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BOLIVIA

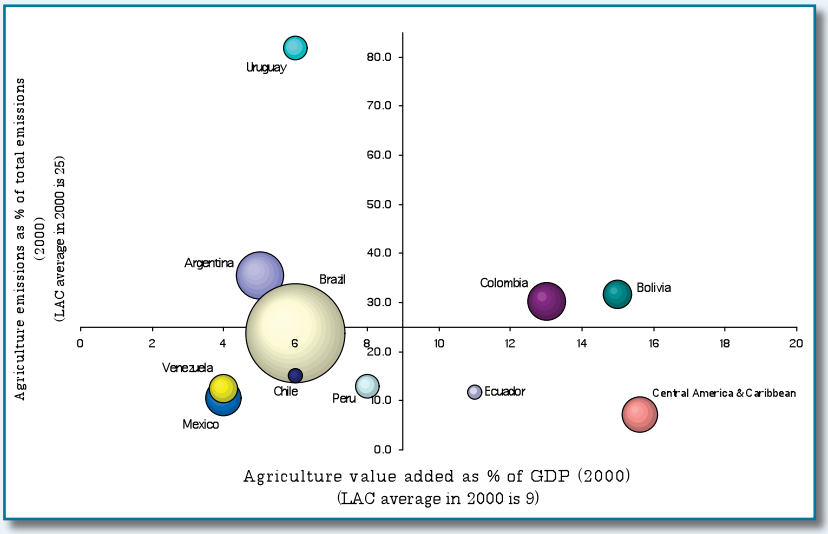
53784

Country Note on Climate Change Aspects in Agriculture

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.

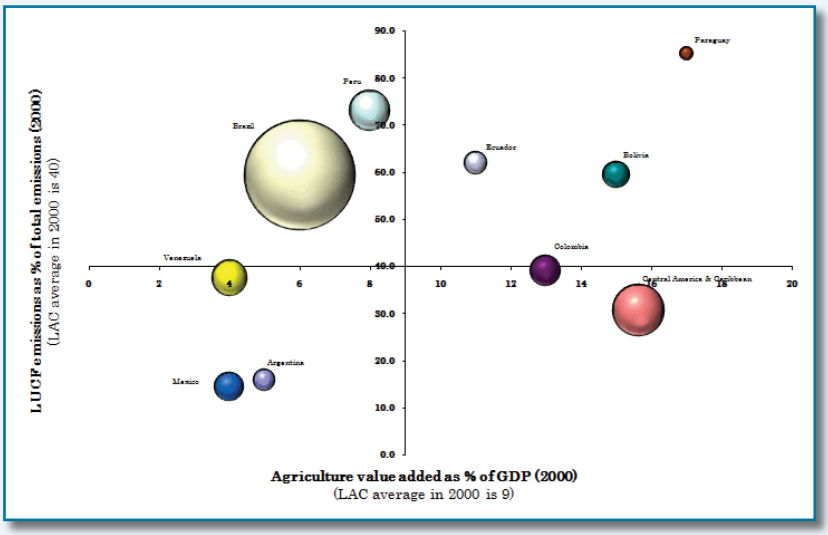
Contribution of agriculture (without LUCF) to the economy and to emissions in LAC countries

(size of bubble in $MTCO_2$ of LUCF emissions; axes cross at LAC average)



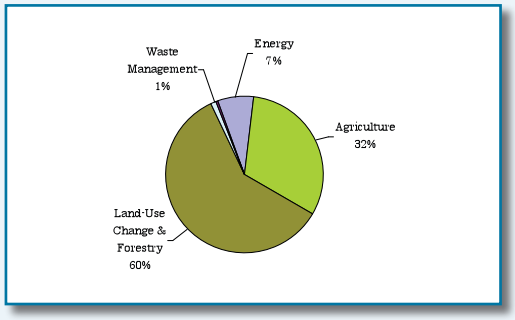
Contribution of agriculture to the economy and of LUCF to emissions in LAC countries

(size of bubble in $MTCO_2$ of LUCF emissions; axes cross at LAC average)



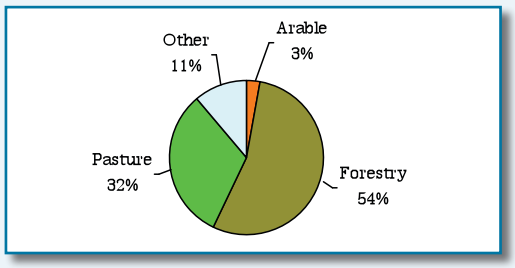
Note: In the first bubble graph, the total emissions for Uruguay do not account for the positive effects of LUCF (i.e. afforestation efforts). If they are considered, agriculture represents 222% of total emissions. Because of afforestation efforts in Uruguay and Chile, land use change and forestry (LUCF) 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.

Percent of GHG emissions in CO_2 equivalent, by sector (2000)



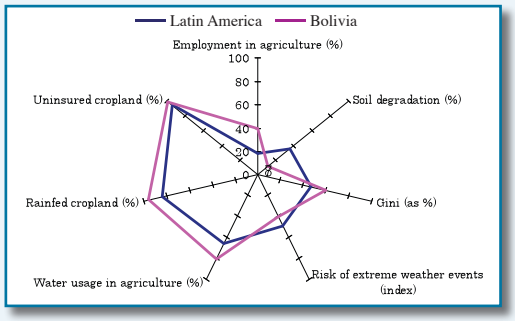
Source: World Resources Institute http://cait.wri.org

Land use (2005)



Source: World Development Indicators

Vulnerability Indicators



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 2005[1]; ****Germanwatch

[1] http://www.fao.org/landandwater/agll/glasod/glasodmaps.jsp?country=BOL&search=Display+map+%21

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Summary

Like most countries in Latin America, Bolivia has submitted one national communication to the United Nations Framework Convention on Climate Change (UNFCCC) with a second one under preparation. Land use change and forestry, coupled with agriculture, are by far the largest contributors to GHG emissions in the country. The emission reduction potential of the sector is large, but not sufficiently explored. Bolivia counts with only 2 registered CDM projects, none of which is in the agricultural sector. Agriculture is highly vulnerable to climate variability and weather extremes and around a third of the population derives their livelihood from agricultural production. A greater emphasis on adaptation strategies, in particular those related to water harvest and sustainable land management, as well as developing and applying adequate insurance mechanisms can be placed for better management of public resources in light of natural disasters in the agriculture sector.

Working definitions

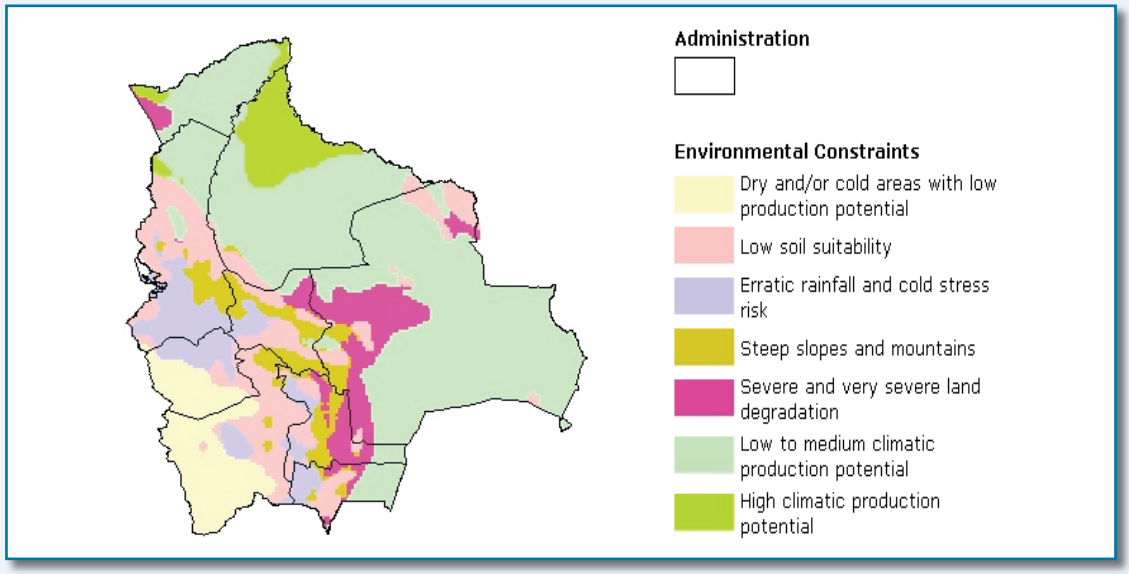
Agriculture is defined as a managed system of crops, livestock, soil management, forest resources (productive use, goods & services) and water resources (irrigation), including land use and land use change. **Climate change** encompasses both **mitigation** and adaptation activities within the agricultural 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 Bolivia's agricultural potential given current environmental constraints and their regional distribution. Around 35% of Bolivia's land is used for agriculture (32% for pasture and 3% for cultivation), with forestry occupying 54% 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 Bolivia and agricultural resources, go to 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[2]:

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 27mm 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 7mm per month. The estimates for 2050 and 2100 follow a similar pattern, however, absolute rainfall increases reach up to 41mm and 76mm, respectively.

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)[3].

[2] 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.

[3] http://www.emdat.be/Database/CountryProfile/countryprofile.php?disgroup=natural&country=bol&period=1999$2008

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[4]. 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.

Furthermore, Impacts of glacier retreat on economic activities have been felt already and include total or partial loss of tourism and snow sports, such as for Chacaltaya glacier in Bolivia, and shortage of water supply for urban populations and agriculture. Zongo glacier has lost 9.4% of its surface area and could disappear by 2045-2050 leading to serious problems in agriculture[5]. The problem of ice losses in Bolivia has been noticed in different areas along the Cordillera de los Andes. The average ice losses, from the Tuni and Condoriri glaciers from 1956 to 2006, is 50 % and if the same tendency of glacier area reduction continues, there is a main concern that the Tuni and Condiriri glaciers will disappear by 2025 and 2045, respectively[6].

2. The Policy Context

Bolivia has submitted only one **National Communication**[7] 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 currently under preparation with the objectives of establishing 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[8].

2.1. National Climate Change Plans, Strategies and Programs

The **National Climate Change Program**[9] (**PNCC**, Spanish acronym) was created in 1995 as operational branch of the formerly known **Vice Ministry of Biodiversity, Forest Resources and Environment**[10,

[4] http://www.germanwatch.org/klima/cri2008.pdf
[5] Magrin, G., Gay García, D. Cruz Choque, J.C. Gimenez, A.R. Moreno, G.J. Nagy, C. Nobre and A. Villamizar, 2007: Latin America. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Forth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, EDS., Cambridge University Press, Cambridge UK, 581-615
[6] Ramirez, E., 2008, "Impactos del cambio climatic y gestión del agua sobre la disponibilidad de recursos hídricos para las ciudades de La Paz y El Alto", Instituto de Hidráulica e Hidrología, Universidad Mayor de San Andrés, La Paz, Boliviahttp://unfccc.int/resource/docs/natc/bolnc1.pdf
[7] http://unfccc.int/resource/docs/natc/bolnc1.pdf
[8] http://www.minagua.gov.bo/webpncc/Copia%20(2)%20de%201.html
[9] http://www.minagua.gov.bo/pncc/index.htm
[10] http://www.agrobolivia.gov.bo/index.php?cpo=mamb

currently Vice-Ministry of Environment, Biodiversity and Climate Change, which acts as the **Ministry of Environment and Waters**'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 not-energy sectors in order to consolidate the National Communications to the UNFCCC. Within the PNCC´s responsibilities also lies the development of **National Climate Change Action Plans**[11] and related strategies as well as the educational dissemination of climate change issues to the Bolivian public.

In 1996, the PNCC formulated its first **National Action Plan on Climate Change** for the energy and forest sectors, 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**[12].

In 2000, the **National Implementation Strategy of the UNFCCC**[13] (**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[14]. Based on this assessment, PNCC established the **National Clean Development Office**.

Bolivia has incorporated cross-cutting policies and programs into the 2006-2010 **National Development Program** to guarantee adequate and early response to the impacts of climate change. In 2007, the country issued its **National Adaptation Plan**[15] (**MNACC**, Spanish acronym) which aims at reducing vulnerability to climate change and promoting planned adaptation within the framework of various sectoral programs. The Plan includes five sectoral programs: 1) water resources, 2) food security, 3) health, 4) human settlements and risks reduction and 5) ecosystems; and three transversal programs: 1) scientific research, 2) education, and 3) social aspects.

The first **Climate Change Adaptation Strategy at the Municipal level**, covering six municipalities of Titicaca Lake and Crucenos Valleys region, was issued in May 2007. Among the adaptation measures

[11] http://www.minagua.gov.bo/pncc/index.htm
[12] 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 CO_2 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.
[13] http://www.minagua.gov.bo/webpncc/biblio/ESTRATEGIA.pdf
[14] http://siteresources.worldbank.org/INTCC/1081874-1115369143359/20480415/NSSBoliviaCDMAbridged2000.pdf
[15] http://www.minagua.gov.bo/webpncc/1.html

identified in the Strategy are the following priority areas: 1) territorial planning; 2) water security; 3) climate-proofing productive systems; 4) development of adaptation capacity, etc.

Bolivia is part of the 9 countries participating in the **Pilot Program for Climate Resilience** (**PPCR**). This is the first program developed by the **Strategic Climate Fund** (**SCF**) of the World Bank and aims at providing incentives for scaled-up action and transformational changes in integrating climate resilience into national development planning while complementing other activities underway. It will consist of two phases. Phase 1 of the PPCR may provide funding for technical assistance to enable Bolivia to build upon existing national work to integrate climate resilience into national or sectoral development plans. Phase 2 of the PPCR may provide additional financial resources to help fund basic public and private sector investments identified by the country in their climate resilient development plans developed or strengthened during Phase 1. The PPCR is above all a country-led initiative which aims at (i) strengthening capacities to integrate climate resilience into national and sectoral development plans; (ii) fostering development strategies that take into account climate resilience; (iii) raising awareness among public, private and civil society actors on the potential impacts and vulnerabilities to climate change; (iv) helping scale-up climate resilient investments and (v) improving coordination between key actors when it comes to implementing climate resilient programs and investments.

2.2. Agricultural Sector Initiatives

The **New Model for Rural Development** within the Ministerial Plan (R*evolución Rural, Agraria, Forestal*) was established in 2007 by the former **Ministry of Rural Development, Agriculture, and Environment**, currently **Ministry of Rural Development and Land**[16] (**MDRyT,** 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 MDRyT´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 economic 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 Environment and Water**[17] (**MMAyA**, Spanish acronym) oversees Bolivia's commitments to UNFCCC and other climate change related actions. The **Vice-Ministry of Environment, Biodiversity and Climate Change** acts as a coordinating body for climate change adaptation activities and is the hosting entity for the National Climate Change Program (PNCC, Spanish acronym). Apart from this vice-ministry, MMAyA also includes the Vice-Ministry of Water Resources and Irrigation.

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.

[16] www.agrobolivia.gov.bo
[17] www.minagua.gov.bo

3.2. Agricultural Sector Institutions

The **Ministry of Rural Development and Land**[18] (**MDRyT**, Spanish acronym), with its Vice-Ministry of Land, the Vice-Ministry of Rural Development and Agriculture and the Vice-Ministry of Forest Development, oversees climate change related programs and projects in the sector.

The **National Meteorology and Hydrology Service**[19] (**SENAMHI**, Spanish acronym) provides weather data for the country's different regions, and represents the 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 climate data and trends specifically for the agriculture and farming sectors.

3.3. Fostering Capacity to Deal with Climate Change

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.

Studies related to climate change and agriculture: Under the **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 and the **US Country Studies Program**[20]. 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 Cruceños 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 (E*valuación Inicial de Necesidades de Tecnología para el Cambio Climático en Bolivia*)

Bolivia is one of seven case study countries for the global study on the Economics of Adaptation to Climate Change led by the World Bank and financed by the governments of the UK, Netherlands and Switzerland.

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[21].

[18] http://www.agrobolivia.gov.bo/
[19] www.senamhi.gov.bo
[20] These programs can be found under the program's website: www.minagua.gov.bo/pncc
[21] http://www.fao.org/docrep/T2351S/T2351S0c.htm#Situación%20ambiental%20en%20relación%20con%20la%20erosión%20en%20bolivia

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 CO_2 emissions from forestry and land use change between 2001 and 2015, reaching 32 million tones of CO_2 in 2015. Based on conservative figures, the projection of carbon losses from forestry during the next 40 years is 833 million tones of CO_2.

Deforestation and forest degradation occur mostly in the Amazonian rainforest, transitional forests, Chiquitano dry forests, Sub-Andean forests and in the Chaco, though in particular in the department of Santa Cruz. Almost 75% of Bolivia's total deforestation occurs in Santa Cruz and is mainly produced by large scale agro-industry for soy bean and other industrial crops. The deforestation monitoring data from the national forestry authority indicate that 40% of the recent annual deforestation (>6 ha) results from approx. 250 large scale deforestation interventions.

The annual deforestation was calculated to be 162,694 hectares annually for the period 1976 – 2004 using a 2007 WWF study. The national forestry authority estimates that between 2004-2007 Bolivia experienced an annual deforestation of approximately 295,000 ha (not considering deforestation less than 5.3 hectares). Only 12,5% if the deforestation has been legally approved.

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 CO_2 through the application of various mitigation measures is as follows[22]:

- 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**[23] (**SATIF**, Spanish acronym) aimed at detecting and monitoring of fires originated in cultivated land, pastures and forests in the country.

In July 2008, Bolivia was selected into the World Bank's **Forest Carbon Partnership Facility** (**FCPF**).[24] The FCPF aims to assist Bolivia in its efforts to reduce emissions from deforestation and forest degradation (REDD). The Facility has the dual objective of building capacity for REDD, and testing a program of performance-based incentive payments in some pilot countries, on a relatively small scale, in order to set the stage for a much larger system of positive incentives and financing flows in the future. As a first step, Bolivia will participate in the so-called Readiness Mechanism of the FCPF. This mechanism supports Bolivia to arrive at a reliable estimate of its national forest carbon stocks and sources of forest emissions. In addition, Bolivia will define its reference scenario based on past emission rates for future emissions estimates. More details regarding Bolivia's next steps under the Readiness Mechanism of the FCPF can be found in Bolivia's **Readiness Plan Idea Note** (**R-PIN**)[25].

[22] http://unfccc.int/resource/docs/natc/bolnc1e.pdf
[23] http://rmportal.net/library/I/A/2/publicados-bolfor/libros/satif-evaluacion-de-incendios-forestales-2002.pdf/view
[24] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTCARBONFINANCE/0,,contentMDK:21631703~menuPK:5216269~pagePK:64168445~piPK:64168309~theSitePK:4125853,00.html
[25] http://wbcarbonfinance.org/docs/Bolivia__FCPF_R-PIN.pdf

It is expected that a new forestry law will be approved in 2010 focusing less on commercial timber extraction and more on community forestry, non-timber products and including forests in the Andean region. This new legislation is planned to be part of a larger national forestry strategy, which include Reduced Emissions from Deforestation and Forest Degradation (REDD).

4.1.2. Livestock

Farming activities are the ones responsible for the highest emissions of methane in Bolivia. Enteric fermentation and manure management were identified as the main source of methane (CH_4). Methane emission totaled 744.63 Gg 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 CH_4 emissions by 2030 as compared to the 1994 levels (870.02 Gg CH_4).

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 CH_4 emissions of 3.81% for 2000, 3.81% for 2005 and 3.82% for 2010[26].

A vulnerability study carried out by the National Program of Climate Change on livestock and using climate change scenarios established that a doubling of CO_2 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 global share of agricultural sector projects (including afforestation and reforestation) is very small (5.71% of total registered projects globally as of December 2009)[27] and the potential is country-specific. Latin America, as a region, currently holds the largest share of registered agricultural projects globally, 61% (75 projects) and a third of the global afforestation and reforestation projects (3 projects).

As of December 2009, there are a total of 3 registered projects in Bolivia, of which 1 is in afforestation and reforestation. Currently, there are no registered CDM projects in agriculture in Bolivia[28].

Some of the studies identified 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*

[26] http://unfccc.int/resource/docs/natc/bolnc1e.pdf
[27] http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html
[28] http://cdm.unfccc.int/Projects/projsearch.html

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.

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 around a third of the economically active population is employed in agriculture[29]. According to preliminary results of various studies conducted by universities and other institutions, there are an estimated 224 adaptation projects in the country. Of these, 43% are at the community level, 20% at the municipal level, 16% at the Departament level, 10% at the national level and 7% at the international level.

5.1. Action frameworks

The **National Climate Change Program 2006/2007** and the **First 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** identifies 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

Rapid shrinkage of glaciers in the Andean countries, for example in Bolivia, Chile, Ecuador and Peru, could lead to droughts which would affect people and the biodiversity of the region. An observed increase in run-off has only been temporary. It cannot last very long without increasing precipitation. The melting of glaciers will cause water shortage for millions of people in the region. This is the main vulnerability in the Andean region[30].

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. The irrigation systems in the South and Southwestern areas 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[31].

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 CO_2 fertilization[32].

[29] Viceministerio de Planificación Territorial y Ambiental, Programa Nacional de Cambios Climáticos, "El Cambio Climático en Bolivia (Análisis, síntetis de impactos y adaptación)"
[30] http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf
[31] http://en.wikipedia.org/wiki/Irrigation_in_Bolivia
[32] Viceministerio de Planificación Territorial y Ambiental, Programa Nacional de Cambios Climáticos, "El Cambio Climático en Bolivia (Análisis, síntetis de impactos y adaptación)"

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** identifies 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.

The **Design and implementation of adaptation measures to address glacial melt in the central Andes** is a project to be funded through the GEF-SCCF and to be implemented by the World Bank. It is planned to support: (i) institutional analysis, legal and regulatory assessments, a stakeholder analysis and consultation process, and public awareness for the implementation of adaptation measures; and (ii) design and implementation of pilot adaptation projects in selected communities, and key economic sectors where vulnerability is greatest and the region's interest is the highest[33]. The project has 3 components, already under implementation: 1) Integrated Watershed management in the Tuni and Condoriri basins, incorporating the impact of rapid glacier retreat; 2) Integrated Pilot Catchment Management Plan for watersheds affected by glacier retreat in the Bolivian plateau and high valleys; 3) Mainstreaming Adaptive River Defense for the Huayhuasi and El Palomar Settlements.

With support from the World Bank, technical assistance is provided to Bolivia related to hydrological modeling for climate change assessment in Bolivia, at the country level (11 main basins), as well as modeling at sub-basin level in 3 different departments of Bolivia (La Paz, Cochabamba, Potosí). This initiative is undertaken in coordination with the Vice-Ministry of Science and Technology, the Vice-Ministry of Environment, Biodiversity and Climate Change, SENAMHI, as well as the universities of San Andres (La Paz), San Simón (Cochabamba) and Tomas Frías (Potosí)[34].

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. Around 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[35]. 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.

[33] http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf
[34] http://projportal.worldbank.org/servlet/secmain?PSPID=P115558&menuPK=109012&theSitePK=213348&piPK=69345&pagePK=112935 and http://essm.tamu.edu/bolivia/cambio_climatico_es.htm
[35] http://hdrstats.undp.org/indicators/147.html and http://www.fao.org/ag/AGP/AGPC/doc/Counprof/Bolivia/Bolivia.htm

Subsistence guided by indigenous knowledge and local networks – the example of the Aymara

- In Bolivia, the rural Aymara indigenous people reside at 3,600 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 livelihood. 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 yatiris 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, some Aymara communities 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[36 37]. These dams are an example of using traditional knowledge to deal with the impacts of climate change. 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[38].

Diversified farming activities and multi-locality – A household with a diversified portfolio of activities in agriculture and transfers from urban areas 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[39]. 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[40]. Multi-locality (through migration of members of the extended household) has also been a traditional strategy for coping with climate variability since long before the European conquest.

Capitalizing on varied agro-ecological conditions –The departments of Chuquisaca and Potosí, located in the highlands of Bolivia, are among the poorest and most isolated areas of Bolivia. Elevation of agricultural lands varies from 1500 to over 4100 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 maize farming (2500-2800m), to the cultivation of fruits and horticulture in the lowest zone (1500-2000m), thought great variability exists within and across these altitude bands given the great variability of agroecological conditions generated by micro climates. According to a study by Zoomers[41], 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 theses 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

[36] Impacts, vulnerability and adaptation to climate change in Latin America
[37] http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf
[38] http://www.unisdr.org/eng/public_aware/world_camp/2003/english/17_Article_BOLIVIA_eng.pdf
[39] Coping and adapting to climate variability: the role of assets, networks, knowledge and institutions (http://www.climateadaptation.net/docs/papers/Valdivia%20paper%20draft.pdf)
[40] Library of Congress, Country Studies, Bolivia (http://rs6.loc.gov/frd/cs/botoc.html)
[41] Rural Life in the Andes: Crossing Borders as a Strategy (from: Fronteras: Towards a Borderless Latin America). CEDLA, 2000. (http://www.cedla.uva.nl/pdf/16zoomers.pdf)

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.

Aside from the national communications, concrete planned or ongoing adaptation projects fundedunder the GEF include a **Community-based Adaptation** (**CBA**) **Programme**. This project, **implemented by UNDP**, is aimed at: (i) developing a framework, including new knowledge and capacity, that spans the local to the intergovernmental levels to respond to unique community-based adaptation needs; (ii) identifying and financing diverse community-based adaptation projects; and (iii) capturing and disseminating lessons learned at the community level to all stakeholders, including governments[42].

The social component of the study led by the World Bank titled "Economics of Adaptation to Climate Change – Bolivia Case Study" attempts to: (i) examine the impacts of climate variability and climate change on households and regions and the implications for development in Bolivia and (ii) identify adaptation options that build resilience of diverse livelihood groups, particularly the most vulnerable persons within these. This is done in a participatory, bottom-up manner; workshops, 45 focus group discussions, 70 household and 42 key informant interviews have been conducted in 14 municipalities. Results will be forthcoming in early 2010.

5.3. Insurance Instruments

Bolivia has two 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, including NGOs, government and private sector, 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 Rural Development (MDRyT): has been a key leader in promoting the agenda of agricultural insurance, but discussion within the GoB has stalled. The Ministry recognizes that given the importance of agriculture in terms of contribution to GDP (14 percent) and large quantity of small farmers, agriculture insurance is key to transfer weather risk out of the sector and country.
- 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 (SECO). 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 pilot farmer

[42] http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_latin_american_wkshp.pdf

("Yapuchiri") that is recognized by the community as an agricultural leader. Though this initiative still carries too much moral hazard and no reinsurance for any significant scale up, it might provide the risk transfer to farmers in the area to conduct the technological innovations the project is implementing. Furthermore, PROFIN has recently been developing (at the design stage) new insurance schemes for hail and other risks in the Department of Tarija.

- The Inter-American Institute for Agricultural Cooperation[43] (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 country has passed a law 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 (Prefecturas) and the Ministry of Agriculture (it paid over US$ 1.6 million in farmer compensation).

The World Bank currently has a project under preparation (PISA) which contains a weather insurance component and whose objective is to promote sustainable agriculture growth, especially among the rural poor, by strengthening Bolivia's Agricultural Innovation and Information Systems and by facilitating the development of private sector based weather insurance[44].

[43] www.iica.int.bo
[44] http://imagebank.worldbank.org/servlet/WDSContentServer/IW3P/IB/2009/04/13/000013944_20090414142754/Rendered/PDF/PID0BO0Agricul1rvices1Concept0Stage.pdf

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.

LATIN AMERICA AND THE CARIBBEAN REGION

AGRICULTURE AND RURAL DEVELOPMENT TEAM

Feedback

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