economic impact, ranks Mexico 26th in the World, underscoring the country's high vulnerability to weather related events. In recent years (between 2002 and 2007), tropical storms (including hurricanes) and floods have had the highest human and economic impact in Mexico, with losses for the period 1997-2006 averaging at 0.17% of GDP - 3.5 million people (around 4% of the country's population) have been affected by hurricanes (3 events) with the cost of the damages reaching US\$8 billion, and 1.6 million people have been affected by floods (1 event) with damages reaching US\$3 billion dollars⁵.

² <http://www.adaptationlearning.net/profiles/country/country.php?id=MX>

³ <http://www.adaptationlearning.net/profiles/country/country.php?id=MX>

⁴ <http://www.germanwatch.org/klima/cr2008.pdf>

⁵ <http://www.emdat.be/Database/CountryProfile/countryprofile.php>

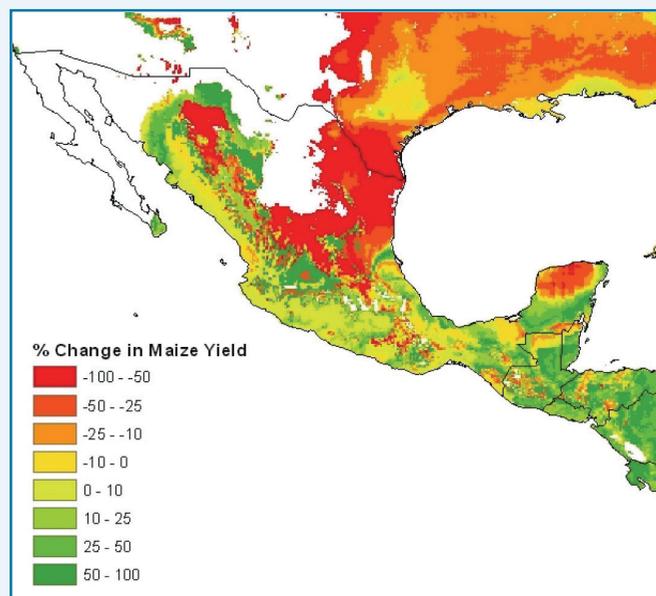
1.2. Agriculture-Related Impacts

During the past two decades, over 80% of the total economic losses from weather-related disasters occurred in the agricultural sector (CEPAL, 2007)⁶. The drought of 1997-1998, for example, produced a record number of forest fires; a period of drought during the 1990's resulted in many water-related conflicts in the North of the country; delays in the rains in 2005 resulted in the reduction of agricultural production by 13%⁷.

Significant changes are expected in covered areas for both forests and grasslands - changes to the order of 67% of temperate forests in Mexico are foreseen due to drier and warmer conditions. It is anticipated that climate change will result in an increase in scale and frequency of fires because climatic conditions will favor initiation and propagation of forest fires, replacement of tropical forests by savannas in Central and Southern Mexico along with replacement of semi-arid by arid vegetation in most of Central and Northern Mexico and extinction of species found in tropical forests. A reduction in agricultural production is expected and a significant reduction in livestock production can also be produced if temperate pastures are adversely affected by droughts caused by higher temperatures (Bucker et al., 2000⁸).

The most important agricultural crop cultivated in Mexico is corn (it occupies 50% of total cultivated area). The crop is highly susceptible to climate variability, in particular droughts. The climate scenarios for 2020 for Mexico predict a moderate reduction in the aptitude of cultivation of seasonal corn and an increase of the land not suited for cultivation of up to 4.2%. The state of Sonora may be the worst affected as far as the reduction of land suitable for corn cultivation. This may lead to a replacement of corn with other crops that are more resistant to severe conditions such as wheat or oat. A further effect will be a reduction of pastureland (6% loss by 2020 and 13.2% by 2050 relative to 2002 base year) used for livestock in the Northern and Central part of the country due to increased drought and land deterioration and an increase of plagues associated with environmental changes⁹.

Crop suitability index from IIASA MAIZE (2055 vs. 1961 - 1990)
GCM: Hadley CM3 (No Carbon Fertilization, High Input Conditions)



Source: IIASA, 2008

2. The Policy Context

To date, Mexico is the only developing (non-Annex I) country to have submitted **three National Communications** to the **United Nations Framework Convention on Climate Change (UNFCCC)**¹⁰, demonstrating a strong commitment to the international climate change agenda. The Communications lay out the actions that the government has already taken and the analytical basis for its policy response to climate change and its commitment to take future actions within an official international framework.

⁶ http://www.cepal.org/publicaciones/xml/4/31414/Serie_92.pdf

⁷ http://www.ine.gob.mx/climatico/edo_sector/quienes_vulnerables.html

⁸ http://www.gefweb.org/Documents/Enabling_Activity_Projects/CDI/documents/LAC_Assessment.pdf

⁹ For more details on the specific models and scenarios used, consult the Third National Communication (see link below)

¹⁰ <http://unfccc.int/2860.php>

- The **First National Communication**¹¹ (December 1997) established the National GHG Inventory and reported the results of the first studies on Mexico's vulnerability to climate change (at the national level). The situation of agriculture, including land use, land use change and forestry is captured in this communication through studies on the impacts of climate change on agriculture and emissions from the sector.
- The **Second National Communication**¹² (July 2001) updated the National GHG Inventory for the period 1994-1998 and included future emission scenarios. Context and programs relevant to the forestry sector feature prominently in this communication.
- The **Third National Communication**¹³ (November 2006) updated the National GHG Inventory as of 2002, as well as included land-use change emissions estimates for 1993-2002, vulnerability assessments for water, forestry and agriculture, with some of the studies conducted at the regional and state levels (e.g. water in Sonora, agriculture in the states of Tlaxcala and Morelos). This communication builds on a newly-adopted approach of extensive public consultations with academics, representatives from government institutions, private sector and non-governmental organizations. One of the recommendations from the consultation process was the advice of preparing a Climate Change Clearing House, which is now available on the website of the National Institute of Ecology, since June 2005 (http://cambio_climatico.ine.gob.mx/).
- The Mexican Government intends to deliver a **Forth National Communication** by 2009 and a **Fifth National Communication** by 2012.

The **Climate Change Performance Index 2008**¹⁴ gives Mexico a high rank - 4th among the 56 countries responsible for more than 90 percent of global energy-related CO₂. Though the index does not explicitly incorporate the role of agriculture and land use change on emissions, it does recognize Mexico's policy commitment to addressing climate change issues. Among its three indicators, the index recognizes the country's domestic and international climate policy, which puts Mexico ahead of other countries.

2.1. National Climate Change Plans, Strategies and Programs

The **National Development Plan 2007-2012**¹⁵ (PND, Spanish acronym) identifies the Mexican Government priorities for development. The Rural Sector is part of the second pillar of the Plan. Water, forests and climate change (including GHG emission reductions and the development of adaptation measures) are part of the fourth pillar of the Plan.

In May 2007 Mexico formulated its **National Climate Change Strategy**¹⁶ (ENACC, Spanish acronym). The Strategy identifies opportunities for emissions reductions on a voluntary basis, as well as measures for the development of necessary national and local capacity for response and adaptation. The Strategy proposes concrete adaptation and mitigation measures for all sectors, including agriculture, covering all the main aspects of climate change policy. The Strategy builds on institutional improvements, analytical work and investments already underway in Mexico. Climate change strategies and action plans have also been developed at the subnational level for Mexico City, the states of Veracruz (by the Universidad de Veracruz) and Nuevo León.

The **Special Program on Climate Change 2008-2012**¹⁷ (PECC, Spanish acronym) is designed to make the Strategy operational by identifying priority actions across sectors and required sources of funding, both domestic and international. Within the opportunities and constraints of each sector and the economy at large, the PECC sets voluntary emission reduction targets. The Program will be made possible through an inter-sectoral cooperation, including the agricultural sector. Under discussion for over a year now, the PECC has not yet been made effective.

2.2. Agricultural Sector Initiatives

The **Agricultural Sector Program 2007-2012**¹⁸ defines climate change as a strategic national and international problem which demands immediate action. The Program, which is based on an assessment of the impact of climate change in the sector, reconfirms the importance of ongoing programs targeting reconversion and rotation of crops, efficient use of fertilizers, conservation tillage, and special attention

¹¹ <http://unfccc.int/resource/docs/natc/mexnc1e.pdf> and http://www.ine.gob.mx/cclimatico/ingles/nat_com_1.html

¹² <http://unfccc.int/resource/docs/natc/mexnc2.pdf> and http://www.ine.gob.mx/cclimatico/ingles/nat_com_2.html

¹³ <http://unfccc.int/resource/docs/natc/mexnc3.pdf>

¹⁴ <http://www.germanwatch.org/klima/ccpi2008.pdf>

¹⁵ <http://pnd.calderon.presidencia.gob.mx/index.php?page=cambio-climatico>

¹⁶ See www.semarnat.gob.mx/Documents/Estrategias_libro_completo_compress2.pdf for the complete Strategy in Spanish. An executive summary in English can be found at http://www.semarnat.gob.mx/quessemarnat/politica_ambiental/cambioclimatico/Documents/enac/sintesis/sintesisjecutiva/Executive%20Summary.pdf

¹⁷ <http://www.semarnat.gob.mx/saladeprensa/boletindeprensa/Pages/boletin07-199.aspx>

¹⁸ http://www.sagarpa.gob.mx/infhome/pdf/sectorial_231107.pdf

programs to farmers affected by extreme weather events. In addition, it promotes other methods, such as generating incentives to expand sustainable use and conservation of natural resources and wildlands. Mitigation activities include eliminating the use of fire, promoting zero tillage, reforestation, retrofitting livestock facilities to capture and use of methane and more efficiency in the use of energy in fisheries. The main initiatives to strengthen capacity to adapt to climate change include targeted research, gene banks and expansion of seed reserves, corridors and conservation areas.

The **National Water Program** 2007-2012¹⁹ (Programa Nacional Hídrico) is developed with focus on climate change policies. Among the proposed adaptation measures in the water sector are fomenting the efficient use of water in the agricultural sector, diminishing the risks of floods, promoting the technical, administrative and financial development of the water sector and the promoting integrated and sustainable water management.

The **Program for Sustainable Use of Natural Resources for Primary Production**²⁰, under SAGARPA, aims at contributing to the conservation, sustainable use and management of natural resources used in primary production; at rescuing, preserving and enhancing the biogenetic resources, to induce a new production structure, and support the generation of bioenergy, through the payment of support and services to develop systems, works, actions and sustainable practices that help conserve and improve the primary resources used in agricultural production and fisheries.

On the mitigation side, the **Trust Fund for Shared Risk (FIRCO)**, Spanish acronym) has a special project to promote energy efficiency in the agricultural sector: "**Proyecto de Desarrollo Rural Sustentable para el Fomento de las Fuentes Alternas de Energía en los Agronegocios**"²¹. The project objectives are focused on helping to implement the commitments made by the country in terms of climate change by reducing emissions of greenhouse gases (GHGs) through the incorporation of clean energy (renewables) in production processes of agribusiness. The project will facilitate the reduction of pollution of soil and water resources for the benefit of preserving and enhancing the environment and is an inducer of the energy savings through the replacement of equipment and energy-efficient practices, which in combination with renewable energy will give the opportunity to replace the consumption of fossil fuels. In a complementary manner to the project, it is proposed to carry out the use of animal excreta from dairy farms and pig farms by biodigestors facility to produce biogas which can be used in electricity generation and / or heat energy that give coverage to the needs of agricultural enterprises, while reducing emissions of GHG gases.

The **Ministry of the Environment**²² (**SEMARNAT**, Spanish acronym) oversees Mexico's commitments to UNFCCC and other climate change related actions, with the **National Institute of Ecology (INE)**, Spanish acronym) as a coordinating body.

3.1. Inter-Sectoral Coordination

The **Inter-Ministerial Commission on Climate Change**²³ (**CICC**, Spanish acronym) was established in 2005 to mainstream climate change in development policy and is the **Designated National Authority (DNA)** on climate change and in particular, on Clean Development Mechanism (CDM) in Mexico. The Commission is responsible for formulating and coordinating the implementation of national climate change strategies and incorporating them in sectoral programs; (ii) promoting national climate change research; and (iii) promoting GHG emission reduction projects. The Commission consists of seven line ministries, including the Ministry of Agriculture, as well as the Ministry of Finance, organized across different working groups. For example, the Working Group on **Adaptation (GT-ADAPT)**, Spanish acronym) was formed to support the formulation of adaptation actions (i.e. policies and strategies) at the sectoral, regional and national levels with one of the six key systems considered being "agriculture, cattle farming, forestry and fisheries". The Commission also receives advice from the **Consultative Council on Climate Change**²⁴ (also known as **C4**) which is composed of scientists and representatives of the civil society and the private sector.

3.2. Agricultural Sector Institutions

The **Ministry of the Environment (SEMARNAT)**, Spanish acronym) is responsible for various initiatives related to climate change aspects in forestry (through CONAFOR), as well as in the water sector (through CONAGUA and IMTA). The **National Forestry Commission (CONAFOR)**, Spanish acronym) manages several

3. The Institutional Context

¹⁹ <http://www.conagua.gob.mx/conagua/Espaniol/TmpContenido.aspx?id=61178e27-98db-4d4c-a358-1005e4507475|Programa%20Nacional%20Hidrico|0|121|0|0|0>

²⁰ www.sagarpa.gob.mx/infhome/uso_sustentable.htm

²¹ <http://www.firco.gob.mx/fae0.html>

²² <http://www.semarnat.gob.mx/Pages/inicio.aspx>

²³ http://www.semarnat.gob.mx/queessearnat/politica_ambiental/cambioclimatico/Pages/cicc.aspx

²⁴ http://www.semarnat.gob.mx/queessearnat/politica_ambiental/cambioclimatico/Pages/c4.aspx

Programs identified in the Strategy (see below for more information on each program). The **National Water Commission (CONAGUA)**, Spanish acronym) is responsible for defining actions to reduce the risk posed on the water sector by extreme events (hurricanes, droughts and severe precipitations) and to attend to these events by reducing the effects on human lives, material goods and economic losses. The **National Weather Service (SMN)**, Spanish acronym) is a technical unit attached to CONAGUA; it is responsible for generating, interpreting and distributing weather information through its various networks. The **Mexican Water Technology Institute (IMTA)**, Spanish acronym) is responsible for generating and distributing knowledge and technology for water management. As of February of 2007, an interdisciplinary group was formed whose role is to evaluate the impact of climate change on the water cycle and to design measures for adaptation taking into account different climate scenarios.

The **Ministry of Agriculture**²⁵ (**SAGARPA**, Spanish acronym), through its different public institutions, is responsible for specific response actions (programs) related to climate change aspects in livestock, land use and land management, as well as the assessment of vulnerabilities to climate change and work pertaining to innovation and technology (e.g. **INIFAP**, **Colegio de Postgraduados**²⁶, **Universidad Autónoma de Chapingo**²⁷). The **National Institute for Forestry, Agriculture and Livestock Research**²⁸ (**INIFAP**, Spanish acronym) and the **National Coordinating Agency for PRODUCE Foundations**²⁹ (**COFUPRO**, Spanish acronym) oversee and maintain the **National Network of Agroclimatic State Stations**³⁰. The network provides climate information to producers aiding their decision making related to crop protection from adverse climate impacts. Furthermore, in conjunction with the **National Weather Service**³¹ (**SMN**, Spanish acronym), **Climate Prediction Forums** are organized where information is distributed to farm producers along with strategies and technological packages recommended by INIFAP.

3.3. Fostering Capacity to Deal with Climate Change

As part of the commitment to delivering periodic information to the UNFCCC, there are several on-going activities related to the official reporting of GHG emissions by sector, action plans for mitigating these emissions and assessment of vulnerabilities to climatic impacts. **INE** coordinates these activities across government agencies and universities.

- **Emissions inventories:** Mexico has made 3 updates to its **National GHG Inventory**³², covering the period between 1990 and 2002 and a user-friendly, searchable database is available to the public³³. The Inventory includes information on emissions from agriculture, including land use change and forestry, providing disaggregated information by type of emission and type of agricultural resource.
- **Modeling climate scenarios and impacts:** the bulk of the capacity resides in the **Centro Mario Molina**³⁴ (focusing on environmental and energy issues), the **INE**, and in the Center for Atmospheric Sciences in the **Universidad Nacional Autónoma de México (UNAM)**, Spanish acronym); the **National Commission on Arid Areas**³⁵ (**CONAZA**, Spanish acronym) oversees the cartographic series on dry and semi-dry areas in Mexico using climate change modeling (they were generated with the support of the **Autonomous University of Chapingo**) – this information is to be used for land management planning in dry and semi-dry areas and it helps develop adaptation capacities from desertification risks. The UNAM, with funding from the British Government and the IADB, is preparing a study on the economic costs of climate change in Mexico, to be completed in 2008. **INE** and **UNDP** recently released a publication on the social aspects of climate change in Mexico “Impactos sociales del cambio climático en México” (Ana Rosa Moreno Sánchez and Javier Urbina Soria). **AIACC**³⁶ has completed a study related to the agricultural sector, focusing on climate change impacts and vulnerability assessment in Mexico (among other countries in the region): “Integrated Assessment of Social Vulnerability and Adaptation to Climate Variability and Change Among Farmers in Mexico and Argentina (LA29)”³⁷.

There are several recent World Bank publications that focus on climate change issues in the Latin America region and on Mexico, in particular: 1) a flagship document for Latin America and the Caribbean titled “Low carbon, High Growth: Latin American Responses to Climate Change”³⁸, encompassing information on climate change impacts in the region, on the potential contribution to mitigation efforts as well as a listing of future low carbon and high growth policies; 2) a study on “Local Institutions and Climate Change Adaptation”³⁹ which addresses the role of these institutions

²⁵ <http://www.sagarpa.gob.mx/>

²⁶ <http://www.colpos.mx/nueva/>

²⁷ <http://portal.chapingo.mx/>

²⁸ <http://www.inifap.gob.mx/>

²⁹ <http://www.cofupro.org.mx/>

³⁰ <http://clima.inifap.gob.mx/redclima/>

³¹ <http://smn.cna.gob.mx/>

³² <http://www.ine.gob.mx/cclimatico/inventario3.html>

³³ <http://www.ine.gob.mx/cclimatico/inventarios/>

³⁴ <http://www.centromariomolina.org/index2.php>

³⁵ <http://www.conaza.gob.mx/>

³⁶ <http://www.aiaccproject.org/>

³⁷ http://www.aiaccproject.org/aiacc_studies/aiacc_studies.html

³⁸ http://www-wds.worldbank.org/external/default/WDSContentServer/WDS/IB/2009/02/27/000334955_20090227082022/Rendered/PDF/476040PUB0Low0101Official0Use0Only1.pdf

for community adaptation and highlights adaptation strategies in Mexico in three different rural communities; 3) a low-carbon study for Mexico titled “Low-Carbon Development for Mexico” (Mexico: estudio sobre la disminución de emisiones de carbono – MEDEC)⁴⁰, which evaluates the potential for reducing greenhouse gas emissions in Mexico over the next 20 years by evaluating low-carbon interventions across key emission sectors in Mexico using a common methodology; 4) a methodology for designing participatory adaptation Action Plans in agriculture (through bottom up prioritization of response options), which was applied in Northwestern Mexico (Yaqui Valley, State of Sonora), among other regions (Peru and Uruguay).

4. The Impact of Agriculture on Climate Change - Mitigation Measures

According to the Strategy (ENACC, 2007), agriculture accounts for 7% of total GHG emissions in the country and forests and land-use change account for 14%, a total of 21% of emissions.

Mexico is the 12th largest emitter of CO₂ from fossil fuels in the world (accounting for 1.5% of global emissions in 2000, excluding other GHGs, land-use change and forestry) and 2nd in LAC (after Brazil at 5.37%)⁴¹. In per capita terms, in 2005 Mexico was the 2nd largest emitter of CO₂ in LAC (at 3.70 t CO₂/capita) after Venezuela⁴². Though the level of GHG emissions has grown as the economy develops, the carbon intensity of the Mexican economy has decreased by 5% since 1993. The carbon intensity of growth in 2005 was 0.40 (kg CO₂ per million 2000 PPP US\$).

4.1. Action Frameworks

The Strategy (ENACC, 2007) identifies measures and associated emission reduction potential that enables Mexico to reduce the carbon intensity of development. With respect to land use, land-use change and forestry, the key measures include significant increases in reforestation, soil restoration, and commercial plantations. In addition, renewable energy sources in rural areas and changes in crop production will contribute to reducing emissions from rural and agricultural sources.

The emissions reduction potential of agriculture and forestry is small, estimated at 10% and 4%, respectively (as compared to other sectors, such as energy efficiency and renewables at 29%). The emission reduction potential associated with each measure of the ENACC is an estimate of the maximum achievable levels by 2012.

4.1.1. Forestry and Land Use Change

The scale of deforestation in Mexico in the last 15 years has been large with 47.8 thousand sq km of forest area change from 1990 to 2005. The average annual net deforestation rate between 1990 and 2005 is 0.5%⁴³. The causes of deforestation in Mexico are diverse and range from conversion of forests for agriculture, illegal logging, and inefficiency in the forest industry, infrastructure development and insufficient institutional support for rural programs among others. For each hectare of forest lost in Mexico, between 20 and 170 tons of carbon were emitted into the atmosphere, depending on the type of forest⁴⁴. The total GHGs for 2002 were estimated at 86,877 Gg in CO₂e of which emissions from combustion and decomposition of biomass associated with converting forests to other uses account for 74% (64,484 Gg in CO₂e units).

Prior to the 1992 Forestry Law, all of Mexico's forests were managed as concessions, without regard to actual land ownership. Concessions were granted by the government and managed by private firms. Indigenous communities and ejidos had no rights to manage their own forests, harvest timber or generate revenue from forestry activities. This situation discouraged good forest management by both concessionaires and the communities; and encouraged over-exploitation by the former and illegal logging by the latter. Due to long rotation periods in some forests (70 years or more), significant areas of forest are still under stocked due to past over cutting and other abusive practices – and it will take many decades more for them to recover fully.

Forest concessions were fully eliminated in 1996 and, with the support of the World Bank, community-managed forestry has gradually emerged in their absence. Currently, about 10,000 indigenous communities and ejidos⁴⁵ own at least 65 percent of the country's forests. Results of community forest management are encouraging and include 250 thousand ha of forest certified as sustainably managed, 1 million ha of community-managed forests, 3.2 million ha with community-approved land management plans, efficiency upgrades in 280 community forest industries, 32 programs established for the payment of environmental services, and the integration of the private sector into community development programs, among other successes.

³⁹ http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1164107274725/3182370-1164201144397/Local_Institutions-Climate_Change_Adaptation_note113.pdf

⁴⁰ Johnson, T. et al, 2009, “Low-Carbon Development for Mexico”, The World Bank, Washington DC

⁴¹ http://www.ai.org.mx/archivos/sem_cambio_clim/Dr.%20Carlos%20Gay%20G.pdf

⁴² http://www.iea.org/Textbase/country/2I_country.asp

⁴³ www.semarnat.gob.mx/Documents/Estrategias_libro_completo_compress2.pdf

⁴⁴ Kaimowitz, David. 2008. The Prospects of Reduce Emissions from Deforestation and Degradation (REDD) in Mesoamerica

⁴⁵ Communities and ejidos are land holdings with either indigenous or non-indigenous members with rights, stipulated in law, to communal resources under which an individual family has a right to an individual plot of land allocated formally by the community as well as access to communally owned lands (often forest lands, pastures and waterways).

The Strategy identified a number of programs related to the forestry sector, most of which are managed by CONAFOR. One of the Programs is **PROARBOL**, which was introduced in 2007 with the objective of consolidating different federal support mechanisms to enhance the forestry sector, especially in the 101 least privileged municipalities. The program issues competitive grants from CONAFOR to requests submitted by organizations or individuals for improving forest planning, forest protection, reforestation, developing commercial activities in wood processing, soil conservation, etc.

The Strategy establishes the following forestry-related actions:

a) conservation of carbon stocks:

- Sustainable forestry (increase the area under sustainable forestry by 2.6 million hectares per year achieving the conservation of 6,000 to 12,000 MtCO₂).
- Payment for environmental services (increase the coverage of existent programs like **PSAH**⁴⁶(Programa de Pago por Servicios Ambientales Hidrológicos) to reach a cumulative area of 2.49 million of hectares, achieving the conservation of 1,500 to 3,100 MtCO₂).

b) carbon capture:

- Reforestation: reforest 285,000 ha a year through **PRONARE**⁴⁷ Program (a component of **PROARBOL**) to accumulate 1.71 million ha by 2012 (estimated carbon capture of 10 million – 20 million tons of CO₂ for the period 2007-2012) and 3.9 million ha by 2020 (estimated carbon capture of 50-100 million tons of CO₂ for the period 2007-2020). Doubling of the budget for **PROARBOL** from 2006 to 2007 has enabled the reforestation of 642,000 hectares of forest in 2007 (double the forest area lost every year).
- Soil restoration with reforestation: restore and reforest degraded soils in an area of 115,000 ha annually, through **PROARBOL**, to accumulate 690,000 ha by 2012 (estimated carbon capture of 5-15 million tons of CO₂ for the period 2007-2012).
- Commercial forestry plantations: expand the area of commercial plantations at 100,000 ha per year to accumulate an additional 600,000 ha by 2012 (estimated carbon capture of 3-7 million tons of CO₂ for the period 2007-2012) and 1.4 million ha by 2020 (estimated carbon capture of 15-30 million tons of CO₂).

c) carbon substitution:

- Forest derived biofuels: introduce 500,000 high efficiency wood burning stoves in rural communities for the period 2007-2012 (estimated carbon capture of 2.5 million tons of CO₂ for this period).

Other action programs in the forestry sector are: i) Forest development program (**PRODEFOR**, Spanish acronym) offers support to owners of forested areas in order to boost their technical and economic development (2001-2006: 9.3 million ha were incorporated); ii) Commercial forest plantation program (**PRODEPLAN**⁴⁸ Spanish acronym) has as objective the recovery of degraded forest area (2001-2006: 351.7 thousand ha); iii) Program for Conservation and Reforestation of Forest Ecosystems (**PROCOREF**⁴⁹ Spanish acronym), previously known as PRONARE, has as objective the restoration of the vegetative cover in strategic areas of the country; iv) **National Inventory on Forestry and Soils**⁵⁰ provides useful statistics and maps.

Mexico is a participant in the World Bank's Forest Carbon Partnership Facility (FCPF), to prepare itself to reduce emissions from deforestation and forest degradation (REDD).

4.1.2. Livestock

Livestock are an important source of methane (CH₄) emissions. Microbial enteric fermentation in the gastrointestinal tract of livestock produces methane gas as a by-product. Of the total methane emissions from livestock in Mexico for the period 1990-2002 89% came from beef and beef-dairy production, 10% from dairy cattle and 1% from other livestock⁵¹. These emissions represent 88% of total livestock related emissions, the remaining 12% being nitrous oxide (N₂O). Methane emissions are influenced by species, animal type within species, weight, and composition of diet, location, time of year, days on feed, productivity level and age.

The Strategy establishes the following mitigation measures:

- a) Rehabilitation of grazing and rangelands - rehabilitate 450,000 ha of grazing and rangelands through the Program for support for cattle production (**PROGAN**⁵² Spanish acronym) for an estimated carbon capture of approximately 4.6 MtCO₂).

⁴⁶ <http://www.ceamamorelos.gob.mx/secciones/ambiente/psah.htm>

⁴⁷ http://www.mexicoforestal.gob.mx/contenido.php?contenido=programa_nacional

⁴⁸ http://www.e-local.gob.mx/wb2/ELOCAL/ELOC_Programa_Desarollo_Plantaciones_Forestales_Co

⁴⁹ <http://www.ceamamorelos.gob.mx/secciones/ambiente/programas/pronare.htm>

⁵⁰ http://148.223.105.188:2222/snif_portal/index.php?option=com_content&task=view&id=1&Itemid=2

⁵¹ www.semarnat.gob.mx/Documents/Estrategias_libro_completo_compress2.pdf

⁵² http://www.e-local.gob.mx/wb2/ELOCAL/ELOC_Productividad

- b) Reduction of methane emissions in intensive farming - introduction of alternative technologies for the adequate management of farm manure in 1200 small farms with the final aim of reducing methane emissions for the period 2007-2012.

4.2. Carbon Trading and Agriculture

Under the Clean Development Mechanism (CDM), developed (also referred to as Annex I) countries can implement project activities that reduce emissions in developing (non-Annex I) countries. Almost a third (29.23%) of all registered CDM projects are in Latin America (LAC). Though the CDM is expected to generate investment in developing countries, especially from the private sector, and promote the transfer of environmentally-friendly technologies in that direction, the global share of agricultural sector projects (including afforestation and reforestation) is very small (5.71% of total registered projects globally as of December 2009)⁵³ and the potential is country-specific. Latin America, as a region, currently holds the largest share of registered agricultural projects globally, 61% (75 projects). In comparison to other countries, Mexico is actively engaging in carbon trading in agriculture, with 20% of all registered agricultural projects globally and 32% of all registered agricultural projects in LAC⁵⁴.

As of December 2009, there are 119 registered projects in Mexico, representing 27% of all registered projects in LAC, only second to Brazil (with 37% share of all LAC projects). Mexico also holds a share of 6.24% of the global number of projects, fourth after India (with 24.61%), China (with 35.15%) and Brazil (8.66%), respectively⁵⁵. Of the registered CDM projects in Mexico, 24 are classified as being related to agriculture (or 20% of all registered CDM projects in the country). All the registered agricultural projects address GHG reductions from improved animal waste management systems in confined animal feeding operations in different regions of the country. Currently, there are no registered CDM projects in Mexico under the "afforestation and reforestation" category⁵⁶.

Furthermore, the **Mexican Carbon Program**⁵⁷ (PMC, Spanish acronym) was established in 2005 to coordinate scientific activities related to the carbon cycle in Mexico, assisting in the design of public policy aimed at tackling and adapting to climate change. Among the participants in the Program are 27 governmental, non-governmental and academic institutions, including some from the agricultural sector.

The World Bank has mobilized a fund to demonstrate projects that sequester or conserve carbon in forest and agro-ecosystems. The BioCarbon Fund, a public/private initiative administered by the World Bank, aims to deliver cost-effective emission reductions, while promoting biodiversity conservation and poverty alleviation. In principle, the BioCarbon Fund can consider purchasing carbon from a variety of land use and forestry projects; its current portfolio includes Afforestation and Reforestation, Reducing Emissions from Deforestation and Degradation and the Fund is currently exploring innovative approaches to account for agricultural soil carbon.

Mexico has initiated a number of studies and assessments, and a number of programs are under preparation, which design local responses to climate change. As of now, two such programs are about to be finalized for the states of Veracruz and Nuevo León. In addition, the following vulnerability assessments have been completed: (i) agriculture, water and forestry in the state of Tlaxcala; (ii) tourism in Quintana Roo; (iii) agriculture in Morelos; (iv) coastal wetland ecosystems along the Gulf Coast; and (v) fresh water supply for the city of Hermosillo.

5.1. Action Frameworks

The Strategy, ENACC (2007), identifies areas to reduce vulnerability to climate change and analyzes the institutional and economic challenges to an effective adaptation policy. The Strategy provides for the reinforcement of national capacity to manage weather-related risks and to improve land use planning as a preventive measure. The design and implementation of a **National Climate Modeling Program**⁵⁸, mainstreaming adaptation in regional, state and municipal development plans, and the expanded use of insurance to reduce vulnerability, are also envisaged.

Among the identified areas for adaptation are:

1. Hydro meteorological hazard risk management and water resources management
 - Improved water resources management programs with emphasis on preserving environmental services;

5. Impact of Climate Change on Agriculture - Adaptation Measures

⁵³ <http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html>

⁵⁴ <http://cdm.unfccc.int/Projects/projsearch.html>

⁵⁵ <http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjByHostPartiesPieChart.html>

⁵⁶ <http://cdm.unfccc.int/Projects/projsearch.html>

⁵⁷ http://cambio_climatico.ine.gob.mx/pmc/english/objetivos.html

⁵⁸ <http://www.ine.gob.mx/cclimatico/descargas/e2005b.pdf>

- Strengthening climate data collection, processing, use, and dissemination;
- Recognition of ancestral practices and lessons learned by communities affected by climate variability.

2. Agriculture, husbandry cattle raising

- Climate information monitoring program for the agriculture sector;
- Climate tools for farmers and ranchers;
- Coordination with biodiversity programs and strengthening of epidemiological surveillance and control programs.

5.1.1. Land Management

Only 13% of the land area in Mexico is used for agricultural activities, 55% for summer pasture and grazing and 23% for forestry related activities. Mexico is responsible for 14.8% of all Latin American consumption of fertilizers (1,711 Mt/year). Fertilizers used in agriculture contribute 16% of total emissions of CO₂Gg tons yearly. According to the Climate Change Inter-ministerial Commission (CICC, 2007), in Mexico CO₂ emissions resulting from activities related to the change in the use of soil and agriculture amounted approximately to 135 million tons of CO₂e in 2002, accounting for 21% of total emissions in Mexico. The emissions of other greenhouse gases, like methane and nitrous oxide, have decreased by 2.7% in the period 1990-2002 (CICC, 2007).

One of the most important problems Mexico is facing in the last decades is the expansion of degraded land. The land affected by water erosion accounts for 37% of the total degraded land. Most of this damage is in the form of loss of topsoil. Other causes for degradation are salinization, biological degradation and loss of top soil from wind erosion. The latter is due to inadequate land cover, whether due to deforestation, mono-cropping, overgrazing or from farming on marginal and hill areas. Chemical deterioration is another problem that Mexico faces and it manifests itself in the form of nutrient loss. Only 36% of Mexican land can be said to be free from degradation of any kind.

There is a high degree of desertification in Mexico with 36% of the irrigated area being affected, 54% of the rainfed cropland area and 90% of the rangeland area (LADA⁵⁹). An estimated 48% of all the land in Mexico is considered vulnerable to the impacts of climate change, particularly in the North and in densely populated areas (Hernández et. al, 1995).

Short and medium term adaptation efforts for drought and desertification affected areas include:

- Rainwater harvesting, irrigated vegetable production, agroforestry, soil and water conservation measures, short duration varieties and improvement nutrient management.
- Long-term measures include the introduction of heat tolerant crops, as well as conversion of marginal cropland to rangeland.

The National Strategy (ENACC) establishes the following land use related actions:

1. Land use reconversion - promote the reconversion of agricultural land to perennial and mixed crops in 900,000 ha, through the Program for Direct Support to Agriculture (**PROCAMPO**⁶⁰ Spanish acronym), (estimated carbon capture of 4,16 MtCO₂ for the period 2007-2012); the potential of carbon capture of this program for the period 2007-2012, estimated to be used on 400,000 ha of land, is at around 0.9 MtCO₂.
2. Efficient use of chemical fertilizers:
 - Develop standards for fertilizers use according to region and crop
 - Produce a Manual of best practices (a first version of the manual should be published by 2009)
 - Assess alternative options
 - Training of technical staff and of producers
3. Prevention of forest fires from cropland burning - promote alternatives to slash and burn agriculture in 100,000 ha which would lead to a reduction from 50% to 35% of slash and burn related forest fires.
4. Conservation tillage - employ conservation tillage and foster cover crops in 200,000 ha (estimated carbon capture of 911,600 tons pf CO₂ for the period 2007-2012).
5. Encourage studies on vulnerability and development of national and local capacities of response and adaptation to climate change.

⁵⁹ <http://lada.virtualcentre.org/pagedisplay/display.asp>

⁶⁰ <http://www.procampo.gob.mx/>

Furthermore, the **Action Plan against Desertification**⁶¹ (**PACD**, Spanish Acronym), coordinated by **CONAZA** serves as a tool against desertification through its various actions of mitigation of drought effects, design of selfhelp schemes, and promotion of social participation to deal with drought, among others.

Mexico has great potential for the development of bioenergy from woody biomass, agricultural residues, liquid biofuels and municipal solid waste. It is estimated that biofuel development could displace up to 30% of the domestic consumption of fuel currently imported. Sugarcane plantations currently cover 680,000 ha, representing 3% of the total arable land in the country. The first plant to produce ethanol from corn is to be established in the Northern state of Sinaloa. Another good crop alternative for biofuels is sorghum which is the second most important crop in Mexico and whose production costs are lower than those of corn⁶². However, the relative mitigation cost of liquid biofuels appears to be much higher than that of other bioenergy alternatives⁶³.

5.1.2. Water Use

More than 85% of the Mexican land area is classified as arid and semi-arid with the Northern and Central part being the most vulnerable to water deprivation. These are also the areas with the lowest availability of water, where the supply is expected to decrease by up to 20% as supposed to the current one. Out of the total cultivated area of the country, only 6.2m ha are equipped for irrigation, representing 23% of the total cultivated area. Out of the total area equipped for irrigation, 93.5% is done by surface irrigation (5.8m ha), 4.8% by sprinkler irrigation (0.3m ha) and the rest of 1.7% by localized irrigation (0.1m ha). Out of the total area equipped for irrigation, 67% is done with surface water and 33% with groundwater⁶⁴.

Agriculture accounts for around 75% of the water usage in the country. Its use is highly inefficient though with 55% of the total usage being wasted, mainly due to leaking and excess irrigation, among other causes⁶⁵. This is a serious problem, coupled with the fact that Mexico may experience significant decreases in run-offs (the difference between precipitation and evapo-transpiration) of 10 to 20 percent nationally and up to 40% along the Gulf Coast wetlands as a result of global climate change. An increase in temperature will cause evapotranspiration to increase and soil humidity to diminish, thus demanding more water extraction to keep crops irrigated.

The Program "**Alianza para el Pueblo**"⁶⁶ focuses on the efficient use of water for irrigation, including the modernization and rehabilitation of irrigation districts. The Program "**Alianza Contigo**" supports land and water management projects, productive reconversion in areas with recurrent drought and use of renewable energy for agriculture.

Vulnerability to droughts is determined by both biophysical and social conditions. In Mexico some adaptation measures to alleviate the negative impacts of climate change on some yields have been proposed; for example, nitrogen fertilization, could be the best option to increase maize yields, although it might not be economically feasible to implement (Conde et al. 1997). Local communities have developed many traditional options for coping with droughts. In many semi-arid areas refined irrigation systems (e.g. Chinapas and Galerías) have been developed over the centuries to store and transport water to settlements and for agriculture. Indigenous social institutions and traditions also served as drought adaptation and risk management strategies⁶⁷.

The Cajete Terrace agroecosystems have been in place for three thousand years in hillside regions in Tlaxcala. In these rainfed Corn–Bean–Squash agroecosystems, food is grown on steep erosion-prone slopes. Rainfall is concentrated between May and September and often occurs in sudden downpours. Sloping terraces feed excess water into tanks (cajetes). The water, which would otherwise not be absorbed into the soil, is collected inside the cajetes and slowly percolates into the surrounding soils after the rain has ended. Eroded soils are also trapped inside of the cajetes, preventing soil loss down the slope. Nutrient rich soils inside of the cajetes are later gathered and distributed into the fields⁶⁸.

5.2. Social Aspects and Interventions

Many people in rural areas derive their livelihoods from agriculture and can be disproportionately affected by changes in climate.

In the 2005 **Human Development index**, Mexico was ranked 52 out of 177 nations (at 0.829), behind Argentina, Chile, Uruguay and Costa Rica in the region. The situation of the country has been improving

⁶¹ <http://www.mexicoforestal.gob.mx/editorial.php?id=95&laPublicacion=87>

⁶² <http://www.iica.int/Esp/organizacion/LTGC/agroenergia/Documentos%20Agroenergia%20y%20Biocombustibles/Agroenergia%20and%20Biofuels%20Atlas%20of%20the%20Americas.pdf>

⁶³ World Bank. Low Carbon Development Scenario Analysis in Mexico (MEDEC): Land use and bioenergy. Draft report.

⁶⁴ http://en.wikipedia.org/wiki/Irrigation_in_Mexico

⁶⁵ www.semarnat.gob.mx/Documents/Estrategias_libro_completo_compress2.pdf

⁶⁶ <http://www.sagarpa.gob.mx/Dgg/ganind2.htm>

⁶⁷ http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf

⁶⁸ http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf

over time (in 1995 the HDI was 0.786), though sharp regional inequalities in terms of social and economic opportunities remain. The Gini index of inequality for Mexico is 46.1, with about 12% of the population living on less than \$2 a day⁶⁹. However, the population in Southern states of Chiapas, Oaxaca, Guerrero, Veracruz and Hidalgo is characterized by a high degree of marginalization. These states represent 20% of the total population of the country (or close to 20 million people).

There appears to be a high positive correlation between the degree of marginalization of a municipality and poverty incidence⁷⁰, which is a limiting factor in the adaptation capacity of communities to diminish the impact of climate change. Small agricultural producers are particularly vulnerable to climatic changes, as they are often poor, depend on rainfed agriculture, and have limited financial resources to spread risk. The link between marginalization and resource use is less clear. Though the marginalization index of the northern states and the Central District is very low, their pressure on water resources is among the highest in the country, with Baja California at 85% and Sonora at 77%⁷¹. The **Agricultural Sector Program 2007-2012** points out that more than half of the value of the total agricultural production of Mexico (54%) is generated in 8 States. The Table below summarizes their respective physical, social and economic vulnerabilities.

State	Region	2020 scenario	Physical vulnerability*	Social vulnerability (marginalization index)	Economic vulnerability (% employed by agriculture)*
Sinaloa	North	Decrease pp (+10 and -10%) Increase temp (0.5-1C)	Droughts, basins with high intensity of water use for irrigation are identified, thorn forests are affected	- 0.0996 (middle)	28%
Michoacán	Center	Decrease pp (+5 and -5%) Increase temp (0.8-1.2C)	Medium pressure on water by year 2025 (20-40%); Increased droughts; 31% of the surface of mountain forests will be affected, followed by temperate forests	0.4491 (high)	24%
Veracruz	Center	Decrease pp (+5 and -5%) Increase temp (0.8-1.4C)	Medium pressure on water by year 2025 (20-40%); Significant crop loss due to floods, hurricanes, vulnerability of seasonal corn; Vulnerability of temperate forests; Droughts	1.2776 (very high)	32%
Jalisco	Center	Decrease pp (5 and 10%) Increase temp (0.8 -1.4C)	Medium pressure on water by year 2025 (20-40%); Occasional droughts; Vulnerability of seasonal crops; 31% of the surface of mountain forests will be affected, followed by temperate forests	- 0.7608 (low)	10%
Sonora	North	Decrease pp (0-10%) Increase temp (1-2C)	Critical pressure over water by 2020; Increase of dry areas of the state by 30%; Low efficiency of irrigation systems, increased soil salinity	- 0.7559 (low)	16%
Chiapas	South	Decrease pp (5-10%) Increase temp (1-2C)	Increase of hot sub humid climates with subtropical forests; deforestation which will put pressure on the vegetative coverage	2.2507 (very high)	47%
Chihuahua	North	Decrease pp (5-10%) Increase temp (1-2C)	Very strong pressure on water resources (60-80%); Pressure on agriculture and livestock with total production loss in some cases; Stronger and longer drought periods; Temperate forests greatly affected by lack of pp	- 0.7801 (low)	9%
Estado de México	Center	Decrease pp (5-10%) Increase temp (1.8-1.2C)	Very strong pressure on water by 2025 (> than 80%); Higher corn productivity in areas situated at higher altitudes due to increase in temp; High wind erosion which lead to loss of topsoil (up to 25t/yr); Increase of hot sub humid climates which favor tropical forests	- 0.6046 (low)	5%

Source: Information on the 2020 scenario and physical vulnerability can be found at http://www.ine.gob.mx/cclimatico/edo_sector/estados/estados.html Information on employment in agriculture, by state, can be found at INEGI at <http://www.inegi.gob.mx/lib/buscador/busqueda.aspx> and http://www.inegi.gob.mx/est/librerias/tabulados.asp?tabulado=tab_em07b&c=11483

⁶⁹ http://hdrstats.undp.org/countries/data_sheets/cty_ds_MEX.html

⁷⁰ <http://www.conapo.gob.mx/00cifras/2000.htm>

⁷¹ http://siteresources.worldbank.org/INTPOVERTY/Resources/335642-1208437838380/Martinez_ClimateChange_Poverty.pdf

Adaptation measures that could result in positive social outcomes include improved management of water availability and a shift to drought resistant crops. In addition, adaptation should ensure that communities' traditional knowledge and capacity in managing climatic changes is recognized and further strengthened. Coping strategies of poor farmers to weather variations in Mexico have included: 1) diversification (short-term reactions range from selling livestock, seeking off-farm employment and informal loan options, replanting and switching to shorter-cycle crops; in the long-term, switching to subsistence maize is a prevalent strategy) - non-farm income (55% of rural incomes in Mexico⁷²) and in particular non-farm wages e.g. from working in public projects, in tourism or other industries are the most profitable form of livelihood diversification; 2) migration to urban areas or the USA - Mexico is the largest remittance-receiving country in the region, with over \$23 billion in 2006 (money originates from the US). Highest concentrations of recipients are in Central Mexico, in the regions of Guanajuato, Jalisco, Michoacán, San Luis Potosí, and Zacatecas⁷³; 3) storage of rainwater for additional irrigation.

Mexico counts with an established cash transfer program "**Oportunidades**"⁷⁴ (formerly called PROGRESA and initiated in 1997) administered by the **Ministry of Social Development (SEDESOL**, Spanish acronym). The program's original objective was to provide support to rural families in extreme poverty (by investing in human capital) as a safety net for those with limited opportunities. In 2001, when the name of the Program changed, the scope of the services was extended to urban populations⁷⁵.

5.3. Insurance Instruments

Agricultural insurance is a complement to existing and future programs focusing on reducing vulnerability to catastrophic climate events and long term climate change. Insurance, the most implemented ex ante instrument for financing disaster risk in Mexico, has decreased both covered area and beneficiaries. Whereas during the 1980s the crop insurance subsidy reached 40% of Mexico's cultivated area, insurance policies were offered by a public insurance company who had the monopoly in the market and were mandatory for producers receiving subsidies credit from the government. This meant large unsustainable losses for the public sector, and from the 1990s the agricultural insurance market was privatized and the purchasing of the policies was voluntary. However, the subsidy to insurance premium remained, but in 2005 was eliminated for livestock insurance. Coverage is now about 16% of cropland. Though low relative to developed countries, this insurance coverage is above the Latin America average of 6%⁷⁶. Despite their novel design, the insufficient penetration of disaster prevention measures has given rise to the current high reliance on post-disaster instruments in Mexico⁷⁷.

There are a total of 4 (public and private) agricultural insurance companies in Mexico (estimates for 2007). The share of agricultural insurance premiums in total premiums is only 0.16%, while the loss ratio (calculated as the ratio of indemnities to premium) is high at 52%. Agricultural insurance contracts are not exclusively related to climate risks. Most agricultural insurance policies offered are multi-peril, including climate risks and other potential losses due to plant disease, fire, etc⁷⁸.

The Government of Mexico has 4 main instruments (programs) in place that directly support the agriculture sector in managing climate risks. All of them require public sector budgetary resources to operate:

- a) **AGROASEMEX**⁷⁹: This is a public sector reinsurance company that operates in the agricultural sector, providing reinsurance to private insurance companies, to the FONDOS (see below) and direct insurance to State Governments. Agroasemex has three main developmental (and subsidy) activities: (i) administer the subsidies to agricultural insurance premiums; (ii) administer and allocate the funds for technical assistance to OINFA (see below); and (iii) operate a development division that focus on designing innovative agricultural insurance instruments, such as an index-based insurance products for State Governments. The Government of Mexico, through Agroasemex provides between 30-70% subsidy for agriculture insurance premiums (not applicable to livestock insurance). The subsidy rate varies per crop and region and private insurance companies have to request the reimbursement of the subsidy to Agroasemex by presenting evidence of signed policies.

⁷² de Janvry and Sadoulet 2001. de Janvry, Alain, and Elisabeth Sadoulet. 2001. "Income Strategies Among Rural Households in Mexico: The Role of Off-farm Activities." *World Development* 29(3): 467-480.

⁷³ http://www.iadb.org/mif/remittances/lac/remesas_me.cfm

⁷⁴ http://www.oportunidades.gob.mx/htmls/quienes_somos.html

⁷⁵ <http://www.eclac.cl/cgi-bin/getProd.asp?xml=/revista/noticias/articuloCEPAL/8/23628/P23628.xml&xml=/revista/tpli/p39f.xml&base=/tpl/imprimir.xslt>

⁷⁶ <http://www.iadb.org/sds/doc/RUR%2DAgriculturalInsuranceRevisitedNOV05.pdf>

⁷⁷ http://www.cepal.org/publicaciones/xml/4/31414/Serie_92.pdf

⁷⁸ <http://www.iadb.org/idbdocs.cfm?docnum=695472>

⁷⁹ www.agroasemex.gob.mx

- b) **FAPRACC**⁸⁰ (*Fondo para Atender a la Población Rural Afectada por Contingencias Climatológicas*) is a Fund established by the Federal Government in 2003 to support State Governments in providing coverage for low-income agricultural producers that do not have agricultural insurance in case of climate-based natural disasters. The State Government can request funding ex-post for indemnity payment on beneficiaries or can purchase ex-ante insurance coverage (through Agroasemex (70% subsidy on the insurance premium) or private reinsurance companies) directly. However, few State governments have contracted it so far, concentrating its expenditure in aid for reconstruction to farmers and leaving exposure to natural hazards unchanged⁸¹.
- c) **FONDEN** (*Fondo Nacional de Desastres Naturales*) is a Fund that operates with State Governments (like FAPRACC), but that finances damages to infrastructure, including agriculture-related infrastructure (roads, irrigation, etc.). However, State Governments do not have the option of obtaining ex-ante coverage. The coverage is only ex-post.
- d) **OINFA** (*Organismo Integrador Nacional de Fondos Agropecuarios*) is the national entity that groups the FONDOS. The **FONDOS** are mutual insurance cooperatives, where its members (agricultural producers) provide co-insurance among themselves. The FONDOS can get re-insurance from Agroasemex or private reinsurance companies. The Federal Government (through Agroasemex) provides support to OINFA (and the FONDOS) through: (i) technical assistance channeled through OINFA's budget; (ii) direct technical assistance to FONDOS; and (iii) the re-insurance rates offered by Agroasemex to the FONDOS.

There are several government entities, NGOs and donors involved in initiatives relating to climate risk management for agriculture in Mexico:

- a) The Ministry of Finance (**SHCP**⁸² Spanish acronym) provides direct oversight of FONDEN and the CNSF⁸³ (*Comisión Nacional de Seguros y Fianzas*) the insurance regulatory body; b) The Ministry of Agriculture (SAGARPA) provides oversight of the FAPRACC and the subsidy to agricultural premiums.
- b) **AMIS**⁸⁴ (*Asociación Mexicana de Instituciones de Seguros*) is the national association of insurance companies. AMIS has a commission for agricultural insurance that provides support, mostly on regulatory issues, regarding agricultural insurance to its member companies;
- b) **ALASA**⁸⁵ (*Asociación Latinoamericana para el Desarrollo del Seguro Agropecuario*) is the Latin American association of agricultural insurance companies that convenes every two years to exchange experiences and best practices regarding the development of the agricultural insurance market in the region.
- c) The World Bank has provided technical assistance to Agroasemex in the development of parametric insurance instruments; b) The Inter-American Development Bank (IADB) has undertaken a pre-feasibility study of an index-based insurance instrument for providing coverage to farmers in irrigation districts against the risk of water shortages for irrigation.

⁸⁰ <http://www.sagarpa.gob.mx/fapracc/>

⁸¹ http://www.cepal.org/publicaciones/xml/4/31414/Serie_92.pdf

⁸² www.shcp.gob.mx

⁸³ http://portal.cnsf.gob.mx/portal/page?_pageid=1058,1&_dad=portal&_schema=PORTAL

⁸⁴ www.amis.com.mx

⁸⁵ www.alasa.org.mx



About *Country Notes on Climate Change Aspects in Agriculture...*

The **Country Notes** are a series of country briefs on climate change and agriculture for 19 countries in Latin America and the Caribbean region, with focus on policy developments (action plans and programs), institutional make-up, specific adaptation and mitigation strategies, as well as social aspects and insurance mechanisms to address risk in the sector. The **Country Notes** provide a snapshot of key vulnerability indicators and establish a baseline of knowledge on climate change and agriculture in each country. The **Country Notes** are the beginning of a process of information gathering on climate change and agriculture. The **Country Notes** are “live” documents and are periodically updated.



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Feedback

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