

## Appendix 5

### "Evaluation and Adjustment of the Socioeconomic and Environmental Baseline of the Agri-Food Systems of Family Farmers of the Valles Macro-region"

A detailed baseline assessment of farmers' socio-ecological situation has been developed, examining the specific challenges, opportunities, resources and constraints facing each discrete community and zones in the proposed intervention area: Los Valles Cruceños, Los Chichas, Gran Centro Potosí, Norte de Potosí, Chuquisaca Centro, Chuquisaca Norte, Los Cintis, Héroes de la Independencia, Cono Sur, Valle Alto, and Zona Andina.

- **SANTA CRUZ**



Figure 1. Comarapa

## Commonwealth of the Santa Cruz Valleys

The Commonwealth of Municipalities of Los Valles Cruceños is formed by eleven municipalities: Comarapa, Samaipata, Mairana, Vallegrande, Moro Moro, Saipina, Pucará, El Trigo, Postrevalle, Pampa Grande and Quirusilla. (Center for Participation and Sustainable Human Development, 2009). Project activities involve the municipalities of **Comarapa, Saipina, Mairana, Pampa Grande, Samaipata, Quirusillas, and Valle Grande.**

The project area is located between the ecoregions of Gran Chaco, Chaco Serrano, Bosque Tucumano Boliviano, most of inter-Andean dry forests, and a small part of Southwest Amazon. These ecoregions are located in lowlands of Bolivia, with the following characteristics: average temperatures range from 12° to 28° C, rainfall from 500 mm to 4200 mm in Yungas to 7000 mm, which vary from one ecoregion to another due to its contrasted orography with mountains, deep valleys, and pronounced ridges. Due to this variation, we can find different ecosystems such as humid evergreen forests (whose representation for the project is minimal); semi-humid forests; and scrub and grassland in the ecoregion of Bosque Tucumano – Boliviano, with impoverished flora with red and very sandy soils. In the inter-Andean dry forests there is deciduous dry forest (10-20 m). The inter-Andean dry valleys is an ecoregion **strongly disturbed by agricultural practices**, livestock and forestry (wood and firewood), so it presents severe problems of soil degradation. Soils in the area are characterized by land suitable for agricultural use (classes II – IV) that mainly occupy valleys, terraces and gentle slopes of the intermediate to high sector; land only for use with perennial crops (classes V, VI and VII) which occupy the lower and middle mountains mainly; and land intended for conservation and/or protection (class VIII) with **habitat fragmentation**. However, it is a region of great biological value and considered as one of the centers of endemism in Bolivia (Autonomous Municipal Government of Mairana, 2008).

These differences create localized microclimates that mark both the characteristics of the landscape and the richness of the different areas. For example, the **agricultural wealth** in the area of Los Negros is characterized by the predominance of a microclimate that could be practically defined as tropical when compared to the aridity of the Pucará area, where **subsistence agriculture and livestock prevail**.

The direct use of the Sub-Basins and headwaters is due to the provision of water to the settled local communities and people belonging to the riparian systems located downstream. Therefore, this resource is directly used for the development of their productive and domestic activities. The indirect use of headwaters of Sub-basins and basins refers to the ecological functions they fulfill as regulators of the hydrological cycle (HELVETAS Swiss Intercooperation, 2014). One of the main problems is **the lack of water** (only a third of producers cultivate with irrigation), caused by drought and insufficient storage infrastructure, which is causing major problems in both agriculture and livestock. **Conserving the headwaters of the basin contribute to the provision of water in quantity, quality and adequate continuity for thousands of families, in addition to biodiversity protection.** These families depend on this vital resource and would avoid floods in rainy seasons that cause significant economic, social and environmental damage in downstream sectors. The Amboró Imna

headwaters Sub-Basin is one of the regions with the greatest pressure due to the human settlements near it, also affected by the advance of the agricultural frontier, especially by **inadequate soil management practices such as cutting and burning**, sloping crops, construction of tackles without discrimination or **excessive use of agrochemicals**. There is also grazing, the extraction of firewood and other forest products.

Most of the territory could be classified as marginal land, devoid of any agrarian potential (only 13.75% of the land is arable), reason why **agriculture is described as poor and subsistence**, as well as difficult to exploit. Practices that can be implemented as possible **solutions to such soil issues** include:

- ✓ Do not enable land for agricultural purposes on slopes that have more than 20% if soils are deep and no more than 10% if soils are shallow
- ✓ Carry out the sowing in furrows or contour strips on gentle slopes and build terraces on larger slopes to reduce the speed of runoff
- ✓ Avoid the extraction of firewood especially in the valley area, since the species used for browsing are scarce and with slow regeneration
- ✓ Establishment of living barriers for the protection of fertile layer of the soil
- ✓ Establishment of dead barriers by using dead plant material such as tree trunks and branches that have been left after cutting and burning, accommodating them on contour lines
- ✓ Incorporation of silvopastoral systems and management of pastures in native forest through the thinning of trees and/or shrubs

The **main economic activities** of this macroregion include **agriculture**, livestock and forestry (Center for Participation and Sustainable Human Development, 2009). The first of them occupies the largest proportion of the population, especially as a self-consumption activity with a surplus that is taken to the local market and adds value to acquire other types of goods. The most important crops are vegetables, fruits and potatoes, and in a very localized way beans. The only products produced and that being processed are sugar cane and tobacco (grown in Mairana). This highlights the growing increase in the cultivation of beans that, even though is not part of the diet of Los Valles, is the main product generating the most income thanks to its export.

As agriculture in place is aimed at self-consumption or the local market, the ability to **organize and access more important markets**, such as Santa Cruz, is seen **as an opportunity**, for which one identified activity is the construction of Collection Centers that favors the centralization and exchange of agricultural products.

**Tourism** is an emerging activity and the industry practically non-existent. Tourism is considered as an undervalued sector in all municipalities and that can be further exploited. Even so, most value comes from the so-called "Route of El Ché" and the ruins of the Fort of Samipata, that belong to the pre-Inca culture. In addition, the region has three protected areas: "Amboró National Park", the "Private Reserve of Natural Heritage" and the "Special Management Area in the Piraí River Basin". So far, **these resources are considered undervalued and underutilized**. Tourism is an emerging

activity and very localized way, mostly in Samaipata and its surroundings. This area is the only one having adequate hotel infrastructure, mostly owned by foreign entrepreneurs who live in the area. Although there is clear awareness of the tourism potential of the area, at present it is not prepared to face such development, as it does not fulfil the most basic needs and infrastructure, such as paved roads, drinking water, restaurants or hotels to house people visiting the different places or adequate medical services, among others (Guzmán, Martínez, Pérez Yruela, & Moscoso Sánchez, 2005).

The Commonwealth of the Santa Cruz Valleys was created in 1998 for the economic, social, territorial development and strengthening of the region. Its main challenge initially was economic because its statutes indicate payments from municipalities at the beginning of the year but some of them make it at the end of the year, in addition to the low attendance at coordination meetings. The Commonwealth has managed to overcome these problems with municipalities delivering contributions on time, and thus making resources available (Service of Information and Analysis of Municipal Management SIAM, 2009). Between April 2004 and December 2005, with the support of the EXPIDER project, activities such as **training, technical assistance, accompaniment and development of legal administrative procedures were carried out, and the institutions of the Commonwealth strengthened** for its recognition, empowerment and advancement of proposals. The project recognizes the speed and solidity of the Commonwealth in comparison to others in the region since it was already formed and functioning (Sumpsi, 2006). In 2017, the Commonwealth signed an agreement that **prioritizes the integral management of watersheds, land management, and the promotion of tourism activity**, among others (Pilot Project for the Transfer of Experiences for Rural Development Planning, 2016). Capabilities include the organization of workshops, specialization courses, and exchange experiences (Center for Participation and Sustainable Human Development, 2009). Regarding sustainability, they do not receive co-participation contributions nor cooperation contributions; but it has been observed that through other agricultural and water management projects they have been successful in investing joint resources from the municipalities and cooperation to raise awareness among beneficiaries. As an example, one successful project where producers have shared their **experiences** is focused on the chicheño peach (Ascarrunz, 2014).

- POTOSI



Figure 2. Potosí (Community of Tarapaya)

### Commonwealth of Los Chichas

Los Chichas is formed by the municipalities of Cotagaita, Vitiche, Tupiza, Atocha and Villazón (Center for Participation and Sustainable Human Development, 2009). The Project involves the municipalities of Vitiche, Cotagaita, and Tupiza.

Three ecoregions can be distinguished, with greater area *Prepuna* and *Puna Norteña* (Semi-Humid Puna) and the smaller *Puna Sureña* (Desertic Puna) area, with average temperatures ranging between 7-17 °C and precipitation between 250 mm and 1100 mm. Vegetation is mostly *chaparrales* (woody species of small size), scrub and grassland. The main **challenge** that these ecoregions are experiencing, especially in the Prepuna, is **ecosystem degradation** (Lopez, 2000). Physiography can be described as *serranías*, high plateaus, small plains and valleys that correspond to the middle courses of the Cotagaita, Atocha, Vitichi and Tupiza rivers, which are important for the communities that use water for agriculture from river banks, and who are **currently experiencing issues due to shortage of water for irrigation** (Ascarrunz, 2014). Soils correspond to cambisols that allow numerous agricultural uses; very shallow leptosols, with little thickness, which form on hard rock or very stony areas, usually on steeply sloping slopes, and unsuitable for agriculture; and fluvisols formed from recent alluvial materials contributed by rivers that have a high agricultural interest. It is observed that the **main issue of soils is desertification and degradation**. (Autonomous Municipal Government of Cotagaita, 2019).

In consideration of these environmental conditions and the social system, the main activities are: mining, livestock (especially sheep and goats, camelids and few cattle); agriculture (mainly corn, potato, garlic, bean; followed by fruit production (especially peach, vine and apple tree)). As stated before, the main issue is soil erosion, as well as trade (this economic structure is completed mainly with the raising of goats for milk and meat production) and tourism.

Based on challenges identified over resources management in 2007, the five municipalities of the Commonwealth have joined together and collaborated with a focus on five important issues: roads,

tourism, mining, agriculture and water (Portal de la Descentralización, 2007). The biggest problem these municipalities are facing is the **lack of consensus**, with managers rotating and not using resources properly. Another problem is the **late formulation and identification of demands**, which arise once projects are being undertaken.

Relevant actions in the area include capacity development on territorial management for municipal authorities and technicians, and a 2022 Social Contribution Program to **empower and train women** (Social Responsibility and Sustainability Information, 2022). In addition, **actions to improve peach production have been implemented, including water and soil management, adaptation and risk, and capacity development**, with direct impacts on peach production and indirect impacts on ecosystem conservation and management (Helvetas Swiss Intercoperation, 2014).

The Commonwealth performs activities that generate its own income, receives contributions from its members that come from tax sharing funds, and receives support from cooperation.

It should be noted that due to the lack of attention at certain times of the year or for very long years, local population tends to migrate to Argentina, which is aggravated by **water scarcity** (Ascarrunz, 2014).

### **Commonwealth of Gran Centro de Potosí**

Initially formed by the municipalities of Potosí, Tinquipaya, Yocalla, Urmiri, Betanzos and Chaqui (Center for Participation and Sustainable Human Development, 2009). The Project involves the municipalities of Caiza D, Puna, Yocalla, Potosí, Tacobamba, and Tinguipaya.

Project area includes the ecoregions of Inter-Andean Dry Forests and Northern Puna. Average temperature ranges from 7 to 16°C, while precipitation stands between 400 - 1100 mm. Such conditions support the formation of deciduous dry forest (10-20 m), mostly destroyed or heavily disturbed, grass with shrubs and low grass in wet places. Before the colonial period the upper parts offered a lot of arboreal (i.e. *queñua* and *kiswara*) and shrubby (i.e. *thola*) vegetation, as well as large wetlands, peat bogs and meadows, and permanent lakes and streams. Problems from environmental pollution generated by mining activity date back to the period of Spanish colonization, especially as a result of the application of extraction processes and concentration of minerals. In that context, the introduction of mercury in 1572 is considered one of the first steps in **environmental pollution**.

**Vegetation is currently subject to destructive practices, such as direct removal of vegetation cover by overgrazing, *chaqueo* and burning, and the indiscriminate use of native forest resources**, such as molle, churqui, thacko, t'ola and other species, that are under constant pressure due to the requirements of firewood for reproductive activities of families and fodder for livestock, in addition to poor management practices and almost non-existent reforestation activities, which is leading to the **soil cover vegetation loss**. Nonetheless, afforestation and vegetation cover conservation actions to avoid water erosion have been implemented in some higher places.

Local physiography shows small plains *serranías*, high plateaus, and valleys with shallow soils classes III to VI, II and III, of moderately light textures, poor in nutrients and subject to an intense process of erosion. Rates **of soil degradation** are mainly determined by the **pressure of use**, both by **agricultural activities** in **rugged areas**, as well as **overgrazing**, that are promoting higher rates of erosion, with a strong tendency to desertification, **loss of soils due to the effect of floods, water and wind erosion** (Local Development Unit of the Gran Potosí Commonwealth).

At the head of the basin there are springs and water holes. This scarce resource is **rationally and efficiently used** with due precautions to avoid contamination and loss. Main rivers are the Mataka River, Miculpaya River, Ribera River, and Pilcomayo River, which is **used for irrigation** and at constant risk of contamination due to stream overflow in the rainy season and with sediments containing a **high percentage of mining waste** (Local Development Unit of the Gran Potosí Commonwealth).

Such places are suitable for mining activities, agriculture, livestock, and use of firewood/wood; However, they also present severe soil erosion problems. As of today, there are productive, industrial, commercial, financial, mining-metallurgical, tourism and service economic activities. Tourism is another preponderant potential of the region, especially in the city of Potosí (Helvetas Swiss Intercoperation, 2014).

The Gran Potosí Commonwealth was created in 2007 for the management of its resources and focused on the preservation of the environment and institutional development (Center for Participation and Sustainable Human Development, 2009). The main problem they faced at the beginning was the limited participation of Mayors that made project coordination difficult. The viable solution at the time was giving priority to municipalities whose Mayors comply with project coordination. The Commonwealth undertakes activities that generate its own income and receives contributions from its members coming from tax sharing funds. It does not receive cooperation inputs.

Significant advances include the development of efforts for improving the conditions of families by promoting the production of beans with the **incorporation of irrigation systems or terraces**, as well as to equip supply centers and enhance the certification of organic bean production plots based on basic export standards and Good Agricultural Practices (Crónicas Emigración, 2020). Another successful project was to articulate allies within the area to achieve consensus, as well as training of technicians and direct beneficiaries. As a result, we can highlight the continuity given to regional projects initiated for potatoes, cereals, and milk, and in parallel manage the execution of other projects (Helvetas Swiss Intercoperation, 2014). We can then conclude that **there is a technical-administrative basis in terms of capacities of the different actors**.

### **Commonwealth of Potosí**

The Commonwealth of Potosí is formed the municipalities of Uncía, Chayanta, Llallagua, Colquechaca, Ravelo, Pocoata, Ocurí, Sacaca, Caripuyo, San Pedro de Buena Vista, Torotoro,



Arapampa and Acasio. (Centre for Participation and Sustainable Human Development, 2009). Project development entails the municipalities of Ocurí and Ravelo.

Ecosystems in the project area include the Puna Norteña and Inter-Andean Dry Forests, characterized by having an average temperature ranging from 7 to 16°C and a rainfall of between 400 to 1100 mm. Vegetation include deciduous dry forests (10-20 m), grasslands with shrubs, low grass in humid places; potentially forested region (possibly with the exception of extensive plains in large valley bottoms). Giant *Puya raimondi* can be found at some places. **The main challenge is natural fragmentation and soil erosion.** This deterioration is aggravated by anthropic actions, **progressive extraction of vegetation, inadequate land use, burning of native grasslands and shrubs, and increased recurrence of extreme weather events such as droughts, torrential rains, hailstorms, snowfall and strong winds.**

Physiography describes dissected valleys, small plains, *serranías*, and high plateaus, with shallow soils in slopes and peaks, except in small fillings, in which they are moderately deep. Soils have good drainage, generally fine texture and with many thick fragments. Between mountains there are small wetlands and alluvial terraces. In wetlands, soils have high organic matter contents, drainage is imperfect and water tables are high. In alluvial terraces, soils are moderately deep. In the valleys, they form sub-landscapes of foothills, terraces and stream beds. In general, deep soils can be found. Areas with higher **erosion degrees correspond to areas with steep slopes** of short amplitude, soils with high erodability, and **regions with intense precipitation and short duration, and areas with very little vegetation cover** that cause the loss of native forests.

As for water resources, the Commonwealth has rivers such as the Chayanta and the Pilcomayo River. However, the area **is characterized by little rainfall**, a situation that is seriously affecting the availability of water across the region. According to soil water balance, the growth period (time of year when enough water is available in the soil to allow the growth of plants), is less than three months. This is worsened by **contamination of water sources**, which contributes to land degradation.

Considering this, **the area is suitable for sheep and cattle ranching, casual crops and the exploitation of minerals and tourism.** To promote these activities and economic, social and territorial development, the Commonwealth of Norte de Potosí was created in 2002 with activities such as institutional strengthening and economic sustainability (Center for Participation and Sustainable Human Development, 2009). At first, one of its main problems corresponded to the lack of a clear vision of its role and that of municipal governments, which seek greater fundraising without clear justification. To address this, the Commonwealth organizes assemblies to discuss and decide the way forward, in addition to activities that generate income, and contributions from its members coming from tax co-participation funds. It does not receive cooperation inputs (Service of Information and Analysis of the Municipal Management SIAM, 2009).

Giving continuity to its objectives through economic support and technical assistance, the Commonwealth has implemented several projects allowing communities to improve their productive and organizational basis; use of natural resources (forest, soils, water) and climate



change adaptation; and facilitating the application of integrated management practices of natural resources that promote agriculture for food security<sup>1</sup> (Helvetas Swiss Intercoperation, 2014).

Within these projects, we can highlight activities such as diversification in crop production (e.g. integrated crop management, establishment of drought-resistant varieties, introduction of early varieties, etc.), generation of additional economic income at family and communal level; reduction of water pollution; reduction of soil degradation, in particular soil erosion and salinity; **increased vegetation cover; increased biodiversity** (e.g. grasses, shrubs of low and medium size); appropriation and replication of **soil management; recovery and conservation** practices; improvement of soil fertility and **soil stability; increased soil moisture retention**; improvement of food and nutritional security of peasant families; consolidation of micro-watershed committees; among others.

- **CHUQUISACA**



Figure 3. Municipality of Culpina (Autonomous Municipal Government of Culpina)

The territory of Chuquisaca is inserted in the vegetation regions of: Puna (above 3100 m), dominated in the upper parts by grasslands of *Stipa*, *Agrostis* and *Sporobolus*; native forests and shrublands in high slopes of the Bolivian Tucuman forest (between 900 to 2500 m), dominated by *Weinmannia*, *Prunus* and *Podocarpus*; forests and scrub of low slopes (between 2000 to 2900 m), with *Cedrela*, *Escallonia* and *Myrsine*; and forests of the Boreal Chaco with deciduous trees and shrub species dominated by *Aspidosperma*, *Schinopsis* and several species of *Acacia* and *Prosopis* (Navarro & Ferreira, 2009).

Chuquisaca is a department with **high biological diversity** and **has areas where biodiversity is protected** in two national protected areas: “El Palmar Integrated Management Natural Area” and “Serranía del Iñao Natural Park and Integrated Management Area”, as well as two municipal areas:

---

<sup>1</sup> "Improving the productive and organizational bases of the North of Potosí region, with the approach of integrated watershed management"; "Conservation of natural resources with afforestation and reforestation activities in degraded areas to mitigate climate change in the North of Potosí"; "Concurrent Action Plan", "Risk management and adaptation to climate change in prioritized municipalities in Northern Potosí"

“Serranía los Milagros Integrated Management Natural Area” and “El Villar Forest and Water Immobilization Zone”. In addition, there are other proposed areas for departmental or municipal conservation. However, the growth of the agricultural frontier and increasing population **result in constant pressure over biodiversity**, which remarks the importance of implementing in situ conservation policies and programs. A Departmental Environmental Action Plan and a Departmental Development Plan (2009-2015) that promote policies for the management and conservation of biological diversity in the Department are in place.

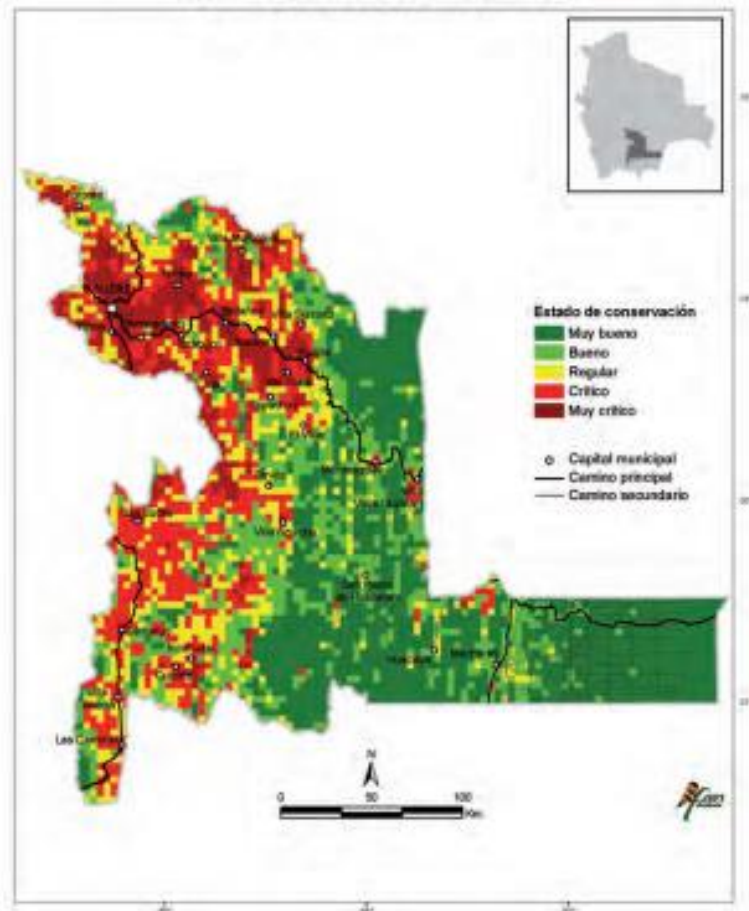


Figure 4. State of Conservation of the ecosystems of the department of Chuquisaca (BEISA-2 Project, 2011)

Figure 4 and Table 1 indicate the conservation status of the Department of Chuquisaca, represented by five categories (very good, good, regular, critical, very critical). A good and very good conservation status is present in the eastern part of the Department, corresponding to the Tucumano – Bolivian Forest, the Serrano Chaco and the Gran Chaco, while a predominantly critical to very critical conservation state is observed in much of the western zone, which corresponds to the Puna and Inter-Andean Dry Forests. This also responds to the presence and layout of roads and population centers.

Vegetation conservation status	Percentage of departmental territory (%)
Very good	36%
Well	20%
Regular	17%
Critical	18%
Very critical	9%

Table 1. Vegetation Conservation Status (BEISA-2 Project, 2011)

According to CEPAD (2009), there are at least four associations in Chuquisaca, of which three are considered for this project:

- a) **Commonwealth of Chuquisaca Centro:** formed by municipalities of Villa Alcalá, El Villar Padilla, Sopachuy, Tomina, Villa Serrano, Taravita and Sucre. Main activities are linked to health, road infrastructure and agricultural technical assistance.
- b) **Commonwealth of Chuquisaca Norte:** formed by municipalities of Poroma, Yotala, Tarabuco, Yamparaez, Icla, Presto, Zudañez and Mojocoya. Principal activities include human and economic development such as agriculture.
- c) **Commonwealth of the Cintis:** formed by municipalities of Incahuasi, San Lucas, Culpina, Las Carreras, Camargo and Villa Abecia. Main activities include road infrastructure and agriculture.

Regarding agriculture, according to the most recent data presented in the Departmental Development Plan (2009-2015), the gross value of agricultural, livestock, forestry, hunting and fishing activity decreased by 1.28% in recent years. However, this sector, which concentrates a third of the workforce (36%), ranking second in terms of departmental GDP (15.22%) after public administration services (17.36%), and representing an important part of the department's economy. Chuquisaca has a small area destined to agricultural production (approximately 3.4% of the departmental area), which is mainly destined to self-consumption with products such as corn, wheat and potatoes that cover 80% of the cultivated area. Only 1% responds to agricultural products for industrial use (PDD, 2015).

In this context, the agricultural sector in Chuquisaca is characterized by low productivity and yield, which is a critical aspect of the situation of rural poverty and the continuous rural-urban migration process. This can be explained by **structural problems** regarding **equitable access to property, production means, natural resources** and other factors.

**Soil salinization and alkalinization issues are widespread, particularly in arid areas.** Mild to severe salinization affects 30 to 40% of irrigated soils (ob.cit), which is typical in crop areas that are irrigated by flooding.

Chuquisaca department does not have mining potential or a productive tradition in this area. However, it has some resources especially of **non-metallic minerals presenting deposits of gypsum**

**and limestone in several provinces**, among metallic ones such as lead, zinc, antimony, iron and some gold deposits of alluvial type. Between 343,000 and 429,000 tons of glues are dumped each year from 14 mining mills (PDD, 2015).

Regarding water resources, eighteen municipalities are part of the Pilcomayo basin: Yotala, Yamparáez, Icla, Tarabuco, Azurduy, Tarvita, Huacareta, San Lucas, Camargo, Incahuasi, Culpina, Villa Abecia, Las Carreras, Sucre (District 8), Huacaya, Machareti, and Monteagudo. **In the eastern part of the basin and along the Pilcomayo and Pilaya rivers, salt mines, gypsum and oil deposits are common. For this reason, water quality is altered as these components are dissolved from the surrounding geology and deposited in rivers (ob.cit), a situation that must be considered in the selection and improvement of irrigation systems.**

Table 2, based on the National Inventory of Irrigation Systems of 2012, shows the number of irrigation systems in place at department level.

Commonwealth	Municipality	Irrigation systems (No.)	Users (No.)	Irrigated area (ha)
Chuquisaca Center Commonwealth	Villa Alcalá	10	157	157
	El Villar	14	500	902
	Padilla	6	292	1855
	Sopachuy	21	305	774
	Sucre	75	2426	2092
	Tarvite	27	993	1414
	Villa Serrano	12	327	620
	Tomina	31	569	908
Chuquisaca Norte Commonwealth	Poroma	7	369	268
	Yamparáez	28	891	1626
	Yotala	34	1141	791
	Villa Zudanez	77	1001	1997
	Villa Azurduy	12	327	620
Commonwealth of the Cintis	Camargo	64	1368	1239
	Saint Luke	142	3106	3796

Table 2 Irrigation data for the department of Chuquisaca of the selected Nancomunidades (based on data from the National Inventory of Irrigation Systems)

Regarding organizations linked to water management, the model implemented by the Chuquisaca Centro Community stands out. The Natural Water Reserve Area (ARENA) model focuses on the **protection and conservation of watersheds and aquifer recharge areas through enclosures**, established through legally validated agreements after consensus among land owners, water users, communities, and supported by municipal governments (Helvetas, 2014). The most important are:

- Communal norms for the protection and conservation of the water recharge area or protection area in the micro-basin.
- Management plan for water recharge area or protected area.
- A charter and internal regulations of the organization overseeing the system.

- Operating and maintenance standards of water for human use, animal and/or irrigation consumption (HELVETAS Swiss Intercooperation, 2014).
- **TARIJA**

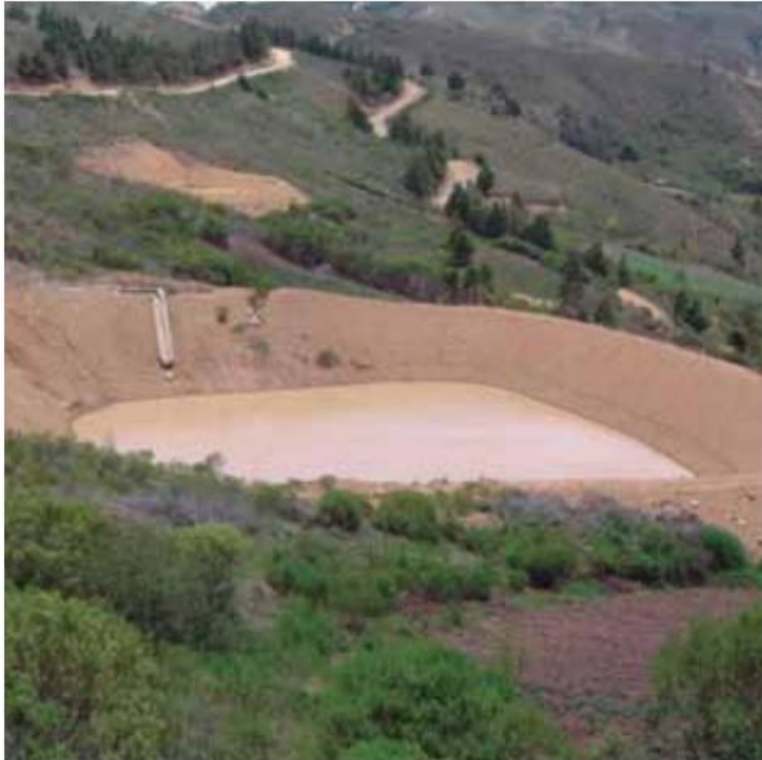


Figure 5. Commonwealth Heroes of Independence (HELVETAS Swiss Intercooperation, 2014)

The department of Tarija is part of the great hydrogeographic system of the La Plata River Basin. The drainage pattern and runoff regime are closely related to physiography in provinces of the Cordillera Oriental, the Subandino, and the Chaco Plain. The four hydrographic systems of the department and its proportion with respect to the area of the department are: the Pilcomayo River (42%), the Bermejo River (32%), the Chaco Plain systems (24%) and the small endorheic systems (less than 1%) (PDOT 2005-2025).

According to 2001 INE data, Tarija had a population of 391,225 inhabitants, with an annual growth rate of 3.18%, a population density of 10.4 inhabitants per square kilometer and a predominantly young population, with 59% of the population between 0 and 24 years old. According to current official data from the 2012 census, Tarija has a population of 508,757 inhabitants.

As of 2003, Tarija had the highest GDP per capita in Bolivia, reaching USD 5300 per year per inhabitant in 2012. In recent years, departmental GDP growth stood at around 8% per year. The structure of GDP indicates that the hydrocarbons sector is the most important sector, representing more than 50% of the GDP at department level, followed by **primary activities such as agriculture, transport, communications**, and manufacturing industries with percentages between 7% and 10%.



## Heroes of Independence Commonwealth

The Heroes of Independence commonwealth is formed by municipalities of Uriondo, El Puente, Yunchará, and San Lorenzo. Its main activity is aimed at promoting local economic development (CEPAD, 2009).

Its physiographic setting is undulate and covers four ecological floors: the high Andean zone, the head of valleys, the valleys, and the subtropical zone. The region's **agricultural production aims for self-consumption with potato and bean crops** in the upper zone in of El Puente and Yunchará. **Corn, vegetables, garlic for export, potato, seed, peach and strawberry can be found at the valleys and head of valleys of San Lorenzo and Uriondo, which concentrate the largest wine industry in Bolivia.** This region has important water resources (surface and underground), concurring its main basins in the rivers: San Juan del Oro, Guadalquivir, Camacho and the endorheic basin of Tajzara.

Climatic features vary according to altitude. The upper part has an arid and semi-arid climate with generally low rainfall, variable temperature in the upper part and head of valleys, medium in the valleys and slightly elevated in the lowlands. Due to **low rainfall**, the main challenge is the **recurrent droughts affecting production**, with result in a consequent **migration** of farmers leaving children and women in the community.

In fact, in the highlands, sub-Andean, and northern Chaco there is an inadequate territorial occupation, in addition to a poorly consolidated economic base with a high rate of rural-city migration to other departments and northern Argentina.

According to current land use, around 125,300 hectares are being intensively use for agriculture, representing 56% of total land with agricultural potential at department level. In this context, **water for irrigation must be guaranteed** through the efficient use of water, **appropriate hydraulic infrastructure (dams, irrigation systems, water harvesting techniques) and efficient irrigation methods (i.e. sprinkler and drip)**, which allow the development of competitive agricultural activities that contribute to food security and sovereignty in Tarija.

Regarding the intensive agricultural potential in the *Zona Alta*, there are 10,800 hectares, concentrated mostly in the valley of the San Juan del Oro River. In the Central Valley, land with conditions to develop **intensive agriculture** represent 54,200 hectares, while in the Sub-Andean the potential is 49,446 hectares, offering good possibilities for the development of fruit agricultural production systems and silvopastoral use. However, according to current estimations the area of intensive agricultural activity is 125,300 hectares, **56% of the agricultural potential** in the department, concentrated in in the Chaco region (44%), Central Valley (26%), Sub-Andean (23%) , and in the High Zone (7%).

**Water resources and their potential for irrigation are fundamental for the sustainable development of the primary productive sector of the Tarija territory.** In this context, the Departmental Land Use Plan (PDOT) and the Municipal Land Use Plans (PMOTs) identified lands with

intensive agricultural potential subject to irrigation in the department, totaling an area of 225,185 hectares, representing 6% of the departmental territory.

Currently, 12,955 hectares are irrigated throughout the Central Valley region, which represents 40% of the total area of intensive crops. Irrigation projects under execution increase this coverage to 64% (20,676 hectares). The execution of programmed projects will allow the Central Valley to add 11,343 hectares, which will represent a total coverage of 99% until 2017. In that sense, the execution of **programmed projects will enable the agricultural and livestock sector of this region to become an important area with irrigation**, in light of the need and continuous authorization of land for agricultural use.

The agricultural potential in the Central Valley is 54,200 hectares, of which 32,400 hectares (60%) are currently in use. It is then necessary to **cover the extension of agriculture, which will require access to irrigation**.

Throughout the Sub-Andean region, 1,777 hectares are irrigated. Considering the projects in execution, 2,466 hectares can be added, totaling 4,243 hectares representing 14% of the cultivated area according to current use. Irrigation projects are programmed for the region, which will allow the addition of 8,707 hectares, which will result in an irrigation coverage of 12,313 ha (42%) until 2017. Therefore, there are 16,887 ha (58%) of crops without irrigation programmed, so it is necessary to reinforce this and **gradually cover irrigation requirements**.

Table 3 shows the number of irrigation systems in place at department level:

Commonwealth	Municipality	Irrigation systems (No.)	Users (No.)	Irrigated area (ha)
Heroes of Independence	El Puente	85	3180	3359
	San Lorenzo	88	3421	7728
	Uriondo	78	2763	4403
	Yunchará	56	1175	1438

**Table 3. Irrigation data for Heroes of Independence (Based on data from the National Inventory of Irrigation Systems, 2012)**

Regarding **socio-organizational** features for water management at this community, the model of **"adaptive management of water and pastures in micro-basins"** has been implemented. This is based on the coordinated, articulated and concurrent work of the departmental government, municipal governments, allied institutions (NGOs) and peasant organizations to plan, develop and implement compatible initiatives for water and natural resource management in micro-watersheds and in response to climate variability, contributing to the strengthening of camelid livestock in the upper area of Tarija.

Adaptive management allows actors to make decisions in consideration of climate variability and local and global socioeconomic dynamics, to increase the resilience of communities, improve the availability and accessibility of resources and, to some extent, reduce uncertainties and develop policies.



- COCHABAMBA



Figure 6. Totorá

### Southern Cone Commonwealth

According to HELVETAS Swiss Intercooperation (2014) and the bioclimatic floors within the valleys of the southern cone, it is observed that this Commonwealth has the following ecological floors:

- Bolivian-Tucumana Biogeographic Province – Ecological Floor Inter-Andean Valley, where land use is mainly for agricultural use, with emphasis on **crops of grains, tubers**, legumes, vegetables, fodder and fruit trees
- Bolivian-Tucumana Biogeographic Province – Ecological Floor of High Andean Puno, where the use of soil and water is mainly for agricultural activities with the development **of tuber, leguminous**, and fodder crops

According to MMCS (2019), agricultural production in the Southern Cone **is function of the type and size of family production units**, as families are the main source of labor. Technology used in agricultural production is characteristic of traditional agriculture in the west side of the country, **a system adapted to environmental and climatic conditions**.

Tillage is done with animal traction (yoke of oxen), a typical plow made of wood or metal, and farming instruments such as pillory, hoe, sickle and shovels. These tools are used throughout the production process, from land preparation to harvesting. Agricultural activity in the different ecological floors is similar, differing in some communities as in the area of the mesothermal valleys with the incorporation of mechanical traction or tractor for the plowing and land preparation.

The second important type of land use is livestock, which complements agricultural activities, especially in steep areas (MMCS and Helvetas Swiss Intercooperation, 2014). The main activity is poultry production, followed by the production of cattle, sheep production, production of pigs, and production of goats. In general, livestock infrastructure is rudimentary and familiar, who maintain animals in traditional pens built of stone and/or adobes with no roof and protection. As such, cattle is subject to climate impacts and consequently susceptible to respiratory infections, foot-and-mouth disease (FMD), etc. (MMCS, 2019).

The Southern Cone Region largely corresponds to the Rio Grande basin, specifically the Mizque River; however, the municipalities of Tiraque and Arani are located in the Caine River basin (Rio Rocha), while the municipalities of Tiraque, Totorá and Pojo also occupy the territory of Ivirizú, Chimoré and Sajta rivers. The Rio Grande basin is the most important and outstanding, converging 8 minor basins (Callao, Lagar, Saladillo, Naranjillo, Ventana Mayu, Pajcha Mayu, Catariri, Molinero) and others. In recent years, the **availability of water resources for consumption and production has decreased in quantity and quality**, due to factors such as climate change impacts, pollution and indiscriminate use of resources. Thus, it is necessary to initiate **actions for the recovery and protection of water recharge areas, water sources, and responsibly use** this vital resource.

As for droughts, Pasorapa, Omereque and Vila Vila **present very high to high threats**; Myzque and Raqaypampa, **moderate, high and very high**; Arani, Tiraque and Pocona **moderate and high**; while Totorá and Pojo present **low, moderate and high** (MMCS, 2019).

In the inter-Andean valleys of the Southern Cone, the use of the natural landscape for tourism purposes is considered as a potential. For example, local communities use natural resources for handicrafts in ceramics and wood (MMCS and Helvetas Swiss Intercooperation, 2014).

The **management of biodiversity** in the Southern Cone has the following characteristics: **native forest species** such as *algarrobo*, *sauce*, *chak'atea*, *tipa*, *ceibo*, *quinaquina*, *mara valluna*, *soto* and *caraparí* are present in the region. Vegetation varies according to the ecological floors. As for the fauna, there is no inventory in any of the areas, nor in the various ecological floors, however, the conservation of the different wild species is considered a priority for the region.

Ancestral knowledge of the Ragaypampa indigenous group about natural and environmental resources is undervalued by the scarce attention from the State and educational and cultural entities linked to the management of natural resources and livelihood of the *Entidades Territoriales Autónomas* (ETAs) (MMCS, 2019).

## Metropolitan Commonwealth

Land use in the Kanata metropolitan region is mostly urban, as seen in Figure 7. Growth of the urban sprawl is observed in municipalities that form the Kanata metropolitan region (Metropolitan Commonwealth). According to the 2012 census, it had a population of 1,141,094 inhabitants.

According to Manzano (2015), urban-rural participation in the metropolitan municipalities of Cochabamba (Table 4) indicate that in 2012 the municipalities of Cochabamba and Colcapirhua were totally urban, while municipalities of Quillacollo, Tiquipaya, Sacaba and Vinto were mostly agricultural.

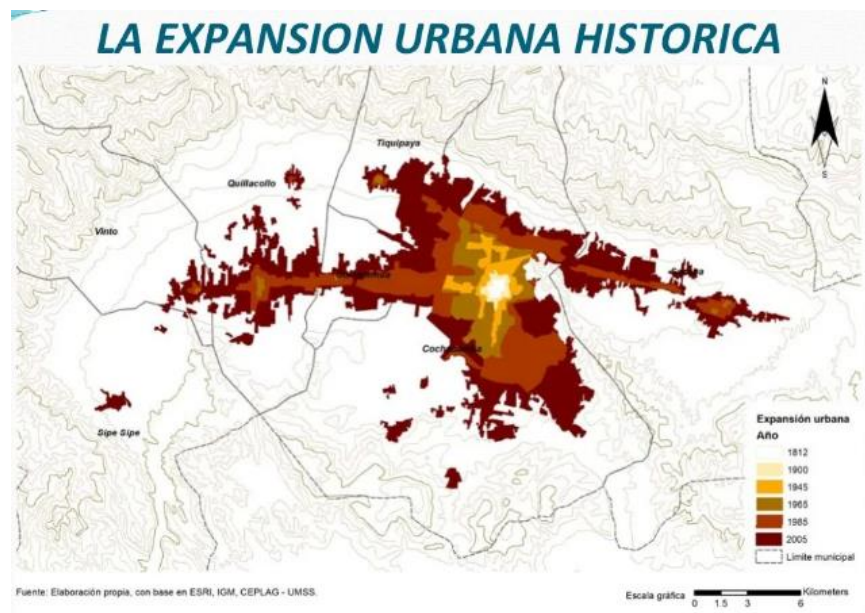


Figure 7. Historic Urban Expansion

Biogeographically, it is located within the province of the Peruvian Puna, represented by two ecological floors:

- Ecological floor Inter-Andean Valley, where land use is mostly urban. Top five activities are manufacturing industry (22.5%), financial and business services sector (17.7%), transport and communications (16.8%), commercial sector (10.9%) and agriculture (2.7%).
- Ecological floor of high Andean Puneño, where **the use of soil and water is fundamentally for agriculture with the development of tuber, legume, and fodder crops.**

According to Manzano (2015), if land use and representative productive sectors are disaggregated by municipalities, agriculture, forestry, hunting and fishing sectors are mostly present in the municipality of Sipe Sipe, followed by Vinto Tiquipaya (in addition livestock and poultry sector).

(En valores constates de 1990)

<i>Sectores</i>	<i>Municipios</i>							<i>Región</i>
	<i>Cochabamba</i>	<i>Quillacollo</i>	<i>Sipe Sipe</i>	<i>Tiquipaya</i>	<i>Vinto</i>	<i>Colcapirhua</i>	<i>Sacaba</i>	<i>Metropolitana</i>
1. Agricultura, silvicultura, caza y pesca	0,95	3,43	17,55	5,23	8,84	1,37	4,67	2,73
2. Extracción de minas y canteras	2,23	1,95	10,97	1,81	4,33	2,30	2,10	2,48
3. Industria manufacturera	24,48	27,50	21,79	23,30	25,52	26,94	23,37	24,72
4. Electricidad, gas y agua	2,96	2,57	2,48	3,20	2,05	2,66	2,50	2,79
5. Construcción y obras públicas	3,63	3,42	4,37	5,08	4,55	3,11	4,55	3,83
6. Comercio	9,72	8,83	6,42	7,91	7,83	7,29	7,96	9,00
7. Transporte, almacenamiento y comunicaciones	15,62	21,59	24,07	22,91	24,06	20,08	23,67	18,57
8. Intermediación Financiera	19,87	11,67	2,38	10,29	5,50	16,62	13,15	16,33
9. Servicios comunales, sociales y personales	7,13	4,84	2,32	7,43	3,32	5,95	5,70	6,33
10. Restaurantes y hoteles	3,29	2,98	2,28	3,08	2,60	2,80	2,76	3,09
11. Servicios de la administración pública	10,12	11,23	5,35	9,77	11,40	10,88	9,58	10,12
<i>Total</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>	<i>100,00</i>

**Table 4. Intramunicipal Structure of Sectoral GDP of the Metropolitan Region of Cochabamba 2012 (Based on INE data)**

The Kanata Region corresponds entirely to the Caine River basin (Rocha-Maylanco River). **It presents a water deficit both in quality and quantity**, reason why the conformation mandates of the region include *promoting integral urban and rural development; ensuring planned urban growth, with soil regulation, protecting agricultural lands and water recharge; guaranteeing the integral management basins at the metropolitan region; and coordinate water integral management and basic sanitation*, among others.

Most of the population is concentrated in the Kanata Metropolitan Region, where the **Rocha-Maylanco Great Basin is significantly polluted by domestic and industrial liquid waste, in addition to residues of pesticides, herbicides and fertilizers**. Results from a recent evaluation performed in the Sacaba-Capinota section of the Rocha River, shows that the region between the urban area of the city of Cochabamba and Sipe Sipe **is the most polluted**, taking into account parameters such as dissolved oxygen, BOD and nitrates present in the water (CONAM, 2005. Manzano, 2015).

Regarding vulnerability linked to water quality, there is evidence (Montaño, *et al.* 2009) that most of the Metropolitan Region has a high vulnerability to pollution (86.4% of the study area), covering an important urban area corresponding to intensive agricultural use. Areas with low vulnerability (2.9%) are located in the highest parts of the region, corresponding to alluvial fan apices (transition zones between the mountainous relief and the valley), where anthropic activity is limited due to the biophysical characteristics of the alluvial fans.

**Water deficit** in the Kanata Metropolitan region has driven the *Misicuni multiple project*, initially conceived to supply water mainly for irrigation. After two decades, the priority of water use is for **human consumption**, followed by irrigation, which again entails improving technologies to optimize the use of this resource.

There is insufficient data on wildlife use in this commonwealth; however, urban and agricultural growth has had an impact on conflicts with wildlife mainly within and in surrounding areas of the Tunari National Park. Main uses of flora in this sector are for natural medicine and food.

### High Valley Commonwealth

The High Valley Commonwealth is formed by 14 municipalities: Anzaldo, Arbieto, Capinota, Cliza, Gualberto Villarroel, Punata, Sacabamba, San Benito, Santivañez, Tacachi, Tarata, Toco, Tolata and Villa Rivero.

It is located between two biogeographic provinces the Peruvian Puna and the Bolivian-Tucumana, presenting in both cases ecological floors of Puna and Valle that differ in terms of the presence of flora species:

- Inter-Andean Valley Ecological Floor, where land use present in the upper valley stands out for agricultural use, including **fruit, corn, legumes and tubers**
- Ecological floor of high Andean Puneño, where soil and water use **is mainly for agriculture. A large part of the territory is composed by rocky outcrops, which limits agricultural activity**

Economic activity in the Upper Valley is articulated around agriculture, livestock, the **production of fruit trees, afforestation and the purchase and sale of labor power. Agriculture has a fundamental relevance in the family income** (51%), in addition to agricultural processing (i.e. production of bread, *wiñapu*, *chicha* and livestock products such as milk, cheese, eggs, meat and woolen clothing), which represents 31% of total income.

However, in the High Valley commonwealth, **soils have low fertility, salinity and sodicity that significantly impact on low productivity and the decrease of agricultural land**. Of the total area that represents the flat part of the Upper Valley (48,899.9 ha), 85% are normal soils, 3% corresponds to saline soils; 3.64% are sodic soils and 7.76% are saline/sodic soils (CISTEL-FAO, 2000).

The Higher Valley including the area of Puna and the valleys, presents a series of **issues that limit agricultural production**, such as **water deficit** (of total agricultural area of 82,631 hectares, only 6.9% has **permanent irrigation and 34.4% has occasional irrigation**). This can explain the low intensity of high-value crops, **high dependence on rainfall**, low contribution to the use of agricultural inputs, low productivity of land and labour, very low income level and seasonal migrations of rural populations engaged in **temporary agriculture** (CISTEL-FAO, 2000).

### Andean Zone Commonwealth

According to CEPAD (2009), the Andean Zone Commonwealth is formed by the municipalities of Arque, Bolivar, Cocapata, Independencia, Morochata, Sicaya, Tocopaya and Tapacarí. Main activities encompasses initiatives to promote human development and sustainable development.

It is located within the biogeographic province of Peruvian Puna, represented by two ecological floors of inter-Andean valleys and high Andean puna, which predominates in the commonwealth.

Within the region, natural resources are used in different areas in consideration of the **potential of agropastoral products such as onion, garlic, carrots, lettuce, beetroot, potatoes, bitter potatoes, quinoa, tarwi, wheat**, etc., most of them for domestic or family use. Pastoral production is composed of sheep, goats, chickens, cows, donkeys and in the upper area mainly llamas. This production is used for trade and for feeding families.

Experiences in **soil conservation** have been implemented and include soil recovery, management and conservation practices in the communities of Churo (Tapacarí), Catacora (Tacopaya) and Huariscallo (Arque). On the hillside, grounds slowly forming terraces with living barriers were established. In total, 15 ha of agricultural plots corresponding to 60 families were preserved. Moreover, groves with native species (*kiswara*) have been established. Crop rotation has also been carried out through the introduction of onions in the community of Collpacota (Bolívar). Soil management and conservation is very important in the region, however given the labor costs and time required, very few families can develop them. **A strategy is required to provide sustainability to trainings, awareness and technical assistance processes on both mechanical and agronomic soil management measures** (Saavedra and MRAC, 2014).

According to the progress report of Saavedra and MRAC (2014); there are experiences developed in the commonwealth, such as the *Disaster Risk Reduction* project and the municipalities of the commonwealth, including comprehensive work for the **management, conservation and efficient use of water from four springs** located in the communities of Huariscallo (Arque, municipality), Uyunoma (Bolívar municipality), Catacora (Tacopaya municipality) and Churo (Tapacarí municipality).

These initiatives for **water recovery and protection of water sources**, together with the development of infrastructure (harvesting and micro-irrigation system) were named *Áreas Familiares de Recuperación y Aprovechamiento de Vertientes* (AFRAV), implemented in a participatory manner with the communities of Huariscallo (Arque), Uyunoma (Bolívar), Catacora (Tacopaya) and Churo (Tapacarí).

In the communities of Churo (Tapacarí) and Catacora (Tacopaya) **afforestation** was carried out **on communal lands**. The direct effect of this activity is the provision of vegetation cover **that facilitate the infiltration of water into the soil**. At the same time, in Huariscallo afforestation was carried out in a family way, distributing the seedlings by family. Species used for this purpose correspond to *kiswara* in a total area of approximately ten hectares.

**The use of native flora for traditional medicine** is preponderant in this commonwealth. As for wildlife, there is no proper use. However, some records on hunting and other activities are available (Romero and Perez, 2008).

## **Type of organization in the different Commonwealths**

The following types of organization can be observed in the different commonwealths, including associations, irrigation committees, grassroots communities, unions, and others (CIPCA, 2018).

There are three main related types of organization:

- In the conourban peasant communities, they are organized by *Organizaciones Sociales de Base* (OTB), located in conurban and rural areas, with the function of regularizing territorial resources as well as municipal services
- In rural areas, peasant communities are organized into agrarian unions, which are grouped into peasant, departmental and national regional sub-centrals and centrals. Authorities are elected every two years, with no rotation need
- Departmental Federations, such as the *Cochabambina Departmental Federation of Irrigation Organizations* (FEDECOR), where associations of irrigators of each community of the department are located. Management bodies for regulating water supply for irrigation purposes.

## **Inconspicuous beneficiaries - Gender**

The Political Constitution of the State, in a textual way refers: "... *strengthen the role of women in the formulation and implementation of public policies...*". Among other regulations that promote the role of women in different areas, including management of natural resources, projects have been developed considering an active participation of women because they are in many cases responsible for activities such as collection, harvesting, given added value to the products (such as dried fruits, artisanal packaging, or sale of the products once the men have harvested them), etc. There are also cases on which men must temporarily migrate and it is women who are responsible for giving continuity to their plots.

The following words are rescued directly from a women who received support and technical assistance to improve production and water for irrigation:

- *"They distributed the tasks by meters I made the ditch that passes through my property, 'changos' have also been allowed to work for a widow ... The torrential rain blocked the canal but work is already being done on cleaning up..."*
- *"The technician explains to the men of the community the recommendations for the use of the solar dryer. However, those who are in charge of this task are the women who look at themselves and laugh. Why isn't the engineer speaking to us?"* (National Irrigation Program, 2003)

In the cases of the "Sin Fronteras" Associations of Municipalities of the Andean Region, Chichas and Aymaras activities were developed and fundamentally based on strengthening the capacities of women leaders, trade unions and women councilors in municipal legislative assemblies. However, progress is still being made in this insertion of women in all activities and projects not only to



empower them but also so that they can contribute economically to their families. (HELVETAS Swiss Intercooperation, 2014).

Under these conditions, the proposed adaptation measures will contribute to strengthening the resilience capacities of both the environment and social organizations as they support an increase in crop productivity, making efficient use of water, as well as better soil management, generating the right conditions to diversify products, as well as the quality of production and in the medium term generate greater added value as well as other alternative activities such as ecotourism. All these aspects are considered in the activities of the different components of *VET*.

- **References**

Ascarrunz, M. A. (Direction). (2014). *Voices of the Concertation: Commonwealth of Los Chichas* [Film].

CAT PRONAR. (2003). Technical Assistance to Irrigation in Bolivia. GTZ Bolivia.

Center for International Forestry Research (CIFOR). (2014). *The Context of Deforestation and Forest Degradation in Bolivia*. Indonesia: Center for International Forestry Research (CIFOR).

Center for Participation and Sustainable Human Development (CEPAD). (2009). *MUNICIPAL ASSOCIATIONS: STATE OF SITUATION AND PROSPECTIVE*. Santa Cruz: El País.

Cerón Hernández, V. A., Fernandez Vargas, G., Figueroa, A., & Restrepo, I. (2019). THE SOCIO-ECOLOGICAL SYSTEMS APPROACH IN ENVIRONMENTAL SCIENCES. *Research and Development, Fundación Universidad del Norte*, 85-109.

CIPCA. (2018). *Impact of Irrigation and Microirrigation Systems in Three Regions of Bolivia*. Cochabamba: Center for Research and Promotion of Peasants.

CISTEL-FAO, (2000). Zoning of the Upper Valley of Cochabamba. Bolivia. FAO GCP/RLA/126/JPN

Chronicles Emigration. (2020). *Gamallo ends his trip to Bolivia with a visit to the municipalities where Cooperation promotes the agricultural sector*. Retrieved in 2022, from <https://www.cronicasdelemigracion.com/articulo/galicia/gamallo-finaliza-viaje-bolivia-visita-municipios-donde-cooperacion-fomenta-sector-agricola/20200305100732098526.html>

Delgadillo O. (2019). Methodological guides and tools to support the services of Accompaniment and Technical Assistance of pressurized irrigation systems. *Revista de Agricultura*, Nro. 60

AGRECOL Andes Foundation. (2018). *Diagnosis of Organic Production in Bolivia and Identification of Training Needs*. Cochabamba: Fundación AGRECOL Andes.

FRIEDRICH EBERT FOUNDATION. (2010). *Deforestation in Bolivia a Major Threat to Climate Change*. La Paz: FRIEDRICH EBERT FOUNDATION.

Autonomous Municipal Government of Cotagaita. (2019). *Directed Work Design and Supervision of Works*. Cotagaita: Luis Alberto Franco Sirpa.

Autonomous Municipal Government of Mairana. (2008). *Municipal Development Plan*. Mairana: Municipal Autonomous Government of Mairana.

GTZ. (2010). *Sustainability and Self-Management*. La Paz: GTZ.

GIZ/PROAGRO, (2018). Profitable investments in technified irrigation. Series: Reflective Articles of PROAGRO III

- Guzmán, M., Martínez, E., Pérez Yruela, M., & Moscoso Sánchez, D. J. (2005). *New Approaches to Rural Development in Latin America*. Andalusia: Public Company Agricultural and Fisheries Development and the Institute of Advanced Social Studies of Andalusia.
- HELVETAS Swiss Intercooperation. (2014). *Water management and climate change, Local climate change adaptation measures for water and food security*. La Paz: HELVETAS Swiss Intercooperation.
- HELVETAS Swiss Intercooperation. (2014). *Advances, achievements and impacts of Supramunicipal Territorial Management*. La Paz: GISTOR Team.
- Helvetas Swiss Intercooperation. (2014). *Advances, achievements and impacts of the Supramunicipal Territorial Management Commonwealth of Municipalities of Los Chichas*. La Paz: GESTOR.
- Helvetas Swiss Intercooperation. (2014). *Advances, achievements and impacts of the Supramunicipal Territorial Management Commonwealth of Municipalities Gran Centro Potosi*. La Paz: Helvetas Swiss Intercooperation.
- Helvetas Swiss Intercooperation. (2014). *Advances, achievements and impacts of Supranational Territorial Management, Commonwealth of Municipalities of the North of Potosi*. La Paz: Helvetas Swiss Intercooperation.
- HELVETAS Swiss Intercooperation. (2014). *Development of capacities and competences for the Concerted Territorial Management of Natural Resources*. La Paz: HELVETAS Swiss Intercooperation.
- Hoffmann, D., Tarquino, R., Corro Ayala, J., & Lavadenz, L. (2014). Methods to characterize the dynamics of socio-ecological systems associated with high Andean wetlands. *Ecology in Bolivia*, 134 - 140.
- Social Responsibility and Sustainability Information. (06 of 2022). *InforSE*. Retrieved on 10, 2022, from <https://www.inforse.com.bo/2022/07/15/el-bdp-contribuye-a-programas-de-empoderamiento-a-mujeres-en-chuquisaca-y-potosi/>
- Leguia Aliaga, J. D., Villegas Quino, H., & Aliaga Lordemann, J. (2011). Deforestation in Bolivia a Spatial Approach. *Scielo*, 7 - 44.
- Lopez, R. P. (2000). The Bolivian Prepuna. *Ecology in Bolivia*, 45 - 70.
- Commonwealth of Southern Cone Municipalities (MMCS), HELVETAS Swiss Intercooperation Swiss Cooperation in Bolivia. 2014. *Advances, achievements and impacts of Supranational Territorial Management – Commonwealth of Southern Cone Municipalities (MMCS). MANAGER Phase 01/09/2010 - 31/08/2014*
- Commonwealth of Municipalities of the Southern Cone (MMCS), (2019). Cochabamba Southern Cone comprehensive development strategy (popular summary 2020-2030).

- Manzano N. (2015). The territorial complex of the Metropolitan Region of Cochabamba. Ed. IESE-UMSS. "[http://biblioteca.clacso.edu.ar/Bolivia/iese-umss/20171024033248/pdf\\_1437.pdf](http://biblioteca.clacso.edu.ar/Bolivia/iese-umss/20171024033248/pdf_1437.pdf)
- Ministry of Environment and Water. (2016). *Amazon Without Fire Program*. La Paz: Ministry of Environment and Water.
- Ministry of Health and Sports, (2022). <https://www.minsalud.gob.bo/es/programas-de-salud>
- Molina Tejerina, O.J., P.G. of Ferari Patton. (2014). The Economics of Climate Change in Bolivia: Health Impacts. C.E. Ludeña and L. Sánchez-Aragon (eds), Inter-American Development Bank, Monograph No. 194, Washington, DC.
- UNDP. (2013). Advances in knowledge Climate change and the challenge of health in Bolivia. <https://www.bivica.org/files/cambio-climatico-salud.pdf>
- Decentralization Portal. (2007). Los Chichas Consolidate a Great Nation. p. 8.
- National Climate Change Program - PNCC. (2011). *Program for Adaptation to Climate Change from Biodiversity and its Ecosystems*. La Paz: National Climate Change Program.
- National Climate Change Program. (2007). *Climate Change in Bolivia (Analysis, synthesis of impacts and adaptation)*. La Paz: National Climate Change Program.
- National Irrigation Program. (2003). *Technical Assistance to Irrigation in Bolivia*. Cochabamba: National Irrigation Program.
- Pilot Project for the Transfer of Experiences for Rural Development Planning. (2016). *Document of Commitments assumed*. Álava: Instituto de Capacitación Oriente.
- OXFAN International. (2009). Bolivia, climate change, poverty and adaptation. Bolivia.
- Rebaudo, F., & Dangles, O. (2014). A socio-ecological model to establish scenarios of wetland dynamics in the face of global changes. *Ecology in Bolivia*, 141-153.
- Resilience Alliance. (2007). Assessing and Managing Resilience in Social-Ecological Systems: Supplementary Notes to the Practitioners Workbook. Vol 2, version 1.0, Resilience Alliance
- Romero-Muñoz A. and Pérez-Zubieta J. (2008). Preliminary evaluation of the trade and use of wild mammals in the pampas market of the city of Cochabamba, Bolivia. *Neotropical Mastrozoology*, vol. 15, no. 2, July-December, 2008, pp. 253-259.
- Saavedra and MRAC. (2014). Advances, achievements and impacts of the Supramunicipal Territorial Management Commonwealth of Municipalities of the Andean Region of Cochabamba (MMRAC). Ed. HELVETAS Swiss Intercooperation. Swiss cooperation in Bolivia.

- Service of Information and Analysis of Municipal Management SIAM. (2009). *Diagnosis of the Situation of the Commonwealths of Bolivia*. La Paz: Andres Martinez.
- National Irrigation Service - SENARI. (2021). *Report 2021*. La Paz: National Irrigation Service - SENARI.
- Sumpsi, J. (2006). *Pilot Experiences of Rural Local Development in Latin America, Lessons from the EXPIDER Project in Bolivia, Ecuador and Honduras*. Washington: IDB.
- SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK - SDSN. (2022). *Deforestation and Forest Fires in Bolivia*. Obtained from <https://sdsnbolivia.org/deforestacion-e-incendios-forestales-en-bolivia/>
- Local Development Unit of the Gran Potosí Commonwealth. (n.d.). *Integrated Diagnosis of the Gran Potosi Commonwealth*. Potosi: Local Development Unit of the Greater Potosi Commonwealth.
- Vice-Ministry of Water Resources and Irrigation. (2013). *National Inventory of Irrigation Systems*. La Paz: Vice Ministry of Water Resources and Irrigation.
- Vice-Ministry of Water Resources and Irrigation. (2014). *Guide for the Development of Minor Technified Irrigation Projects*. La Paz: Vice-Ministry of Water Resources and Irrigation.
- Zegada Escobar, Alejandro Gabriel. (2018). Impact of irrigation and microirrigation systems in three regions of Bolivia. Center for Research and Promotion of the Campesinado CIPCA. Cochabamba