Climate Change Aspects in Agriculture

Bolivia Country Note

December 2008

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

Vulnerability Indicators

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<th>Indicator</th>
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<th>Bolivia</th>
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<td>Employment in agriculture (%)</td>
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<td>Non-insured cropland (%)</td>
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<td>Rainfed cropland (%)</td>
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<td>Water usage in agriculture (%)</td>
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<td>Soil degradation (%)</td>
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<td>Gini (as %)</td>
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Note: Employment in agriculture (% of total employment)*; Non-irrigated cropland (% of total cropland)*; Gini*; Water usage in agriculture (% of total annual freshwater withdrawals)*; Insured cultivated land area (% 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 20052; ****Germanwatch

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

Source: World Resources Institute [http://cait.wri.org](http://cait.wri.org)

Land use (2005)

Source: World Development Indicators

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Relevant Reference Material

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.

Feedback

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1
Summary

This note summarizes information on climate change aspects in agriculture\(^3\) in Bolivia, with a focus on policy developments (including action plans and programs) and institutional make-up. Like most developing countries, Bolivia has submitted only one national communication to the United Nations Framework Convention on Climate Change (UNFCCC), with a second one being in the works and scheduled to be submitted by 2009. Land use change and forestry, and agriculture are the largest contributors to GHG emissions in the country. Mitigation actions in the sector need to be actively pursued. Furthermore, the livelihoods of many rural poor households depend on agriculture. Reducing vulnerability to climate change and, in particular, to soil erosion due to overgrazing of livestock and deforestation and water scarcity due to glacier retreats (Zongo glacier has lost 9.4% of its surface area and could disappear by 2045-2050 leading to serious problems in agriculture\(^4\)) is of increasing importance in the agricultural sector, coupled with more sustainable land management practices and production decisions.

1. The Climate Context

Baseline map: Current Major Environmental Constraints related to Agricultural Potential

![Baseline map of Bolivia showing environmental constraints](http://www.fao.org/countryprofiles/maps.asp?iso3=BOL&lang=en)


1.1. Country Projections

According to the First National Communication the following future impacts from climate change related events can be expected in Bolivia:\(^5\):

a) **increase in temperature** – by 2030 temperature increases are estimated to range from 0.8 to 1.7°C, with lower increases in the Western and Southern part of the country (Oruro, south La Paz, Chuquisaca, Tarija). It is estimated that by the year 2050 the climate in Bolivia will become warmer by 1 to 2°C, especially in the West and South and during the dry months (May, June, July). For 2100, it is expected that temperature increases in dry and humid months would range from 2-4°C with smaller increases (1.4 to 3.9°C) in the eastern part of the country (Santa Cruz),

b) **increase in precipitation** – for 2030, during the dry months the rainfall estimates range from 0 to 20% in the West and South, while the Northwest (Pando, north La Paz) and Southeast (Santa Cruz, with subtropical forests and the Chaco’s plain) show a larger variation and potential precipitation decrease (-4 to 22%). However,
in absolute terms the estimated rainfall increase is higher during the humid months, reaching up to 27 mm per month between December and March. In the dry months, the percentage increase is bigger but, in absolute terms, variations are lower and the maximum estimated increase is 7 mm per month. The estimates for 2050 and 2100 follow a similar pattern, however, absolute rainfall increases reach up to 41 mm and 76 mm, respectively.

The Global Climate Risk Index constructed for the period between 1997 and 2006 and covering both human and economic impact, ranks Bolivia 50th which suggests that Bolivia is moderately vulnerable to climate related events. In recent years (between 2001 and 2007), floods and droughts have had the highest human and economic impact in Bolivia, with losses for the period 1997-2006 averaging 0.15% of GDP – 1.4 million people have been affected by floods (6 events) with the cost of damages reaching US$ 0.8 billion, and 75,000 people have been affected by droughts (2 events)7.

1.2. Agriculture related impacts

Since 1983, Bolivia has suffered increases in drought and floods, with more frequency and higher incidence in the last years. According to estimates by Beck and Roche (1986), more frequent and intensive floods in the Northeastern part of Bolivia (Beni) cover 10m ha and are mainly localized in the Mamoré River watershed. In the Western high plains and valleys of the country, El Niño caused droughts with consequent resources losses in crops and livestock, while floods in the East damaged crops, livestock and forced inhabitants’ migration. According to a study by the Andean Development Corporation (CAF), El Niño 1997/98 caused a loss of US$530m in Bolivia (equivalent to 7% of national GDP), 53% of which stemming from the droughts in the Altiplano and 47% from the floods in the North and East. Additional marginal effects of El Niño are extreme winds, serious forest fires, and hailstorms in the inter-Andean valleys. In 2002, 70 to 90% of rainfed crops (mainly corn) were destroyed in the middle basin of the Rio Grande due to lack of rain. In 2003 a drought in Southern Santa Cruz destroyed almost the whole agricultural production. During the same year, almost the whole country was affected by heavy rains and floods in different places, leading to landslides and severe destructions of infrastructure. In 2006 more than 103,000 ha of agricultural area were damaged by floods: 64,000 ha of maize, soy, rice and sorghum and 30,000 ha of pastureland. Bolivia also experiences consequences of La Niña in the form of cold fronts during summer in the Eastern part of the country, leading to increased rainfall. In 2004, a 12 hour snow storm affected the Southern provinces of Potosí, with severe damages in livestock and tourism installations.

2. The Policy Context

Bolivia has submitted only one National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) in November 2000. The Communication established the National GHG Inventory for the year 1994, it presents the main vulnerability challenges to climate change for the forestry, water and farm sectors, as well as provides mitigation options and a description of the existing projects in the various sectors.

A Second National Communication is in the works and scheduled to be submitted by 2009. The objectives of this will be to establish strategic relationships with local governments and institutions for a better understanding of the impacts of climate change, to generate a national GHG inventory, to generate vulnerability studies of human systems to climate change, to collaborate with the development of climate change scenarios and to offer support to the development of pilot projects in mitigation of GHG from key sources.

2.1. National Climate Change Plans, Strategies and Programs

The National Climate Change Program (PNCC, Spanish acronym) was created in 1995 as operational branch of the Vice Ministry of Biodiversity, Forest Resources and Environment (formerly Natural Resources and Environment), which acts as the Ministry of the Sustainable Development and Planning’s coordinating body. The Vice-Ministry plays the role of a technical advisor to the government on climate change adaptation issues and actions to comply with the UNFCCC. The PNCC initiated research activities related to climate change issues and the first investigations on the national inventory of greenhouse gas (GHG) emissions, the analysis of vulnerability and adaptation of forest, agriculture, livestock and water resources and the analysis of mitigation options for GHG emissions in the energy and non-energy sectors in order to consolidate the National Communications to the UNFCCC. Within the PNCC’s responsibilities also lies the development of a National Climate Change Action Plan and related strategies as well as the educational dissemination of climate change issues to the Bolivian public. As of today, the PNCC contains eleven focus areas for which new implementing
actors were created (e.g. the Office of Clean Development (ODL, Spanish acronym), described below) or alliances with existing institutions were built:

1) Capacity-Building and Education on Climate Change (through the Climate Change Five-Year Action Plan 2004-2009),
2) Strengthening of Research on Climate Change (in alliance with research centers and universities),
3) Development and Monitoring of Bolivia’s GHG Emissions Inventory,
4) Building an Institutional and Legal Framework for Adaptation and Mitigation Projects,
5) Development of the National Adaptation Plan,
6) Local Vulnerability Assessment to Climate Change (in alliance with national and international research centers),
7) Vulnerability Assessment for Food Safety in the Lake Titicaca and Valleys Cruceños regions (in alliance with national and international research centers),
8) Human Health Assessment in Relation to Climate Change (in alliance with national and international research centers),
9) Assessing Mitigation Options (through the pilot project of Climatic Action Noel Kempff Mercado, described below),
10) Building a Coordinating Institution to Participate in the Clean Development Mechanism (through the Office of Clean Development), and
11) Consolidation of the Second Communication to UNFCCC.

In 1996, the PNCC formulated its first National Action Plan on Climate Change for the energy and forest sector, prepared the GHG emission inventory, and initiated the National Implementation Strategy of the UNFCCC, with support from the US Country Studies Program and the UNDP.

In April 1998, Bolivia formulated the National Program of Combined Implementation (PRONIC, Spanish acronym), which seeks technical assistance and financing in order to undertake projects aiming to reduce GHG emissions in cooperation with Annex I countries, such as the Project of Climatic Action Noel Kempff Mercado.

In 2000, the National Implementation Strategy of the UNFCCC (ENI, Spanish acronym) was approved by the Inter-Institutional Climate Change Council. ENI defines the responsibilities of the implementing institutions of the UNFCCC and activities to address climate change for a time period of 10 years. It is comprised four pillars: a) promotion of clean development and reduced emissions through technical changes in agriculture, forestry, and industry, b) cooperation on the reduction of carbon in forests, tropical areas, and other ecosystems, c) increased effectiveness of energy and infrastructure use to diminish risks of contingencies and to mitigate the effects of GHG emissions, and d) increased observation and the investigation of climate and environmental changes. Its four strategic lines are: a) to strengthen and transform the productive sector, b) to increase human security, c) to use education and communication in order to achieve adaptation to climate change, and d) to establish strategic alliances on the international, national, municipal and communal level in order to achieve the implementation of the ENI.

In May 2001, Bolivia conducted a National Strategy Study for the Participation of Bolivia in the Clean Development Mechanism with support from the Swiss Cooperation and the World Bank. This study analyzed the options and opportunities associated with the implementation of GHG emission mitigation projects in Bolivia and provided a conceptual reference framework and analytical instruments to evaluate proposed options. Based on this assessment, PNCC established the National Clean Development Office, which is described below.

In July 2004, Bolivia formulated its Five-Year Climate Change Action Plan (2004-2009), which aims to foster capacity-building and knowledge transfer of climate change issues to the Bolivian population. Activities include cooperation with the Ministry of Education and universities to introduce education on climate change in the national curriculum as well as the dissemination of climate change issues through websites, flyers, and brochures. The Plan also provides funds for educational projects and scientific research projects on climate change as well as community level adaptation projects and activities aimed at reducing GHG emissions.

The 2004-2009 Climate Change Action Plan initiated activities to develop the National Mitigation Strategy, prepared in 2006 by the Ministry of Development and Planning, the Vice-Ministry of Territorial Planning and Environment, and the National Clean Development Office. The Strategy incorporates actions in the following three areas: 1) Strengthening institutional capacity for Bolivia’s effective participation in GHG emissions trading within the CDM and similar schemes, 2) Establishing mitigation programs and projects in compliance with
Bolivia’s National Development Plan, and 3) Facilitating access to information on the CDM and similar schemes. The Strategy estimates that US$6 to US$13 are required for its implementation until 2012.

Within the 2004-2009 Climate Change Action the **National Adaptation Plan** (Mecanismo Nacional de Adaptación al Cambio Climático) was finalized in November 2007 by the Ministry of Development and Planning and the Vice-Ministry of Territorial Planning and Environment. The Plan comprises a multi-sectoral vulnerability analysis to climate change and provides a ten year plan on policies and adaptation strategies on the local, regional, and national level to address climate change in five sectors: 1) Water Resources and Management, 2) Sanitary and Human Health, 3) Food Security and Agricultural Production, 4) Ecosystems, and 5) Human Settlements and Risk Management) and three transversal climate change areas (1) Scientific Research, 2) Capacity-Building and Dissemination, and 3) Anthropological Aspects and Ancestral Knowledge-Building).

### 2.2. Agricultural Sector Initiatives

The **New Model for Rural Development** within the Ministerial Plan (Revolución Rural, Agraria, Forestal) was established in 2007 by the **Ministry of Rural Development, Agriculture, and Environment** (MDRAyMA, Spanish Acronym), and promotes integral rural sustainable development through adequate management of the environment and natural resources. Climate Change is mentioned among the causes of declining contribution of agricultural output to GDP. The Plan promotes productive systems that are resistant to severe climatic changes in order to recover natural resource potential, especially for the poor and indigenous populations. It also mentions the severe problem of land degradation caused by climatic changes, such as droughts and cold fronts, especially in the inter-Andean valleys.

Within the MDRAyMA’s project **EMPODERAR** (Emprendimientos Organizados para el Desarrollo Rural Autogestionario), which aims to promote agricultural and agroforestal productivity considering cultural aspects of local populations and strengthening local institutions to stimulate productive rural development, one activity targets the creation of a farm insurance to offer farmers to insure themselves against economics losses from extreme weather events. EMPODERAR is financed by the international cooperation and partly through a credit from the Bank for Productive Development.

### 3. The Institutional Context

The **Ministry of the Sustainable Development and Planning** oversees Bolivia’s commitments to UNFCCC and other climate change related actions. The **Vice-Ministry of Biodiversity, Forest Resources and Environment** (VBRFMA, Spanish acronym) acts as a coordinating body for climate change adaptation activities, while the **Vice-Ministry of Territorial Planning and Environment** and the **Office for Clean Development** (ODL, Spanish acronym) are in charge of mitigation activities.

#### 3.1. Inter-Sectoral Coordination

The **Inter-Institutional Climate Change Council** (CICC, Spanish acronym) was created in 1999 and it represents a forum for climate change related dialogue among Bolivia’s social, government, non-government sectors, and is the agency which proposes policies and strategies to implement the UNFCCC in Bolivia. Members of the CICC are the Vice-Ministries of Environment and Natural Resources (chair), Agriculture, External Policy, Public Investment, Energy and Hydrocarbons, as well as the environmental NGO LIDEMA, National Science Academy, and the Confederation of Private Enterprise (Hydrocarbon Chamber).

In March 2002, the PNCC established the **National Clean Development Office** (NCDMO, Spanish acronym). The NCDMO is in charge of the promotion, technical evaluation, operation and negotiations of climate change mitigation projects under the CDM or other schemes, in addition to the capacity-building of social actors.

#### 3.2. Agricultural Sector Institutions

The **Ministry of Rural Development, Agriculture, and Environment** (MDRAyMA, Spanish acronym) through its **Vice-Ministry of Biodiversity, Forest Resources and Environment** (VBRFMA, Spanish acronym) oversees climate change related programs and projects in the sector. The VBRFMA signed an agreement of cooperation with the Government of the Netherlands through which several studies and projects are conducted, also related to climate change.
The National Meteorology and Hydrology Service\textsuperscript{21} (SENAMHI, Spanish acronym) provides weather data for the country’s different regions, and represents the data source of weather data used in the National Communications and other climate change studies. With support of the World Meteorological Organization (WMO), SENAMHI is modernizing its services, including the availability of climatological data and climate trends specifically for the agriculture and farming sectors.

3.3. Fostering Capacity to Deal with Climate Change

- \textit{Emission inventory}: To date, Bolivia counts with one National GHG Inventory with 1994 as its base year. The inventory includes information on emissions from energy, manufacturing, transport, agriculture, fisheries, land use change and forestry, providing disaggregated information by type of emission and type of agricultural resource.

- \textit{Economic and Social Analysis}: Under the \textbf{National Climate Change Program (PNCC, Spanish acronym)} several local, regional, and national vulnerability and adaptation studies have been developed with support from international donors, such as the Government of the Netherlands, the US Country Studies Program\textsuperscript{22}.

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

According to the World Development Indicators, agricultural land covers 34\% of total land area (13,154,262 sq km) but arable land only 3\% (3,050,000 ha). Agriculture accounts for 32\% of GHG emissions in the country, forests and land use change for 60\%, energy for 7\% and the rest is due to industrial processes and waste management.

Agriculture in the highlands is mostly traditional and rainfed, thus making it more vulnerable to weather related events. Soil erosion is a very serious problem in Bolivia with 35\% to 41\% of the soil being affected by erosion, be it wind (35\%) or water erosion (45\%). One of the causes of this soil erosion is the overgrazing of livestock, deforestation and poor land use.\textsuperscript{23}

4.1. Action frameworks

The National Mitigation Strategy as well as the First National Communication identify measures and associated emission reduction potential that enables Bolivia to reduce the carbon intensity of development. Some of the key measures associated with the forestry, land use and land-use change include forestation, improved use of agro-forestry and the introduction of sustainable forest management.

4.1.1. Forestry and Land Use Change

The natural forest cover of Bolivia represents about 50\% of its territory. According to the National Mitigation Strategy from 2006, forest management until 1995 was unsustainable due to uncontrolled licensing of forest area allocations for industrial use and the lack of effective technical planning and institutional oversight. The consequence was uncontrolled exploitation of 37\% the national forest area by private companies, principally in the departments of Santa Cruz, Beni, and La Paz. In 1996, the New Forestry Law was created, returning control of 75\% of formerly licensed forest areas to the State and requiring the remaining licensed companies to comply with Forestry Management Plans. In addition, the new law established protected forest areas and promotes reforestation, in order to ensure sustainable use of forest areas.

Forestry and land use change accounts for 60\% of Bolivia’s GHG emissions and thus has a high potential for carbon capture. Emission from forestry and land use change in Bolivia almost doubled between 1990 and 2000 to 51,772 Gg in 2000. Projections show an average annual increase of 1.47\% of CO2 emissions from forestry and land use change between 2001 and 2015, reaching 32 million tones of CO2 in 2015. Based on conservative figures, the projection of carbon losses from forestry during the next 40 years is 833 million tones of CO2.

According to figures in the First National Communication, the annual average deforestation for the period 1975-1993 was very high, especially in the Amazonian, with an average rate of 168.012 ha per year compared to a very small reforestation rate of only 1.900 ha per year for the same period of time. However, sources like the FAO and World Resource Institute report much higher national deforestation rates for the period 1981 to 1990, in the
order of 625,000 ha per year, which would raise emissions projections to a much higher level. The annual average deforestation rate for the period 1990-2005 is reported at 0.4%.

The 2006 National Mitigation Strategy identifies the following mitigation actions to be undertaken in the forestry sector:

- Forestation of natural and exotic species with multiple benefits, such as for the development of the forest industry and wood supply for local communities, protection from desertification in the high plains, inter-Andean valleys and the Chaco plains, and the conservation of biodiversity
- Enforcing sustainable forest management according to the 1996 Forestry Law through information campaigns, strengthened protection and surveillance mechanisms in order to avoid unnecessary destruction of biomass and emissions
- Development and promotion of environmental services for forestry, including ecotourism
- Promoting alternatives to migratory agriculture (e.g. zero tillage) to reduce GHG emissions and encourage sustainable land use
- Carbon sequestration and conservation in biological corridors (e.g. Amboro Madidi)
- Improved use of agroforestry for carbon capture
- Implementation of agro-forest projects in local economies
- Increased fines for those who provoke forest fires and regulation of fire management in areas exposed to this risk
- Intensification of research about the introduction of forest species resistant to lower temperatures in the high plains of Bolivia.

The potential for reducing CO2 through the application of various mitigation measures is as follows:

- The formation of new tree growing areas in the temperate area of Bolivia could have a carbon retention potential of 2.39 tons C/ha annually
- The natural regeneration of tropical forests could possibly retain 5.62 t C/ha per year for a 30 year period
- Carbon emissions retained through the implementation of the New Forest Law, added to the invigoration of the planning and protection capacities in protected areas totals 119.21 C/ha in humid tropical forests.

The National Climate Change Program for 2006/2007 identified the following mitigation projects in the forestry sector:

- **Carbon sequestration and recovery of degraded areas through community forestry in colonization areas of Nor Yungas**: benefited 270 families by increasing their life standard through the implementation of two sustainable agro-forest greenhouses with a production capacity of 20,000 plants and the added benefit of carbon sequestration
- **Distribution of adapted reforestation to specific social and environmental groups and development strategies designed to mitigate climate change**: benefited 513 families and had as an objective the identification and valuing of degraded areas through the active participation of municipalities and social actors in the design and implementation of reforestation strategies.
- **Reforestation Median Sub-Basin Central Strip of Pirai River**: benefited 244 families by reforestation of 46 hectares in the area, reduction of high degradation and soil erosion levels and production of a greenhouse of 66,500 plants of various species.

The intense forest fires of 1999 lead to the implementation of **Forest Fires Early Warning Systems** (SATIF, Spanish acronym) aimed at detecting and monitoring of fires originated in cultivated land, pastures and forests in the country.

### 4.1.2. Livestock

Farming activities are the ones responsible for the highest emissions of methane (CH4) in Bolivia. Enteric fermentation and manure management were identified as the main source of methane (CH4). Methane emission totaled 744.63Gg in 1994. These emissions are generated during the digestion process of the herbivores and they depend on the age, type, weight and quality and quantity of food the animals receive. In the First National Communication, projections for 2010, 2020, and 2030 were presented in relation to the increase of cattle population and leading to increases of up to 16.8% in CH4 emissions by 2030 as compared to the 1994 levels (870.02Gg CH4).
Some of the mitigation measures identified in the First National Communication for the livestock sector include the improvement of animal breeding techniques in order to reduce the methane emissions generated from enteric fermentation related to the breeding of bovine and ovine in Bolivia. This would have a potential increase of the productivity index for bovine and ovine of 10%, representing a 3.8% annual reduction of methane, assuming that the method is applied to 5% of bovine and ovine livestock. Using mitigation scenarios for the period 2000-2020, the application of measures related to improved animal breeding techniques would allow a reduction of CH4 emissions of 3.81% for 2000, 3.81% for 2005 and 3.82% for 201026.

A vulnerability study carried out by the National Program of Climate Change on livestock and using climate change scenarios established that a doubling of CO2 concentration in an incremental scenario causes a considerable decrease in the weight of bovine livestock, which is more pronounced in zebu livestock (between 11% and 15%) than in Creole one (between 9% and 12%). Furthermore, grass production would increase where there are increases in temperature and precipitation.

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. 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 share of agricultural sector projects (including afforestation) is very small (6.21% of total registered projects globally)27 and the potential is country-specific. This potential has not yet been explored by Bolivia. As of August 2008, the country has only 2 registered projects, representing less than 0.5% of all registered projects in LAC28 with no registered projects in agriculture29.

Some of the studies on PNCC website related to the subject are:

- Mercados de Carbono y Fondos de Financiamientos para Proyectos MDL
- Análisis de Opciones de Mitigación de Emisiones de Gases de Efecto Invernadero
- Mecanismo de Desarrollo Limpio, Proyectos en Bolivia
- Instructivo Anotado para la Formulación de Proyectos para el Mecanismo de Desarrollo Limpio y otros Proyectos de Mitigación del Cambio Climático

5. Impact of Climate Change on Agriculture - Adaptation Measures

Agriculture is highly sensitive to climate change in Bolivia and the importance of this sector stems from the fact that more than half of the economically active population is employed in agriculture30.

Bolivia has a low adaptation capacity to climate change due to scarce financial, human and technological resources. The PNCC outlines several adaptation measures for the agricultural sector in order to prevent or reduce the negative effects of climatic changes, especially in crops that are important economically and for food security. The measures strongly relate with Bolivia’s Economic and Social Development Plan and comprise the following: a) Management of land and water, 2) Agricultural research, and 3) Interactive technology transfer.

With support from the Government of the Netherlands through the Netherlands Climate Change Studies Assistance Program and the Netherlands Development Assistance as well as the US Country Studies Program, GEF, UNITAR-UNDP, Bolivia has initiated a few national and regional studies and assessments to address the present and future impact of climate change. Some of these studies are as follows:

- Vulnerability and Adaptation to Climate Change in Bolivia – Participatory research in the regions of the Lake Titicaca and the Crucenos Valleys (Vulnerabilidad y Adaptación al Cambio Climático en Bolivia: Resultados de un proceso de investigación participativa en las regiones del lago Titicaca y los Valles Cruceños)
- Vulnerability and adaptation to climate change and climatic variability in the food systems of dry mountain regions (Vulnerabilidad y adaptación al cambio y variabilidad climática de los sistemas alimentarios en zonas semiáridas de montaña)
- Climate Change in Bolivia – análisis, impacts, and adaptation (El Cambio Climático en Bolivia · análisis, síntesis de impactos y adaptación)
- Evaluation of technical requirement for Climate Change in Bolivia (Evaluación Inicial de Necesidades de Tecnología para el Cambio Climático en Bolivia)
5.1. **Action frameworks**

The National Climate Change Program 2006/2007 and the National Communication identify areas to reduce vulnerability to climate change and among these are the implementation of a system of forecasting of floods and draughts, training in the effective management of water for agriculture as well as an improved soil management.

5.1.1. **Land Management**

The National Climate Change Program identified the following adaptation project:

- **Recuperation of native species in the Ayllus pastures of Comanche**: the objective is to increase the adaptation capacity to climate change in the region through soil management and conservation techniques and planting of native species in uncultivated and degraded soils.

The application of measures related to control of land at risk from degradation has a carbon retention potential of 1.35 tons C/ha/year for a 40 year period with the application of agricultural systems. The carbon retention potential through natural regeneration of grasslands for a 25 year period is 1.12 tons C/ha/year.

5.1.2. **Water Use**

The altiplano and lowland regions of Bolivia have a very unequal distribution of water resources and irrigation infrastructure. Only 11% of the total agricultural land (2,100,000 ha) is irrigated in Bolivia. Most of the irrigation systems are situated in the South and Southwestern areas and consist of rudimentary web of canals supplied by rainfall which make them very vulnerable to climate change. The efficiency of the irrigation systems varies from 18-30% in traditional systems to 35-50% in improved systems. Irrigation for agricultural purposes accounts for 94% of water withdrawal in the country.

Climate change studies performed specifically on potatoes demonstrated that the most important adaptation measure that increased the crop yield from 30% to 60% was water contribution in the form of irrigation. The study showed that the correct application of water, at the right times was more efficient that the CO2 fertilization.

In the First National Communication, the following adaptation measures in the water sector were proposed:

- Coordinated planning of the use of water in the different basins
- Construction of regulation, irrigation and storage works
- Adoption of conservation politics
- Control of water quality
- Systems of controlled and remunerated supplies
- Adoption of contingency plans
- Operations that could allow the transfer of water to intermediate basins
- Systems for forecasting floods and droughts
- Training and education in the management and consumption of water

The National Climate Change Program 2006/2007 identified the following adaptation projects:

- **Mitigation of draught effects in farms for increased food security**: it consisted of training of 81 families in efficient water using techniques, soil conservation and micro-irrigation and agronomic evaluation and verification of yield increase as a consequence of the newly applied techniques.

- **Management alternatives and use of natural resources to reduce the effects of climate change for farm production systems**: introduction of new irrigation techniques which lead to increased water availability and an increased farm production in 13.5ha of rehabilitated land.

5.3. **Social Aspects**

According to the Human Development Index from 2005, Bolivia ranks 117 out of 177 nations (at 0.695) – significantly behind its neighbors Argentina (38), Chile (40), Brazil (70), Peru (87) and Paraguay (95). More than a third of Bolivia’s population lives in rural areas (38%) and almost half of Bolivia’s workforce is heavily
involved in the agriculture sector. The country has the highest rate of income distribution inequality in Latin America with a GINI coefficient of 0.60 and is believed to be the most ‘indigenous’ country of the continent with approximately 55% of its population of ‘pure’ indigenous descent\(^{34}\).

In rural Bolivia, people manage their assets in a variety of ways to deal with both climate variability and change. Below are various examples of coping strategies which illustrate the ways in which farmers adapt to changing circumstances in an effort to ensure positive livelihood outcomes.

**Subsistence guided by indigenous knowledge and local networks**

- In Bolivia, the Aymaran indigenous people reside at 4,000 meters above sea level. Their livelihoods are extremely dependent on rainfall. In recent years, increased intensity of drought has had devastating effects not only on agricultural production but also on the production of meat, wool and milk – physical assets crucial to their survival. The Aymara look to their yatiris (wise men or advisors) who, based on observing nature, are able to make yearly predictions on how intense the droughts of the upcoming year will be. These forecasts are passed on to other yatris and subsequently to their respective communities and the greater Aymaran population is thereafter able to more effectively prepare for the effects of upcoming drought.

- To prevent and cope with disasters caused by drought, the Aymaran people have adopted traditional practices to harvest rainwater in the mountains and pampas by building small dams called *qhuthañas*. These dams collect and store rainwater for future use so that women and children may not have to travel long distances to obtain more water and so that communities may have a source of clean water ready for consumption\(^{35}\). These dams are an example of using traditional knowledge to deal with the impacts of climate change.

- Finally, in order to ensure that the Aymara’s ancestral knowledge is not forgotten, the Aymara hold regular lectures and training on their traditional knowledge, beliefs and values to the younger generations\(^{36}\).

**Diversified farming activities** – A household with a diversified portfolio of activities in agriculture will enjoy increased resilience to climate change and climate variability. For example, in the Altiplano, forage and dairy activities are a vital supplement to income as livestock systems are far less susceptible to climate stress than cropping and other agricultural activities. Sales of milk and feed often serve as buffers from climate variability and contribute to a long-term, climate-resilient livelihood strategy\(^{37}\). Households with livestock are more likely to enjoy access to credit to purchase seed and food which will facilitate engaging in activities that adapt better to variability. However, the acquisition of sheep, llama and alpaca may also result in soil infertility erosion which consequently has detrimental effects on crops\(^{38}\).

**Capitalizing on varied agro-ecological conditions** - The departments of Chuquisaca and Potosi, located in the highlands of Bolivia, are among the poorest and most isolated areas of Bolivia. Elevation varies from 1500 to over 3800 meters above sea level and with these changes in altitude come shifts in livelihood activities. At the higher altitudes, farmers engage mostly in non-commercial, livestock-dependent activities. As the elevation decreases activities range from commercial potato farming (at 3000-3600m) to marginal subsistence agriculture (2500 – 2800m) to the cultivation of fruits and horticulture in the lowest zone (1500-2000m). According to a study by Zoomers\(^{39}\), functional relationships with these ecological boundaries enable farmers to capitalize on their differences. For example

- Rather than concentrating all activities in the more productive zones, farmers in each of these agro-ecological zones attempt to capitalize on the assets originating in different agro-ecological zones by engaging in functional relationships of reciprocity. More specifically, villagers in the higher elevations migrate downwards with their llamas for a few months of the year to exchange salt, clay and medicinal plants for grain and maize. Recently, as average temperatures have risen and drought has increased, the ‘arable farming frontier’ has been pushed upwards and more people have been able to engage in farming; this has had a positive impact on the livelihoods of these highland farmers while also bearing important implications land use and altered sources of income.

- In order to mitigate the risk of a total harvest failure and to spread labor across time, farmers within different households arrange to work different plots of land across the various agro-ecological zones. On average, a farmer will attend to nine parcels of land located in distinct zones in order to maximize gains from each activity as much as possible and diversify livelihood possibilities.
5.4. Risk

Bolivia has eight active and regulated private insurance companies, a few of which offer single peril insurance products to producers. The agricultural coverage is assumed to be modest. In June 2006, the government formed an Agricultural Insurance Support Committee (AISC), comprised of various stakeholder organizations and whose missions is to study the feasibility of introducing and expanding agricultural insurance. Among these stakeholders are:

- ABA, the national insurance association, has expressed interest in agricultural insurance and some of them have been innovating with new insurance instruments, in particular in the Province of Santa Cruz with soy producers.
- The Ministry of Agriculture (MDRyAMA): has been a key leader in promoting the agenda of the AISC, seeking financing for their feasibility studies.
- Financial Entities Association (ASOFIN): this is a group of financial intermediaries that shows great interest in agricultural credit.
- PROFIN: it is a development NGO working in rural areas and agriculture with support from the Swiss Cooperation. They have conducted a pilot project of index based agricultural insurance close to the Titicaca Lake: the scheme is based on the yield of a chosen good farmer (“Yapuchiri”) that is recognized by the community as an agricultural leader.
- The Inter-American Institute for Agricultural Cooperation (IICA, Spanish acronym) has organized workshops on the subject of agricultural insurance and is an active member of the AISC. They have established a website to follow up on the Committee’s activities:
  
  http://www.iica.int.bo/AgroSeguros/Presentacion.html

The Government of Bolivia (GoB) has issued a decree creating agricultural insurance in the Province of Tarija, mandating that the Province support the insurance premiums of small farmers to purchase policies. However, the operating regulations of such decree have not yet been finalized.

In 2007, after losses from floods and droughts from La Nina effects, various government institutions provided ex-post compensation to small farmers and among these were: the Ministry of Planning, the Provincial Governments and the Ministry of Agriculture (it paid over US$ 1.6 million in farmer compensation).

Within the Ministry of Agriculture’s project EMPODERAR (Organized Initiative for the Development of Self-Management), which aims to promote agricultural and agroforestry productivity considering cultural aspects of local populations and strengthening local institutions to stimulate productive rural development, one activity targets the creation of a farm insurance to offer farmers to insure themselves against extreme weather events. EMPODERAR is financed by the international cooperation and partly through a credit from the Bank for Productive Development.

Relevant Reference Material:

3 General information on the linkages between climate change and agriculture can be found at http://en.wikipedia.org/wiki/Climate_change_and_agriculture, including the references and links provided.


5 These projections are base on the analysis done by the National Meteorology and Hydrology Service (SENAMHI) in 1998 for the period 2000-2100, using the Hadley Center HADCM2 general circulation model implemented by the United Kingdom Meteorological Office (UKHI) and the Goddard Institute of Space Studies
(GISSEQ). The results displayed stem from the reference global scenario of climate change (IS92a) established by the Negotiations Committee of the UNFCC and that estimates a halving of future emissions.


http://unfccc.int/resource/docs/nate/bolnc1e.pdf


http://www.pncc.gov.bo


The Project Climatic Action Noel Kempff Mercado started operating in 1997 and is planned to continue until 2026. Until XX the project avoided emissions in terms of almost one million tons of CO2 in an area of 624.000 ha of natural forest. The Government of Bolivia, the Foundation Amigos de la Naturaleza, The Nature Conservancy, American Electric Power, British Petroleum and Pacific Corp. are involved in this project.


These programs can be found under the program's website: www.pncc.gov.bo

http://www.fao.org/docrep/T2351S/T2351S0c.htm#Situación%20ambiental%20en%20relación%20con%20la%20erosión%20en%20Bolivia

http://unfccc.int/resource/docs/nate/bolnc1e.pdf


http://unfccc.int/resource/docs/nate/bolnc1e.pdf

http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html

http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjByHostPartiesPieChart.html

http://cdm.unfccc.int/Projects/projsearch.html

Viceministerio de Planificaciòn Territorial y Ambiental, Programa Nacional de Cambios Climáticos, “El Cambio Climático en Bolivia (Analisís, sintesis de impactos y adaptación)”


Viceministerio de Planificaciòn Territorial y Ambiental, Programa Nacional de Cambios Climáticos, “El Cambio Climático en Bolivia (Analisís, sintesis de impactos y adaptación)”


http://hdrstats.undp.org/indicators/147.html and


Impacts, vulnerability and adaptation to climate change in Latin America


Coping and adapting to climate variability: the role of assets, networks, knowledge and institutions (http://www.climateadaptation.net/docs/papers/Valdivia%20paper%20draft.pdf)


www.iica.int.bo