IMPACT OF CLIMATE CHANGE IN ANDEAN BOLIVIAN COMMUNITIES THAT DEPEND FROM TROPICAL GLACIERS
Prepared by:
Adriana Soto Trujillo

Review and complementation:
Matilde Avejera, Danitza Salazar, Paula Pacheco, Martín Vilela, Edwin Torrez

Agua Sustentable

La Paz
Calle Nataniel Aguirre Nº 82 entre 11 y 12 de Irpavi
Telf/Fax: +591 (2) 2151744
lapaz@aguasustentable.org

Cochabamba
Calle Irigoyen Nº 150, entre Juan de la Rosa y Yuracaré (zona Sarco)
Telf/Fax +591 (4) 4423162
cochabamba@aguasustentable.org

Tupiza
Av. Tomás Frias Nº 350 (Zona Plaza San Antonio)
Telf/Fax +591 (2) 6945338
tupiza@aguasustentable.org
In the last years, Bolivia has been affected by the impacts of climate change (increase of heat waves, changes in rainy season, floods, droughts and forest fires.), which mainly affect rural communities, who are the most vulnerable because of their low adaption capacity; probably because their way of living is based on the use of natural resources highly sensitive to the changes of climatic conditions, such as water.

The impact will be much greater in communities that live in the highlands (mountainous area) if projections from the IPCC (2008) are considered, which indicate that water stored in glaciers and in the snow cover will decline this century, reducing water availability in warm and dry seasons in those regions depending on the principal mountain ranges’ snowmelt.

In this sense, researches were made in basins that depend on Tropical Glaciers in our country to identify the impact of climate change on the livelihoods of communities, establishing adaptation strategies to cope with this situation.

This brochure shows the decline in two Bolivian tropical glaciers: The Mururata and Illimani. It also recommends some adaptation strategies for the Sajhuaya River micro-basin, which water source comes from the Illimani glacier.
IMPACTS: Maximum and minimum temperature increase in the last decades

Data recorded for the 1975-2009 periods by El Alto city station show that the maximum and minimum temperatures have extreme values.

The registered data for the same period in La Paz city show increase of maximum and minimum temperatures.¹

---

¹ Data obtained from Espinoza D. and Fernandez R.; Analysis of Climate Trends in the Region of Sajhuaya River basin. 2011
The IPCC (2007, quoted by PNUD, 2011) states that the increase in atmospheric temperature has generated an accelerated melting of glaciers in the Andean region, with obvious impacts on water availability.

As shown by figures 5 and 6, in the last 46 years, Illimani glacier has lost approximately 21.3 % of its surface and 22 m of thickness (depth), at an average speed of 47 cm a year; thus, reducing the capacity of the basin for water storage.
According to the National Service for Meteorology and Hydrology (SENAMHI) (Figure 8), in the last period (2002 – 2006), the average temperature values are higher than former periods, showing temperature increase in the last years\(^2\).

At the same time, the results of the study made by Ramírez (2009) in Mururata Glacier show that this glacier has lost approximately 20.13% of its surface in the last 42 years (Figure 9).

Figure 8. Average Temperatures in Mururata glacier region.


Figure 9. Mururata glacier surface extensions from 1975 to 2009.

\(^2\) Results presented in this point correspond to the Project “Adaptation to climate change in regions affected by the melting of tropical glaciers in Bolivia”, supported by DANIDA.
When analyzing 1946 – 2009 period, it is possible to see an increase of precipitations with variations in dry and humid seasons.

However, the population from Sajhuaya micro-basin perceived that there has been a decrease in rainfall in the last years, matching with the observed data from 1976 – 2009 periods.

According to interviews made – to recover the memories of the population about extreme climate events - most individuals remember 1983 (El Niño Southern Oscillation Year), recorded as the driest year in the Bolivian West. In general, this type of extreme events (droughts and floods) affect to the families' economy; in fact more than 50% of the surveyed families use their savings to cope with the impacts of extreme climate events, while 17% of community families – from the upper basin- temporally migrate to urban centers (García et. al., 2010).

Source: Espinoza and Fernández, 2011
At the foot of the glacier there are highland wetlands, known as cushion bogs or “bofedal”. These ecosystems are fragile and essential because they produce the necessary food for livestock; what’s more, they are the habitat for native flora and fauna and store water coming from the melting glaciers, rainfall or groundwater, acting as water regulators, especially in dry season.

Studies carried out by Carafa (2009) indicate that between 1989 and 2009 the cushion bog area increased from 33.7 to 107.6 hectares, which could be associated with a higher melting of the glacier.

Communities from the high zone use these areas for pasturing llamas all year long. Another issue that adds to the climate change impacts is that this area is used as a tourist campsite.

**IMPACTS: Cushion Bogs**

**ADAPTATION STRATEGY**

- **Promote the development of sustainable tourist activity**
  - Signposting to guide tourists to campsites and at the same time let them know about the melting of the glacier, also about the importance and caring of the cushion bogs.
  - Relocate the tourists’ campsite to an area outside the cushion bogs.
  - Conservation of the cushion bogs through regulatory frameworks (e.g. declaration of the place as a Protected Area).

- **Elaborate a Management and Conservation Plan for Cushion bogs**
Together with communities, the principal climate and non-climate risks were identified, having maps showing the different risks per community.

Climate risks are next:

Hail is common from December to March. There is also frost from May to June; however, the latter has not been occurring lately.

The lack or bad distribution of rainfall affects to communities from the low area especially.

Non-climate risks: these are the landslides, rock falls and river overflows caused by the strong rains and land instability.
Communities should create their own Early Warning System for flooding, hail and drought.

Combine the traditional and scientific knowledge in order to prepare weather forecast reports.

Through the Municipal government prepare in communities, a sensitization and broadcast plan consisting of weather and risk information.

Among communities and led by the Municipal Government, generate an emergency plan for river overflowing and flooding.

Strengthen the use of local techniques (cleaning of channels to avoid river overflowing, among others).

Present a Food Security Strategy, including different actions, such as, food storage in case of loses caused by extreme events.

Build live barriers with fruit trees or other local material.

Recover soil through gullies (drainage) management.
Communities in the micro-basin are mainly engaged in agricultural production. In relation to previous years, their productive systems have suffered some variations:

Increase in temperatures has caused an expansion of crop areas, going from a dry production system to an irrigation commercial agriculture with a tendency towards monoculture of lettuce (because of its yield and market value), especially in the lower basin. This crop is produced in different times during the year causing in the long-term, soil degradation.

On the other hand fruit trees have been moved towards the basin’s upper side.

Moreover, dependency for irrigation in lettuce production has generated greater demand (Fig. 10).

This has also caused a greater resistance and increase in pests that attack different crops. Due to this, farmers currently use pest controls that are highly toxic, affecting soil, water, and their health.
ADAPTATION STRATEGIES: Production Systems

**Integrated Crop Management**

- It is recommended to incorporate higher profitability fruit trees in the middle and lower basin.
- Implementation and production of improved varieties (seeds and/or seedlings) resistant to diseases and climate changes.
- Elaborate a periodic register for production and costs.

**Integrated Pest Management (MIP)**

- Use category III and IV pesticides in order not to put our health at risk.
- Manage and store pesticides in safe places.
- Reduce the use of chemical pesticides by the incorporation of organic pesticides.
- Get information: Participate in MIP events.

**Soil Conservation**

- Maintain the aynoqas\(^3\) (soil rotation management) in some sectors (upper basin).
- Continue or recuperate crop rotation and terrace practices.
- Planning land-use at property level.
- Apply learnt practices regarding fertilizers and organic pesticides.

\(^3\) Succession and rotation of plots at community level.
Currently the snow-melting of the Illimani glacier is apparently creating greater water availability in the micro-basin communities.

However, if we consider the loss of the glacier area, the increase in the evapotranspiration (ET), and changes in rainfall distribution, in the future, can generate: water reduction, availability, and quality for communities.

Although water management in these communities has adapted to changes, going from a system without irrigation schedules to one with established schedules within the community and among communities with one single irrigation system, today these agreements are getting very complex. This could generate greater conflicts, especially among communities in the basin’s high and low areas.
Water storage reservoirs have been constructed as pilot adaptation measures in Khapi and La Granja communities.

One Aljibe (closed reservoir) made of geo-membrane stores water to supply controlled irrigation to an experimental plot.

Two “Atajados” (small excavated ponds) have been built and covered with geo-membrane. They collect water from irrigation channels and store it for their use during water shortage periods; they will also be used to try sprinkle and drip irrigation.

Besides, it is recommended the implementation of micro-irrigation systems (drip irrigation, sprinklers).

**Technologies for water efficient use**

*Actions for reducing hydro erosion*
- Implement infiltration ditches in pasture and fruit-tree areas
- Building of live barriers
- Control of gullies

**Quality Control**
- Sanitation Education
- Solid waste management plan
- Community monitoring system for water quality

**Conflicts Management**
- Improve the alliances between communities from the low and high areas of the micro basin.
- Promote dialog for the resolution of conflicts.
Over time, there is increasing scientific evidence confirming the causes of global warming and its effects, pointing with certainty to their anthropogenic origin. Consequently, Global Warming and Climate Change will have a significant impact on hundreds of people in the Andes since the Andean region’s ecosystems are particularly sensitive.

The Andes are known for their rich biological and cultural diversity, and now face the threat of Global Warming and Climate Change. Since 1939, the temperature of the tropical Andes mountain range has increased from 0.10°C to 0.11°C per decade, and has accelerated its pace in the last 25 years with a warming of between 0.32°C and 0.34°C per decade\(^4\). The current rise has already caused serious damage to the Andean ecosystems, including the accelerated melting of tropical Andean glaciers, and even more adverse scenarios are expected.

The tropical glaciers of the Andes are particularly sensitive to Climate Change since the process of glacier’s ice accumulation only occurs under certain conditions during the summer months when rainfall is more intense. According to the IPCC, accelerated glaciers’ melting is a "critical" matter in Bolivia, where water availability has been compromised. The IPCC also states that tropical glaciers are "likely" to disappear in the following decades\(^5\). A representative example is the Chacaltaya glacier (4500 m.a.s.l.) which left its condition of glacier in 2009.

The melting of these glaciers associated with other impacts of climate change affect and will significantly keep affecting hundreds of highly sensitive communities due to their dependence to water provided by glaciers and their environment. This will involve the violation of their human rights, such as right to life, food and self-determination among others, which implies that effective measures have to be taken for the adaptation of these communities.

This year, in the framework of the COP17 negotiations in Durban, steps will be taken towards a new global agreement to address this threat; with expectation, we hope that governments have the capacity to arrange mechanisms that curb this disaster in a consistent and disinterested manner, addressing the underlying problems for the benefit of life on the planet.

\(^4\) Vuille & Bradley, 2000 quoted by PNUD, 2011.

\(^5\) IPCC, 2008.
REFERENCES

Agua Sustentable. Estrategia de adaptación al cambio climático para comunidades afectadas por el retroceso del Glaciar Mururata, caso: Microcuenca del Río Choquecota. 2011


García, M., & Taboada, C. Informe del Proyecto Illimani: "Vulnerabilidad y adaptación al cambio climático en comunidades de la cuenca del río Sajhuaya". La Paz, Bolivia. 2010

IPCC. Documento Técnico VI: El cambio climático y el agua. 2008

PNUD. “Tras las huellas del cambio climático en Bolivia: Estado del arte del conocimiento sobre adaptación al cambio climático, agua y seguridad alimentaria”. 2011

