# MIGRATION–CLIMATE CHANGE

From a disaster risk management perspective in the municipalities of Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma

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# MIGRATION–CLIMATE CHANGE

## From a disaster risk management perspective in the municipalities of Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma


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ESTADO PLURINACIONAL DE BOLIVIA

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# Foreword

Due to climate change, climatic, water, hydraulic, meteorological and biological anomalies, among others, are intensified, creating recurrent adverse events and frequently affecting the most vulnerable sectors of society (communities of indigenous villages and farmers) located mainly in rural areas, and influencing human movement processes.

In the Plurinational State of Bolivia, the worst adverse events have occurred in the last three decades with floods, droughts, frost and fires of a powerful nature. The floods in the departments of Pando and Beni and the region north of the La Paz department, has turned these regions into high-risk areas. As a result, the food vulnerability and unsatisfied basic needs (UBN) indexes, in addition to migration rates, shed light on the figures with high criticality.

In response to these events, and by paying attention to the existing risks in these regions, the Government of the Plurinational State of Bolivia has proposed guidelines for the plurinational policy on climate change and strategic actions, proposing an approach for disaster risk reduction, which focuses predominantly on the balance and harmony between man and nature, acknowledging the intercultural rights of the indigenous communities and farmers.

This study on the relationship between migration and climate change was carried out within the framework of the project, "Migration–climate change in indigenous communities in a situation of vulnerability", and seeks to contribute to the development of public policies on the basis of a thematic understanding of the migration–climate change relationship, by identifying and characterizing the structural and contingent factors that arise from migratory processes and unplanned human displacements related to the effects of climate change, disasters and/or emergencies. It also aims to identify the strategic lines that form the basis for the development of resilient capacities of local actors (indigenous, rural and municipal communities) that allow for the prevention, preparation, prosecution and confrontation of migratory processes that concern population groups in a state of vulnerability, considering the economic and sociocultural patterns through risk management.

**Reymi L. Ferreira Justiniano**
Minister of Defence

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| | |
|---|---|
| **AASANA** | Airports and Auxiliary Services for Air Navigation Agency (Administración de Aeropuertos y Servicios Auxiliares a la Navegación Aérea) |
| **APMT** | Plurinational Authority of Mother Earth (Autoridad Plurinacional de la Madre Tierra) |
| **CIPCA** | Farmers' Research and Promotion Centre (Centro de Investigación y Promoción del Campesinado) |
| **CODERADE** | Departmental Committees for the Management of Risk and Disasters/ Emergencies (Comités Departamentales de Reducción de Riesgo y Atención de Desastres) |
| **COE** | Emergency Operations Committee (Comité de Operación de Emergencias) |
| **COED** | Departmental Emergency Committee (Comité de Emergencia Departamental) |
| **CONARADE** | National Council for Disaster Risk Reduction and Emergency Response (Consejo Nacional de Reducción de Riesgos y Atención de Desastres y Emergencias) |
| **EBB** | Biological Station of Beni (Estación Biológica del Beni) |
| **GAM** | Autonomous Municipal Government (Gobierno Autónomo Municipal) |
| **INE** | National Institute for Statistics (Instituto Nacional de Estadística) |
| **IOM** | International Organization for Migration |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **MRI** | Municipal risk index |
| **OND** | National Disaster Observatory (Observatorio Nacional de Desastres) |
| **PDM** | Municipal Development Plan (Plan de Desarrollo Municipal) |
| **PTDI** | Territorial Plans for Integrated Development (Planes Territoriales de Desarrollo Integral) |
| **SENAMHI** | National Meteorology and Hydrology Service (Servicio Nacional de Meteorología e Hidrología) |
| **SENASAG** | Programme for the eradication of foot-and-mouth disease (Servicio Nacional de Sanidad Agropecuaria e Inocuidad Alimentaria) |
| **SERNAP** | National Service of Protected Areas (Servicio Nacional de Áreas Protegidas) |
| **SINAGER-SAT** | National Information System for Alerts-Warnings (Sistema Nacional de Información de Alertas) |
| **SNIS** | National Heath Information System (Sistema Nacional de Información de Salud) |
| **SPIE** | State Integral Planning System (Sistema de Planificación Integral del Estado) |
| **TIM** | Multiethnic Indigenous Territory (Territorio Indígena Multiétnico) |
| **UBN** | Unsatisfied basic needs |
| **UDAPE** | Social and Economic Policy Analysis Unit (Unidad de Análisis de Políticas Sociales y Económicas) |
| **UGR** | Risk Management Unit (Unidad de Gestión de Riesgos) |
| **VIDECI** | Vice Ministry of Civil Defence (Viceministerio de Defensa Civil) |

# Executive summary

The Plurinational State of Bolivia is located in a zone of intense climatic variability and due to its geography, topography and meteorological conditions, it is a country that is frequently subject to natural phenomena such as the El Niño–Southern Oscillation (ENSO), which affects the livelihoods of populations, including food security, social and productive infrastructure, and the economic activities of the society's vulnerable sectors (indigenous and farming communities), who are mainly located in rural areas. The processes of forced displacement, human movement and migration are potential effects of these circumstances.

Similarly, this situation is associated with effects of climate change, which, although not a new phenomenon, requires an understanding that emphasizes the complex relationship between migration–climate change and risk management. This is how the environmental and/or climate migrant category is important to the extent that it allows for the identification and development of operative actions targeted at population groups in situations of vulnerability and risk, for which there is a need for the understanding of the socioeconomic, demographic, institutional and organizational dynamics and the migratory patterns manifested.

The Plurinational State of Bolivia continues to be a country with a significant rural population (32.5% and 67.5% urban).[1] As the number of people exposed to disaster risks is still high, it affects in different ways the more vulnerable population groups, such as women, children and adolescents, devastated by exposure to different situations such as sexual violence, loss of secure environment and overcrowding in shelters and camps. According to information from the Vice Ministry of Civil Defence (Viceministerio de Defensa Civil or VIDECI), under the Ministry of Defence, during the last five-year period (2008–2013), 76.6 per cent of the 339 municipalities in the country were affected by floods; 12.5 per cent of this number is affected each year, with the departments of Beni, Cochabamba, Chuquisaca, La Paz, Oruro, Pando, Potosí and Santa Cruz being the most affected. With regards to the recurrence of hailstorms, in a period of 11 years, 51.9 per cent of the total number of municipalities were affected by this event and 5.6 per cent is affected on a recurring basis.

This situation requires a strategic approach to the relationship between migration–climate change and risk management, which allows for risk prevention and reduction actions for vulnerable groups (indigenous and farming communities), within the framework of the Mother Earth concept. This concept is designed to be a dynamic living system, shaped by the indivisible community of all the interconnected, interdependent and complementary life systems, in the face of socionatural disaster situations and climate change impacts that require the promotion, incorporation and application of a prevention culture, risk management and resilience in the face of disaster risks and adaptation to climate change.

Within the framework of this necessary analysis, this study offers to analyse the migration–climate change relationship in the territorial area in the Bolpebra municipality of the Pando department, and San Ignacio de Moxas and Santa Ana del Yacuma of the Beni department.

This study was conducted to improve the knowledge of the connection between migration and climate change, so that territorial actors and institutions can incorporate strategies oriented towards prioritizing and expanding the objective vision in each municipality, which is to be used for the risk management carried forward.

[1] Instituto Nacional de Estadística (INE), *Population and Housing Census* (2012).

# Chapter 1

# Conceptual framework

## 1.1. Climate change

The inclusion of climate change in the development agenda of the United Nations through the World Meteorological Organization and the United Nations Environment Programme, has triggered the implementation of mechanisms oriented towards improving the knowledge surrounding the causes that provoke this phenomenon. Among them is the establishment of the Intergovernmental Panel on Climate Change (IPCC), a United Nations scientific entity that coordinates with thousands of scientists from all over the world to bring together their contributions, later systemizing and publishing them in issued reports.[2]

Until now, the IPCC has produced and released five reports from each of the three workgroups; it is composed of the following: (a) Working Group I (WG I), which assesses the physical scientific aspects of the climate system and climate change; (b) Working Group II (WG II), which assesses the vulnerability of socioeconomic and natural systems to climate change, negative and positive consequences of climate change and options for adapting to it; and Working Group III (WG III), which assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere.[3] This study focuses on the systemization and the conclusions of the IPCC that were expressed in the fifth report, since it cumulatively includes the previous four reports as a theoretical and empirical basis for its development.

The IPCC defines climate change as the significant statistical change in the average state of the climate and in its variability (which includes statistical data such as standard deviations and the occurrence of extreme phenomena, among others; on all temporal and spatial scales, beyond particular extreme phenomena) during a period of time (decades or more years) that can be caused by both internal nature processes, such as "external forcing", understood as the alteration in the composition of the atmosphere or of the Earth, which is the product of persistent anthropogenic actions.[4]

### 1.1.1. Human-induced climate change

The definition of climate change elaborates that this could be due to natural internal processes. However, the changes that are being recorded do not only originate from the climate variability of nature and climate, but in the greater action of the forcing of the external climate of both the atmosphere as well as for the use of the Earth that can be found in deforestation and the increase

[2] Intergovernmental Panel on Climate Change (IPCC), n.d.a.
[3] Ibid.
[4] Allwood et al., 2014.

of greenhouse gases, which is understood as the process where gases from the atmosphere trap the heat that comes from the sun within the system of the Earth's troposphere. Trapping the heat directly impacts the temperatures of the Earth's surface; in this sense, an increase in greenhouse gases signifies an increase in trapped heat (increased greenhouse effect)[5] and therefore an increase in temperatures, giving rise to global warming.

The fifth IPCC report indicates that increased temperature in the climatic system is evident since the middle of the twentieth century; the figures that shed light on all the studies indicate that the planet is heating up like never before in hundreds and even thousands of years. "The atmosphere and the ocean are heating up, the volumes of snow and ice have decreased, the sea level has risen and the concentrations of greenhouse gases have increased".[6] The evidence of changes in the atmospheric temperature "demonstrate a temperature increase of 0.85 [0.65 to 1.06]°C during the period 1880–2012";[7] while with regards to oceans, especially in the upper ocean which measures between 0 and 700 meters, "(it is) practically certain (...) that there has been an increase in temperature between 1971 and 2010".[8] Similarly, it is stated that the main cause of the 40 per cent increase in greenhouse gases during the pre-industrial era is likely the result of the concentrations from human activities, and these have contributed to an increase in global average temperatures from 0.5°C to 1.3°C during the period 1951 to 2010.[9]

Therefore, the IPCC states that: "it has been determined that human influence has caused an increase in the temperatures of the atmosphere and the ocean, changes in the global water cycle, a decrease in the quantity of snow and ice, an increase in the global sea-level average, and changes in some extreme climate events.[10]

### 1.1.2. Climate change impacts

Due to the fact that climate change leads to diverse complex interactions and modifications in the impact predictions, both for climate variability as well as extreme meteorological events, its consequences are multidimensional. In this sense, the impacts refer to the "effects on life, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructures due to the interaction of climate changes or dangerous climate phenomena that occur in a specific time frame and also refer to the vulnerability of the societies or systems exposed to them."[11]

The IPCC report indicates that the effects establish two impact points at the global level: the human system and the natural system. The consequences of climate change on natural systems can be divided into two levels: (a) physical level, which includes phenomena, such as droughts, floods or the increase in sea levels; and (b) biological level, which addresses the effects on living organisms. On the other hand, the consequences on the human system include all the variables that form part of the life and the development of societies, mainly those related to health, food security and socioeconomic development.

The natural impacts observed up until now focus mainly on the changes in the global water cycle and the carbon cycle. It must be mentioned that, due to the interrelation between the physical and biological variables, many consequences of global warming reproduce their conditions or increase them through effects based on other factors.

5 IPCC, 2013:25.
6 Ibid., 4.
7 Ibid., 5.
8 Ibid., 8.
9 Ibid., 17.
10 Ibid.
11 Ibid., 9.

One of the biggest effects occurs in relation to the hydrological cycle; on the one hand, an increase in the atmospheric moisture and a pattern in strong rainfalls on continental regions has been observed, which has influenced the sequence and intensity of floods and droughts. On the other hand, the quantity of ice and snow is decreasing, which provokes an increase in sea water, effects on run-off waters and downstream water sources. In this sense, it is stated that: "in many regions, the changes in rainfall or the melting of snow and ice are changing the hydrological systems which affects hydrological resources in terms of quantity and quality".[12]

Another significant effect is the change in the carbon cycle. The circular movement of carbon does not have its roots in the atmosphere, oceans, seas, rivers, lakes, the Earth's crust, soils, forests, vegetation or in human beings.

In the terrestrial plain, the increase in carbon dioxide ($CO_2$) emissions implies a potentially larger growth in plants. The emission causes an increase in temperatures and humidity, which extends the growth season. However, the increased temperatures also reduce the plants, and a season extension means a greater need for water in order to survive. With this in mind, different studies state the contrary; in other words, longer and warmer seasons that are subject to water scarcity provoke a deceleration in vegetative growth and dryness in forests, making them more prone to forest fires. Forests in the extreme north have suffered from a higher frequency of fires, while the tropical forests have decreased in their growth and thereby their ability to absorb $CO_2$.

In the aquatic ecosystems, especially in the oceans, $CO_2$ is trapped through a direct chemical exchange and converted into bicarbonate upon joining with carbonate ions present in the rocks and shells of marine animals. The IPCC estimates that approximately 30 per cent of $CO_2$ emitted by human activities has been absorbed by the oceans, provoking greater acidification that has resulted in the weakness of shells belonging to marine organisms. Similarly, it is estimated that in the long term, acidic water will dissolve rocks, thereby freeing more carbonate ions and increasing the ocean's capacity to absorb $CO_2$. In the meantime, an increase in carbon could enhance the growth of some plant types as well as phytoplankton, whose development is more optimal in low temperature areas that are characterized by accommodating a higher quantity of nutrients.

The physical impacts, subjected to other external forces of human origin, lead to derivations for the ecosystems as well as for the human systems. In both cases, the effects are present in the vulnerability of extreme climate events and other lower-intensity changes, depending on the extent of exposure.

On the natural system level, as well as the devastation resulting from extreme events, the main radical consequence in the generation of environmental imbalances are in variations in the development and behaviour of biotic components. On the other hand, in the human systems, the extreme climate events create "(...) disorganization in food production and water supply, damages to infrastructure and settlements, morbidity and mortality, and consequences for mental health and human well-being"; examples of this are the tsunamis in Indonesia and Japan, or the hurricanes such as Mitch, whose devastating consequences affected more than a million people.

### 1.1.3. Climate risk as a result of vulnerability

The impacts necessarily evoke disaster risks that are measured in the context of climate change tendencies and vulnerability. Similarly, vulnerability is observed by exposure to climate events and the ability to adapt to both the natural and human systems.

In the human systems, exposure is an important component in identifying the scope of vulnerability of populations. However, adaptation is even more determining, since they are the capacities that result in better socioeconomic positioning, which ultimately defines the risk level for each sector of society.

[12] Ibid., 4.

In this sense, to a great extent, vulnerability results from interconnected social processes that create inequalities. The sectors of the population that are marginalized on the social, economic, cultural, political and institutional levels are more vulnerable to the effects of climate change. Impacts, such as damage to infrastructure and settlements, disorganization in food production and water supply, or reduction in crop yields are more intense as in many cases, and they do not only represent a huge economic loss, but also the total destruction of their livelihoods, which in turn creates diverse consequences at different levels.

The IPCC argues that there is great uncertainty concerning vulnerability, exposure and the future adaptive responses, as each one of the central concepts leads to a large number of variables, such as richness and the distribution of wealth, demography and migration, accessibility to information and technology, forms of employment, responses to adaptation and social values, as well as government structures and inter-State and commercial international relations. Consequently, the study of risk evaluation takes a focus centered on multiple socioeconomic scenarios.[13]

### *Global risks*

Even though human influence on the climate system is clear, determining dangerous interference occurs in accordance with value judgements and analysis of the risks. In this sense, areas of concern are established, which demonstrate the consequences of temperature increases and the limits of the ability to adapt for the ecosystems as well as for people and the economy.

In this sense, the following can be determined: the IPCC predicts that, from the dates of the progression of climate change in recent centuries and the analysis of the causes of changes operated in the climate system; "(...) the average global temperature could increase between 1.4 and 5.8°C (2.5–10.4°F) for the year 2100; this projection uses 1990 as a reference year and part of the basis that no policies were adopted to minimally reduce the causes of climate change".[14] According to this tendency, the greatest risk in the natural system at the global level is the loss of regional ecological systems, which revert to the extinction of global environmental functions that are in charge of reducing the causes and impacts of global warming. Among the most endangered ecosystems are the glaciers of the Arctic polar caps and the coral reef systems, especially in the Caribbean. Similarly, it is argued that the evidence of endangered species shows a risk of changes that are sudden and irreversible.

On the other hand, it is likely that due to the connection between climate change and natural disasters, the tendency related to the increase in temperature signifies the multiplication and intensification of heat waves, intense rainfall, larger floods and other atmospheric phenomena, such as cyclones and tsunamis.

### *Climate change in the Plurinational State of Bolivia: impacts and risks*

In the Plurinational State of Bolivia, it is difficult to distinguish between the influence of climate change in the occurrence of natural disasters and typical climate change, since both factors have always existed over the course of history. This fact is mainly due to the lack of reliable and complete historical climate records, as well as there being little research available on impacts. Even though it has not been possible to cogently verify the influence of climate change on the climatic variability of the country, different governmental and non-governmental institutions have highlighted that the number of climate-related disasters has increased in recent years, with a particular focus on El Niño and La Niña, which are both linked to temperature variation in the Pacific Ocean.[15]

[13] IPCC, 2014a.
[14] Ibid.
[15] Oxfam International, 2009.

### *Impacts of climate events*

Part of the evidence that can be the basis of responses are provided through the International Autonomous Project *DesInventar*, which created a database that registers and classifies disasters and its impacts. It was in operation since January 1970 until November 2013, taking information from the civil defence of national governments as a starting point and supplementing it with other information sources such as the press register. From the results, it can be highlighted that floods in general, because of their higher frequency, represent 40 per cent of the total 4,962 registered events. Similarly, it is worth emphasizing that the highest occurrence of floods increased during the period 2000–2004, doubling compared to previous periods and multiplying by eight in the period 2005–2009. Finally, the impacts caused by climate events demonstrate that floods generate greater impacts in absolutely all areas, with the exception of livestock and agricultural production that are mainly affected by droughts.[16]

Similarly, the National Disaster Observatory (Observatorio Nacional de Desastres or OND), under the Ministry of Defence, created a consolidated database that goes from 2002 to 2012. Among the information that is worth highlighting is the fact that the highest occurrence of disasters was mainly during the period 2007–2008. At the same time, climate disasters represent more than 90 per cent in almost all periods. In the same vein, it is pointed out that floods occur the most frequently, followed by hailstorms, frosts and droughts and other types of events to a lesser extent.[17]

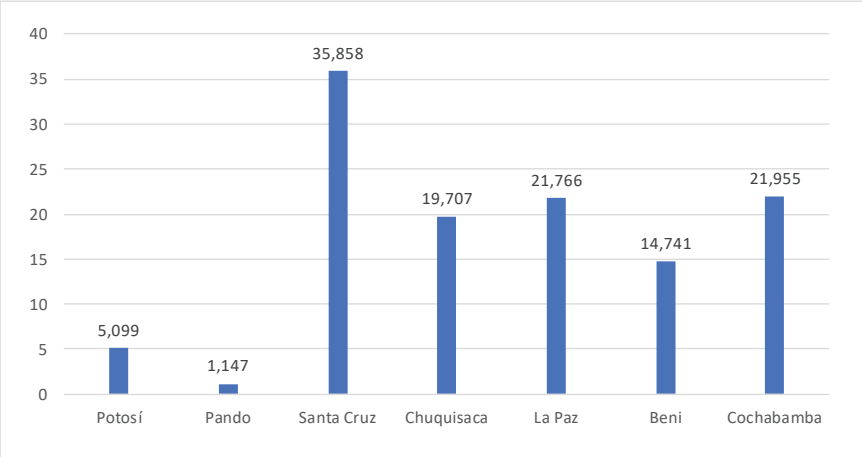
Aside from the difficulty of the study on climate change in the Plurinational State of Bolivia, the impacts generated by climate impacts are quite serious on the natural system level, as well as on the human system level, given that the socioeconomic composition of the country shows a significant number of vulnerable people who are the ones who face the worst consequences. According to some studies, the results of climate change are evident in the reduction of food security, the scarcity of water, an increase in the frequency and intensity of "natural" disasters, an increase in the spread of diseases transmitted by mosquitoes and a higher number of forest fires.[18]

A study carried out by Social and Economic Policy Analysis Unit (Unidad de Análisis de Políticas Sociales y Económicas or UDAPE)[19] shows the impacts and damages created by climate disasters at the municipal level in a quantitative and complete manner, from October 2013 to May 2014. According to these results, during this period, the Plurinational State of Bolivia was confronted with diverse climate events that affected livelihoods and production in the communities of 129 municipalities, especially affecting the most vulnerable. It points out that the main consequences were for the farming sector. The main road network was affected, generating impacts in departments and municipalities that led to significant economic losses in trading and the seclusion of various communities in the country. Many families lost their homes, while the public health and education infrastructure suffered direct damages, creating significant changes in their functioning.

It is necessary to understand that due to the vulnerable characteristics in the Plurinational State of Bolivia and the effects of this study, we must prioritize the data on the most serious areas to highlight the impacts on the most vulnerable people. In order to generate a visual approach that refers to the effects of natural disasters, some relevant data pertaining to the results of a study from UDAPE are presented in Figures 1 and 2.

16 DesInventar, n.d.
17 Oxfam International, 2009.
18 Ibid.
19 Social and Economic Policy Analysis Unit (Unidad de Análisis de Políticas Sociales y Económicas, UDAPE), 2015.

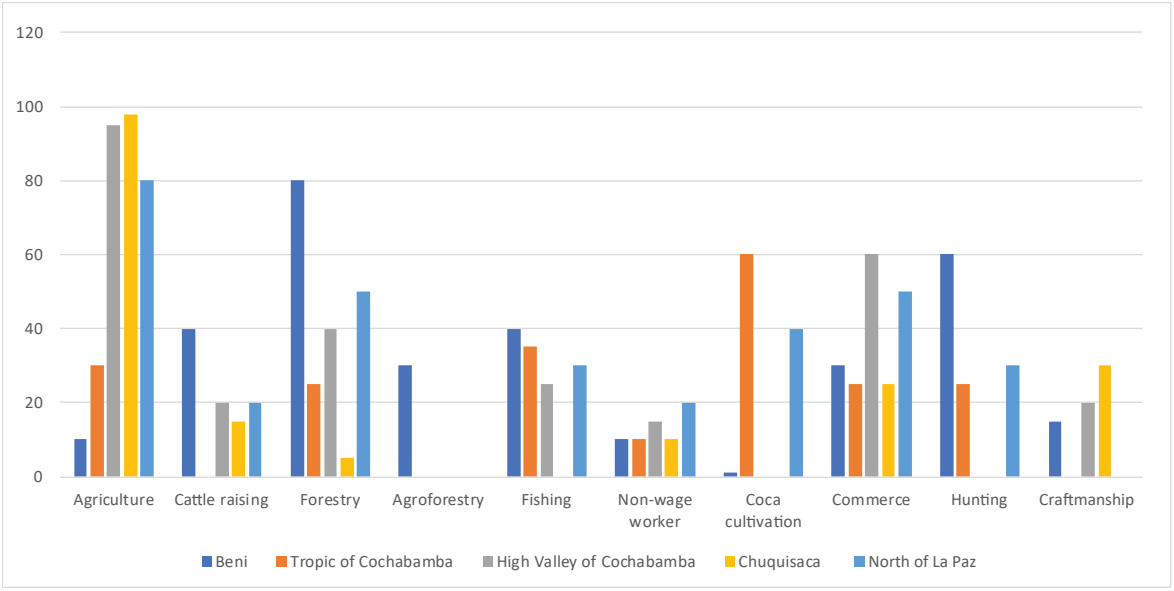
Figure 1. Affected cultivated area (in hectares)




*Source*: UDAPE, 2015.

According to the study data, the losses for the agricultural sector are calculated on production volumes that were not harvested in affected areas, which resulted in the loss of incomes for the non-commercialization, adding to the cost for production not harvested for self-consumption. The affected cultivated area was 120.272 ha at the national level, where almost 100 per cent were not harvested.

Figure 2. Impact on livelihoods




*Source*: UDAPE, 2015.

Likewise, this study has identified 10 categories that include the main livelihoods through interviews, as well as the percentage of families dedicated to each one of them, as Figure 2 shows. As may be seen, the proportion of impacts related to livelihoods varies according to department; in the case of Beni, the biggest consequences were forestral wealth, then hunting and fishing, while in other municipalities such as Valle Alto de Cochabamba, Chuquisaca and North of La Paz, the biggest impact was on agriculture and then forestry.

Table 1. Total evaluation of damages and losses by sector (in bolivianos (Bs))

| Sector | Damages | Losses | Total | % |
|---|---|---|---|---|
| **Social sector** | **303 212 169** | **18 529 877** | **321 742 046** | **7.4** |
| Education | 39 827 086 | 2 140 467 | 41 967 553 | 1.0 |
| Health | 33 801 810 | 15 619 409 | 49 421 219 | 1.1 |
| Housing | 229 583 273 | 770 001 | 230 353 274 | 5.3 |
| **Infrastructure sector** | **577 035 302** | **27 257 229** | **604 292 531** | **14.0** |
| Transport | 470 456 918 | 21 230 325 | 491 687 243 | 11.4 |
| Water and sanitation | 99 073 576 | 3 205 889 | 102 279 465 | 2.4 |
| Electricity | 5 990 848 | 1 545 368 | 7 536 216 | 0.2 |
| Telecommunications | 1 513 960 | 1 275 647 | 2 789 607 | 0.1 |
| **Economic sector** | **1 301 528 877** | **2 099 299 645** | **3 400 828 522** | **78.6** |
| Farming | 641 804 998 | 1 009 706 122 | 1 651 511 120 | 38.2 |
| Livestock | 641 804 998 | 320 180 778 | 961 985 776 | 22.2 |
| Agriculture | | 689 525 344 | 689 525 344 | 15.9 |
| Forestry, hunting and fishing | | 37 400 532 | 37 400 532 | 0.9 |
| Industrial | 14 990 281 | 34 179 189 | 49 169 470 | 1.1 |
| Tourism | 2 928 600 | 8 307 680 | 11 236 280 | 0.03 |
| **Total** | **2 181 776 348** | **2 145 086 751** | **4 326 863 099** | **100** |

*Source*: UDAPE, 2015.

Regarding the global disaster situation during the period 2013–2014, the biggest monetized damage in the country was in the economic sector, which reached 78.6 per cent, follow by the infrastructure which reached 14 per cent, and finally the social sector with 7.4 per cent. It is worth highlighting that farming activities represent 38.2 per cent of the total losses and damages at the national level, livestock represents 22.2 per cent, agriculture 15.9 per cent and transport 11.4 per cent.

In demographic terms, from 1900 to 2015, according to the Centre for Research on the Epidemiology of Disasters (CRED) through the International Disaster Database (EM-DAT),[20] the total number of people affected by natural and human-induced disasters was 7,867,714. However, disasters that are specifically climate related managed to harm a total of 7,615,586, which means that it represents 96.90 per cent of the total number of affected people, and demonstrates the prevalence of climate events as the biggest impact that affects community lives.

### *Predictions, risks and future scenarios for the Plurinational State of Bolivia*

Climatological predictions cannot be measured accurately further than a few days; this fact means that the projections of the behaviour of climate indicators are not very reliable in terms of long-term predictions. In this sense, the studies have opted for the creation of hypothesized scenarios according to different variables that are mainly linked to the level of external forcings, demographic growth, economic development and the use of new technologies. On top of these hypotheses, the predictive studies generate mathematical models, which consist of the projection of climate events by relating them with climatological variables related to the atmosphere, the oceans and the Earth's surface. The construction of models is important because they are useful for setting up possible scenarios that are useful for action planning for possible situations.[21]

[20] EM-DAT, n.d.
[21] See Salinas Murillo, 2014.

The IPCC has proposed a collection of scenarios composed of six groups deriving from four families from evolutionary scenarios: a group from each one of the A2, B1 and B2 families, and three groups from the A1, A1F1, A1B and A1T families, which are differentiated by type of energy they use.[22]

The A1 scenario and evolving lines family is based on the incorporation of more efficient technologies, fast economic development and an increase in the global population, which reaches its maximum value at the middle of the twenty-first century and then decreases. Among the most important characteristics, the convergence between regions is noted as well as the increase in cultural and social interactions and the reduction of regional inequalities in terms of income per capita. On this basis, the variations for family A1 are as follows: (a) Group A1F1 shows an intensive use of fossil fuels; (b) A1B involves the use of combustibles in a balanced way; and (c) the A1T scenario implied the use of non-fossil fuels.[23]

The evolving lines family and B1 scenario, just like family A1, shows a world consistent between regions, whose population reaches its maximum point halfway through the century and then declines afterwards. However, accelerated changes are shown on the economic structure, which is mainly oriented towards the services and information, creating a reduction in the use of materials and clean technologies, with an effective advantage of resources. In this sense, there are many answers regarding global availability, focused on the sustainability of the economic, social and environmental areas, as well as on better equality.[24]

On the contrary, the B2 family of evolutionary lines and scenarios shows a prevalence at the local level in the answers to economic, social and environmental sustainability. "It is a world whose population progressively rises at a lower rate than in A2, with some intermediate economic development levels, and with a slower and more diverse technological change than in the B1 and A1 evolutionary lines. Although this scenario is also oriented to the protection of the environment and social equality, it is mainly centred on the local and regional levels".[25]

As previously mentioned, the creation of models on these scenarios is focused on guiding actions to confront possible situations. Table 2 is an overview of the models applied in the Plurinational State of Bolivia.

[22] IPCC, 2000.
[23] Ibid.
[24] Ibid.
[25] Ibid.

**Table 2. Models and climate forecasts for the Plurinational State of Bolivia**

| No. | Model | Climate forecast/estimation |
|---|---|---|
| 1 | Regional: MM5 for North-East Argentina and the Plurinational State of Bolivia's high plateau until 2100 (in Soloman et al., 2007; Nuñez et al., 2008). | Increases in the temperature of about 3.5°C for the A2 scenario and 2.5°C for the B2 scenario during the summer months are predicted. The temperature increases are higher for the winter months (4.5°C for A2 and 3.5°C for B2). The region is characterized by humid summers and dry winters. For the end of the twenty-first century, a reduction in rainfall of 40% for the summer months is predicted, which represents an increase in the acidification for the region. |
| 2 | Studies from Seth et al., 2010; Thibeault et al., 2010 (Meehl et al., 2007) (in Andrade, 2011). | Future climate where the heating up of the high plateau intensifies. Under the A2 scenario, it is predicted that until the end of this century, an increase in the concentration of atmospheric $CO_2$ up to 850 parts per million volume (ppmv), this warming up can reach around 4.5°C in some regions of the high plateau. Under the B2 scenario (which projects a concentration of 550 ppmv of $CO_2$ at the end of the century), the warming up will be around 2.5°C for the same period. The results suggest that the seasonality will be stronger, reducing the rainfall during the period for September–November and increasing the intensity of the events in the rainy season, typically from January to March. In particular, for the projected change in the annual rain cycle in the Plurinational State of Bolivia's high plateau, the model indicates a start to the rainy season characterized by rain, which is less frequent but more intense. |
| 3 | IS92a, IS92c (optimistic scenario) and IS92e (pessimistic scenario), model worked by the National Meteorology and Hydrology Service (Servicio Nacional de Meteorología e Hidrología or SENAMHI) (1998) (in National Climate Change Programme (Programa Nacional de Cambio Climático or PNCC), 2004). | All the scenarios show the same tendency in the increase in temperatures. The total increase of rainfall is higher in the humid months (October to February), while in the dry months (May to August), the variation of rainfall is lower in complete terms. |
| 4 | Generating model for climatic scenarios (Model for the Assessment of Greenhouse Gas Induced to Climate Change, A Regional Climate Change Scenarios Generator or MAGICC/ SCENGEN). | Variation in the average temperature of 0.99°C; the likelihood of an increase in rainfall will be between 60 and 80%. |
| 5 | Japanese model MRI/JMA-TL959 (Meteorological Research Institute/ Japan Meteorological Agency). | Changes in the minimum temperature of around 3 to 4°C over a large part of the national territory the scenario A1B (crossed use of fossil and non-fossil fuels) in which there are reductions in the rainfall higher than 70% in a probability of 50%, which indicates an average rate of reliability. |
| 6 | Validation of Japanese model MRI/ JMA-L959 in the continental scale (in United Nations Development Programme (Programa de las Naciones Unidas para el Desarrollo, PNUD), 2011). | With the study, it was clear that the Japanese model adequately reproduced the spatial distribution of rainfall and circulation on the continental scale; in other words, it captures the seasonal evolution of the American monsoon system. The result would allow the local confirmation to be studied. |

| No. | Model | Climate forecast/estimation |
|---|---|---|
| 7 | Providing Regional Climates for Impacts Studies (PRECIS) model (in C. Seiler, FAN 2009). | Increase throughout the entire country (1–2°C in 2030, 5–6°C in 2100). A more extreme increase in the high plateau and the Amazon. More rainfall during rainy season (ΔPmax +53% lowlands, 2100); less rainfall in the dry season (ΔPmax -36% lowlands, 2100). Annual decrease in net rainfall in the high plateau and far north (Amazon). |
| 8 | Validation of PRECIS model (created by Andrade and Blacutt, 2010). | An increase in average, minimum and maximum temperature is expected. The increase in the maximum temperature would be by 4.6°C. The minimum and average temperatures will increase by around 4.2°C each. The changes are statistically significant. The results of the model indicate that towards the end of the century (scenario A2), there will be an increase in the rainfall in the lowlands of the country. This increase would be around 30% and only during summer. |
| 9 | Analysis of tendencies (created by M. Garcia et al., 2006). | Maximum temperatures have a homogenous variation in the studied areas (centre and south of the country) in contrast with the minimum temperatures. This implies that the increases will fluctuate in the ranges between 0.018 and 1.16°C until the year 2050. In the lake zones and more strongly in the high plateau and the high valleys of Potosi and Chuquisaca, a higher thermal range is expected, resulting in increased aridity associated with desertification. |
| 10 | Model TL959 and Model ETA (Autonomous Territorial Entities) corridas by the PRAA (Andean Regional Project for Adaptation to Climate Change). | Increases throughout the entire Bolivian territory of between 1 and 3°C approximately, being higher for the mountain range and north-east of the country. For the near future, increases in the intensity of rainfall between 5 and 25% are expected for the Bolivian mountain range, while smaller changes or even decreases in rainfall intensity are visualized in the model TL959 for the lowlands. Regarding the distant future, firstly with regards to rainfall intensity, the TL959 and ETA models suggest different behaviours. Although for the two scenarios (A2 and B2), the ETA suggests similar behaviour (with increases in the intensity of rain along the mountain range and decreases basically in the rest of the country), the TL959 provides an almost completely opposite scenario. |

*Source*: Ministerio de Medio Ambiente y Aguas (MMAyA, Ministry of Environment and Water), 2010:28.

The interpretation of the models is a complex task worthy of specialized study. In this sense, it is necessary to support ourselves in the results expressed in the investigation titled "Baseline on climate models and scenarios of the Plurinational State" by Giovanna Salinas Murillo.

Among the most outstanding results, an increase in the average annual temperatures in the tropical Andes since 1939 by 0.10 and 0.11°C by decade was shown; however, in the last 25 years, it has increased by 0.32 and 0.34°C, which would provoke the destruction of the glaciers of the Cordillera Real. According to Salinas, the annual average temperature in the Amazon region would have increased by 0.08°C from 1901 until 2001, while the IPCC's predictions show the same range between 1.8 and 5.1°C for the year 2050, and a larger part of the models show an increase of between 2.6 and 3.7°C.[26]

[26] See Salinas Murillo, 2014.

With regards to the projected rainfall for all the scenarios, the IPCC establishes that the eastern region and the Amazonian region will experience colder winters and more humid summers. The rainfall patterns could delay the beginning of rainfall and at the same time shorten the seasons. These two occurrences would increase the likelihood of frequent extreme events.[27]

With reference to these risks, in general, the forecasts show that the temperatures – in all the scenarios and periods – have increased more than before at 1–2°C; depending on the scenarios, the variation in the temperatures in the projections range for the following decades (2030) between 0.99°C and 3°C; for 2050 between 2.5 and 4°C; for 2100 between 3 and 6°C.

In this sense, rainfall increases depend on the period and the scenarios; in short cycles and optimistic scenarios, they increase between 5 per cent and 25 per cent, while in the most pessimistic scenarios, it occurs between 60 per cent and 80 per cent with a longer time period. The increase in rainfall during the rainy season and their reduction in the months during the dry period signifies a reduction in the annual rainy season, creating a greater burden of rainfall in short periods and lengthening the dry months, which at the same time increases the probability of extreme events, such as floods during rainy months and droughts during the dry months.

## 1.2. Disaster risk management

The impacts and risks promote the need for a response oriented towards the future in a margin of action determined by the current situation. In this sense, risk management is defined as "a complicated social process which drives planning and application of policies, strategies, instruments and measures oriented to prevent, reduce, predict and control the adverse effects of dangerous phenomena on the population, goods and services, and the environment".[28]

Even though Lavell's (2005) notion is accurate, it is necessary to carry out a conceptual breakdown that allows us to have a broader view. In this sense, the IPCC divides climate risk management into two poles: adaptation and mitigation. However, it is also pointed out that between them, there are mutual benefits and synergies and downsides that occur in the form of interactions.

> Increasing efforts to mitigate and adapt to climate change are coupled with an increasing complexity of interactions, especially at the intersections between the water, energy, land use and biodiversity sectors, but the tools available to understand and manage such interactions are still limited. Among the examples of measures that generate co-benefits there are: i) more efficient and cleaner energy sources, which result in lower emissions of air pollutants that alter the climate and damage health; ii) lower consumption of energy and water in urban areas, with increasingly green cities and through the recycling of water; iii) sustainable agriculture and forestry; and iv) protection of ecosystems to provide carbon storage services and other ecosystem services.[29]

The mitigation of climate change constitutes an important part in the reduction of vulnerability and risk; however, adaptation is the most dynamic and relevant axis in this task, since its actions show results in a shorter time.

[27] Ibid.
[28] Narváez, Lavell and Pérez Ortega, 2009.
[29] IPCC, 2014a.

The IPCC maintains that there is no single method for adaptation, since it depends more on the particular context of each space. However, it is established that at the minimum, adequate adaptation must contemplate vulnerability and exposure dynamics, as well as its relationships with socioeconomic processes, sustainable development and climate change.

In this sense, the so-called "overlapping approaches" (clarified as a cautious and open view) are established, understood as a proposal by the IPCC to determine the scope of climate risk management in terms of adaptation, through different categories encompassing in three axes. The first axis is reduction of vulnerability and exposure, which includes categories of human development, poverty alleviation, security of livelihoods, disaster risk management, ecosystem management and spatial planning or land use. These categories seek to encompass aspects related to development planning in general terms, oriented towards a vision of sustainability, strengthening the response to disasters and better distribution of income. The second axis called "adaptation" encompasses the structural/physical and institutional categories, both refer to generating gradual and transformative changes; the first case is channeled into the conception of technological and ecosystem options, in addition to adapting infrastructure and services aimed at basic needs. On the other hand, the institutional category focuses on the creation of economic, regulatory and governmental policy options regarding natural resource management and adaptation. Finally, the third axis called "transformation" contains social and spheres of change categories; the first element highlights the impulse of knowledge management through educational, informative and behavioural options linked to the problem of risks; the second identifies the fields of practice, politics and personnel as points of origin for change.[30]

In short, the planning and implementation of the adaptation has as an articulating axis on the implementation of measures from the decision-making space. However, it must be emphasized that responding to climate-related risks implies a scenario of constant changes and uncertainty of the severity and timing of the impacts, in addition to the limit on the efficiency of the adaptation. In this sense, it is necessary to generate higher levels of integration between decision-making spaces, as well as the implementation of complementary measures in the governmental and personal spheres, mainly in risk awareness. On the other hand, the role of the financial aspect in the dynamics of climate risk management must be exploited, both in the empowering sense of adaptation and resilience, and in the incentive towards the transformation of practices that support mitigation and decrease the risk.

### 1.2.1. Disaster risk management in the Plurinational State of Bolivia

Within the framework of the IPCC's transformative approaches, risk management in the Plurinational State of Bolivia has its main driver of change in the political sphere. The following legislations: (a) Political Constitution of the State; (b) Law No. 300, Framework Law of Mother Earth and Integral Development for Living Well, approved on 15 October 2012; (c) Law No. 602 on Disaster Risk Management, approved on 14 November 2014, with Regulatory Decree DS No. 2342 of 29 April 2015; (d) Law No. 777 and Law of the State Integral Planning System (Sistema de Planificación Integral del Estado or SPIE) approved on 21 January 2016; added to different collateral policies, mainly referred to the best distribution of wealth and fight against poverty. They are a sign of significant progress at the level of the areas of change, which have an impact on both the adaptation and the reduction of vulnerability and exposure. On the other hand, there is also a social dynamic from the ancestral knowledge of the farming and indigenous communities; although they were not conceived in the framework of climate change, they are part of the efforts to face their impacts.

[30] IPCC, 2013.

### *Regulatory policy*

Law No. 300, Framework Law of Mother Earth and Integral Development for Living Well, establishes a referential framework that inscribes integral development, the productive activities around care and the preservation and regeneration capacity of the life systems and the components of Mother Earth. Likewise, in line with other regulations, the approach to prevention and management of disaster risk and adaptation to climate change is incorporated, in a transversal way, to inter-institutional planning and coordination, as well as the establishment of mechanisms such as a system for climate information and early warnings. In this sense, the economic activities oriented to integral development promote the use, care and regeneration of Mother Earth's components: biological and cultural biodiversity, land and territory, water, forests, mining and hydrocarbons, agriculture, fishing and livestock, air and environmental quality, energy, climate change, waste management and education. Likewise, territorial planning must be subject to the "zoning and life systems management", as well as through participatory processes involving all government levels, with the following objectives: (a) guarantee equitable access to the components of Mother Earth; (b) distribution and redistribution of benefits of using the components and functions of Mother Earth; (c) equitable access to water sources; (d) prevention against the foreignization of the land; and (e) elimination of the concentration of land ownership.

It is worth mentioning that this law not only establishes guidelines, but also creates institutional instances that ensure compliance. The Plurinational Council for Living Well and in Harmony with Mother Earth is established, for which the Ministry of Development Planning will be responsible for. Likewise, the Plurinational Authority of Mother Earth (Autoridad Plurinacional de la Madre Tierra or APMT) is established, whose main tasks are the following: (a) creation of regional platforms for adaptation and mitigation; (b) creation of a plurinational fund for the collaboration of activities aimed at adapting to climate change; (c) systematization and creation of information on climate change; and (d) preparation of national reports from the Plurinational State of Bolivia for the United Nations Conference on Climate Change.

Law No. 777 of SPIE can be considered as an integral vision, where its greater scope is given through the establishment of the methodology of the Territorial Plans for Integrated Development (Planes Territoriales de Desarrollo Integral or PTDI), whose approach integrates development planning with territorial ordering, and is oriented to the management of life systems, risk management and climate change.

These laws constitute an advance in the adaptation approach, especially in the institutional sphere, mainly with the elaboration of specific regulations on the management of natural resources, the reorientation of public investment and the creation of financial tools. Although there is a potential impact on all approaches exposed by the IPCC, it should be mentioned that due to the recent implementation of the norms and their mechanisms, it is not yet possible to generate an analysis that allows to see their effects with greater accuracy.

Regarding Law No. 602 on risk management and its regulation, this suggests an advance in the risk reduction and vulnerability approach, mainly in relation to disaster risk management. This regulatory instrument defines as a priority the incorporation of the topic of risk management into strategic planning at all national, sectoral and all regional levels; likewise, in an operational sense, the law is mostly developed around disasters and emergencies.

Within this framework, a national risk management system is created, organized in the National System for Risk Reduction and Disaster/Emergency Care (Sistema Nacional para la Reducción de Riesgos y Atención de Desastres y/o Emergencias or SISRADE), which has the National Council for Risk Reduction and Risk Reduction (Consejo Nacional de Reducción de Riesgos y Atención de Desastres y Emergencias or CONARADE) at its national level. CONARADE is in charge of coordinating with the departmental autonomous governments, Departmental Committees for Risk Reduction and

Disaster/Emergency Care (CODERADES) and the autonomous municipal governments through the Municipal Committees for Reduction of Disasters/Emergencies (COMURADES). In relation to the specific attention of emergencies, the National Emergency Operations Committee (Comité de Emergencia Nacional or COEN), together with the Departmental Emergency Committee (Comites de Emergencia Departamental or COED) and Municipal Emergency Committee (Comité de Emergencia Municipal or COEM), are also founded.

At the same time, the Risk Assistance Fund – (Fondo de Fideicomiso para la Reducción de Riesgos y Atención de Desastres y/o Emergencias or FORADE) is created with funds equivalent to 0.15 per cent of the total National Treasury (Tesoro General de la Nación or TGN) resources and with the objective of financing the risk reduction management. The National Information System for Alerts-Warning (Sistema Integrado de Información y Alerta Para la Gestión del Riesgo de Desastres or SINAGER-SAT) is generated that is constituted by the following components: (a) National System of Early Warning for Disasters (Sistema Nacional de Alerta Temprana para Desastres or SNATD); (b) OND; (c) Spatial Data Infrastructure (Infraestructura de Datos Espaciales or GEOSINAGER); and (d) Virtual Library of Disaster Prevention and Attention (Biblioteca Virtual de Desastres or BIVAPAD).

Under this institutional framework, the central level of the State grants the necessary competencies to the departmental and municipal sublevels, and at the same time articulates their own systems that these develop for risk management. It is necessary to point out that a large part of risk management falls on the autonomous entities whose competencies are focused on the following: (a) identifying, evaluating, measuring and zoning the areas with degrees of vulnerability and/or risk; (b) establishing prevention and mitigation measures; (c) issuing norms for the prohibition of occupation for the purpose of human settlements; and (d) equipment in areas of risk that threaten the safety and integrity and the transfer of risks in the construction of homes, commercial and industrial establishments, among others.

### *Ancestral dynamics*

The climate and its impacts play a fundamental role in the life of peasant and indigenous communities, not only from the perspective of production, but also as part of cultural visions. Climatic observation and prediction are important for the economic activities of indigenous peoples and indigenous nations, since they have a direct influence on the efficiency of the work and the results of production, mainly agriculture and livestock. In traditional forms of production, climate knowledge is accompanied integrally by productive methods, types of seed, access to water, soil characteristics, bio-indicators, inter-community organization and storage possibilities, among others. Both aspects are related to ritual and festive activities within the framework of cultural beliefs and world views.

Historically, knowledge and ancestral practices linked to climate have complemented, and in a certain way, continue to complement the institutional frameworks, demonstrating an important role both in the sense of adaptation and in the conservation of the environment. Although today they are used in a largely practical sense, there is the notion that these knowledge are being lost and, in a certain way, its scope is partial due to the weakening of the living conditions of the communities.

In relation to the approaches proposed by the IPCC, it can be said that ancestral knowledge covers most or all of the categories developed, although in a particular way, since although they include all aspects of the life of the communities, their effectiveness is questionable when demonstrating greater vulnerability to climatic events. That is why it is important to point out the need to generate complementarity between conventional risk management and local adaptation dynamics.

## 1.3. Migration

Migration is a phenomenon that exists within every historical period of mankind. Together with the growth of the population and the resources available for its needs, migration has become a fundamental issue due to the impact it has on the global demographic configuration and the changes it causes in the economy of a country. Both, in fact, are translated into the level of life and the socioeconomic, cultural and political conditions of the population that migrates.[31]

The International Organization for Migration (IOM) defines a migrant as "any person who moves or has traveled across an international border or within a country, outside of their usual place of residence, regardless of: (a) their legal status; (b) the voluntary or involuntary nature of the displacement; (c) the causes of displacement; or (d) the length of their stay".[32]

One of the many consequences of climate change is related to the phenomenon of migration. According to some studies, the projections for migration related to the effects of climate change for the rest of the twenty-first century are alarming. Variations in climate are becoming the first cause of massive migrations, far surpassing other causes.[33] However, other studies point out that it is difficult to attribute migration in a direct causal relationship with climate change, given that it has several predominantly economic variables. In this sense, the relationship between migration and climate change is created by the influence of climate change on the other migration variables, such as vulnerability, which is considered a proponent of migration.[34]

Due to the characteristics of this study, it is essential that we bear in mind the definition of internal migration while analysing international migration as it is the most recurrent process. In this sense, we understand internal migration as a "movement of people from one region to another in the same country with the purpose of establishing a new residence. This migration may be temporary or permanent. Internal migrants move within a country but remain in it".[35] International migration is the "movement of people who leave their country of origin or the country in which they have habitual residence, to settle temporarily or permanently in a country other than their own. These people have had to cross a border for this. If this was not the case, they would be considered internal migrants".[36]

The concept of internally displaced persons must also be understood as "persons or groups of persons who have been forced or forced to flee or leave their homes or habitual residence, particularly as a result of or to avoid the effects of an armed conflict, widespread violence, violation of human rights or natural or human disasters and that have not crossed a border of an internationally recognized state".[37] This decentralization is the "forced displacement of a person from their home or country due, in general, to armed conflicts or natural disasters". These two categories are fundamental for this study since the types of migration that occur in relation to climate change have different characteristics and definitions. It is also necessary to point out a figure related to the dynamics of both variables: the so-called "trapped", a term that refers to people who do not have the means to migrate when a disaster occurs.

31 United Nations Convention on Migrants' Rights, 2003.
32 IOM definition.
33 Kamal, 2016.
34 Foresight, 2011.
35 IOM, 2004.
36 Ibid.
37 United Nations, 1998.

The first sign of migration due to climate change is the temporary migration to other population centres; it is a sign that the work deployed in the same community is not enough to fully supply the necessary resources for the total reproduction of the conditions of family life, in such a way that some of its members must go to spread this work to other regions. Migration, from this involuntary perspective, becomes an element that hinders the local development of communities, since it creates pressure on infrastructure, services and livelihoods in the centres that receive it; but at the same time, it creates lower living conditions for the communities of origin because work and the production of wealth in the communities of origin and family are reduced.

### 1.3.1. Internal urban–rural migration

According to the Population and Housing Census data for 2012, 67.5 per cent of the population live in urban areas and 32.5 per cent live in rural areas. If analysed from a historical perspective, it can be seen that in 1950, 26.2 per cent lived in urban areas while 73.8 per cent lived in rural areas, which is the opposite of the current situation. This phenomenon is due to an internal exodus that takes place from the rural area communities to the populated centres and can occur due to economic, political, social and cultural reasons. Among the main causes, it can be stated that the intensification of incorporating communities into the domestic market with the agrarian reform of 1952 is a fact that creates an increase in the relationship between the two areas and obviously the need to establish and increased presence of actors linked to agricultural production in the cities. Another fact is the concentration of the public investment in the cities generating better living conditions in the cities by their greater agglutination. It can also be stated that the search for bigger opportunities has mobilized large segments of the population towards the cities, and one of the significant causes in recent years is the lack of lands due to the excessive fragmentation as a result of the small size of the properties that future generations will inherit.

#### *Migration dynamics and relationship between municipalities and communities*

For this study, the most important element that is concerning is the mobility of the population from the rural to the urban sector. This trend, which has been accentuated worldwide and began in developed countries, now continues or increases in the region, expressing itself in some way in the economic activity data developed by people from different countries focused mainly on primary activities. Added to this mobility characteristic is vulnerability, which "despite the fact that a third of the population of Latin America and the Caribbean is middle class, many people who overcame poverty still find themselves in vulnerable situations".[38]

In relation to the forced national migration linked to climate disasters, it can be seen that the total number of people affected by the greatest catastrophe (floods) reaches 1,447,180, while the total affected is 490,366. There were 53,366 evacuated from disaster areas, among which are those who subsequently returned to their communities or homes; but there are also those who have not returned. Finally, the 1,430 people who were relocated moved their homes definitively, in general within the same municipality.[39]

[38] Ferreira et al., 2013.
[39] DesInventar, n.d.

# Chapter 2

# Methodological reference

In the context of great responsibilities and growing threats, vulnerable municipalities that are small in population and budget have limitations in complying with the law's mandates. In this sense, it is necessary to analyse climate change and its consequences in order to strengthen the construction process of municipal policies aimed at tackling the problem and establishing different social and institutional practices.

## 2.1. Methodological description

The methodology around the desired objectives is guided by six pillars. Firstly, the study and strategic planning will be oriented towards **sustainable development**, since the issue of climate change is directly linked to the development and conservation of the environment. Secondly, the **prioritization of a more vulnerable population** is established, because they are the sectors most affected by the impacts of climate change. According to both, the third pillar is the approach towards **resilience**, understood as the development of one's own capacities that are linked to the ecological environment to face the consequences and the recovery of climatic disasters. The fourth pillar proposes a **transdisciplinary**, **intercultural**, **gender and ecological perspective**, which is transposed in the fifth pillar, referring to the precepts of participatory study action, which is based on the active participation of local actors in the identification of problems and their solutions. Finally, the sixth pillar reiterates the importance of coordination with public planning, for the **advocacy of the elaboration of regulations and public policies** at different autonomous levels.

In this sense, the case study methodology is used, which is characterized by combining and articulating the general knowledge surrounding the problem with the information obtained from the current, specific and detailed situation of the actors involved.

## 2.2. Study instruments

The instruments developed for the case studies generate fundamental information to draw strategic guidelines. Four mechanisms for obtaining information are prioritized. The first instrument is the bibliographic review during the whole study work and the formulation of strategic guidelines; the review of data on climate change and the population at the national and international levels is carried out, with the aim of constituting a conceptual and referential framework.

At the same time, the other three instruments are implemented – surveys, in-depth interviews and focus groups – as instruments that are worked on in the field. The surveys seek to determine the municipal situation using different population indicators, such as socioeconomic, environmental and population indicators. Through in-depth interviews, the perceptions and opinions of authorities and public servants are analysed at different levels of autonomous entities, indigenous authorities and other actors linked to the problem. Finally, focus groups are organized to understand the population situation, as well as that of the territory, but above all, to analyse the consequences of climate change, the current strategies used to confront it and the proposals or existing needs in each region.

The information obtained from the surveys is organized into six large groups:

- Migration data;
- Data on the perception of climate change;
- Experience in relation to their perception of the effects of climate disasters;
- Opinion on the causes and consequences of displacement;
- Opinion on the livelihoods available; and
- Perception of community organization in relation to climate disasters.

At this point, it is necessary to show the number of surveys by community, area and nation or indigenous people to which it belongs in the three municipalities.

### 2.2.1. Surveys

**Table 3. Surveys by community, area and self-identification in Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma**

| Municipality | Community | Area | Self-identification | Number of families | Number of people | Number of surveys |
|---|---|---|---|---|---|---|
| **Bolpebra** | San Pedro de Bolpebra | Urban | | 35 | 146 | 18 |
| | Yaminahua | Rural | Yaminahua | 17 | 132 | 8 |
| | San Miguel de Macheri | Rural | Manchineri | 10 | 34 | 11 |
| | | | **Total** | **62** | **312** | **37** |
| **San Ignacio de Moxos** | San Ignacio de Moxos | Urban | | 0 | 10 | 0 |
| | Monte Grande del Alpere | Rural | Moxeño-Ignaciano | 72 | 169 | 7 |
| | San Miguelito de Moxos | Rural | Moxeño-Ignaciano | 36 | 171 | 5 |
| | San Miguel del Matire | | Moxeño-Ignaciano | 29 | 166 | 5 |
| | | | **Total** | **137** | **516** | **17** |
| **Santa Ana del Yacuma** | Santa Ana del Yacuma, D1, D2, D3 | Urban | | 0 | 12 | 10 |
| | San Lorenzo D4 | Rural | Indigenous | 62 | 0 | 14 |
| | Caricacho D4 | Rural | Farmer | 19 | | 7 |
| | Mapajo La Rampa D4 | Rural | Indigenous | 22 | 75 | 12 |
| | Puerto Junín | Rural | Farmer | 36 | 111 | 10 |
| | Soberanía D4 | Rural | Indigenous | 20 | 33 | 15 |
| | Perú Rio Alpere D5 | Rural | Indigenous | 270 | | 5 |
| | | | **Total** | **429** | **231** | **73** |

*Source*: Own elaboration based on the field assessment, 2016.

### 2.2.2. In-depth interviews

The objective of the interviews is to examine topics based on the specific knowledge of the interviewees, whether they are specialists, leaders, people who have had experience in disasters and migration and others. Among the interviews, technical meetings have been incorporated to work on the subject from the perspective of local needs, especially with the technicians of the autonomous municipal governments (Gobierno Autónomo Municipal or GAMs).

**Table 4. Interviews of the population, specialists and authorities from Bolpebra**

| No. | Institution | Name | Position |
|---|---|---|---|
| 1 | Autonomous Municipal Government | Erlin Hurtado Casanova | Honourable Mayor of the Bolpebra municipality |
| 2 | Autonomous Municipal Government | Juan Santos Cruz | Administrative Municipal Secretary |
| 3 | Autonomous Municipal Government | Eliza Artaza | Chairperson of the Local Council |
| 4 | Autonomous Municipal Government | Irineo Martínez | Town Councillor for the San Pedro de Bolpebra community |
| 5 | Autonomous Municipal Government | Almir Flores Muzumbita | Town Councillor for the San Miguel de Machineri community |
| 6 | Autonomous Municipal Government | Elsa Albes | Town Councillor for the Nareuda community |
| 7 | Autonomous Municipal Government | Roly Zeballos Paz | Chief of the Municipal Productive Development Unit |
| 8 | Autonomous Municipal Government | Marcelo Junior López García | Municipal Accountant General |
| 9 | Autonomous Municipal Government | Juan Carlos Flores Vargas | Health Technician Coordinator |
| 10 | | Francisco Moreno Napoleón | Leader of the Machineri |
| 11 | | Batalla Rodríguez Toro | Leader of the Yaminahua |

*Source*: Own elaboration based on the field assessment, 2016.

**Table 5. Interviews of technicians from the Government's Risk Management Unit (Bolpebra)**

| No. | Institution | Name | Position |
|---|---|---|---|
| 1 | Autonomous Municipal Government | Adrián Pérez Campos | Director of Risk Management Unit (Uinidad de Gestion de Riesgos, UGR) |
| 2 | Autonomous Municipal Government | Jean Carla Rivero | Risk Management Coordinator (COED) |

*Source*: Own elaboration based on the field assessment, 2016.

**Table 6. Interviews of authorities from neighbouring countries**

| No. | Institution | Name | Position |
|---|---|---|---|
| 1 | Prefectura de Assis – Brazil | Helen Sabrina Araujo Becerra | Director of the Secretariat for Environment and Tourism |
| 2 | Municipalidad Provincial de Tahuamanu – Iñarapi (Peru) | Juan Y. De la Vega Peña | Chief Executive of the Municipality |

*Source*: Own elaboration based on the field assessment, 2016.

**Table 7. Interviews of the population, technicians and authorities from San Ignacio de Moxos**

| No. | Institution | Name | Position |
|---|---|---|---|
| 1 | UGR, Autonomous Municipal Government – San Ignacio de Moxos | Luis Guaribana Sorich (Engineer) | Technician, UGR Moxos |
| 2 | UGR, Autonomous Municipal Government – San Ignacio de Moxos | Mariano Cuellar Noza | Manager, UGR-M |
| 3 | SENAMHI – Trinidad | Rubén Yujo | Managing Technician, Trinidad |
| 4 | Autonomous Departmental Government of Beni | Diego Cortez González | Director, Protected Areas Departmental Section |
| 5 | Agricultural Promotional Unit, Autonomous Municipal Government – San Ignacio de Moxos | Elena Jiménez Lozano (Engineer) | Managing Technician, Agricultural Promotional Unit |
| 6 | Autonomous Municipal Government – San Ignacio de Moxos | Eliseo Peña | Health Officer |
| 7 | Autonomous Municipal Government – San Ignacio de Moxos | Juan Valero (Engineer) | Technician for the Municipality of Ganadería |
| 8 | Asociación de Ganaderos – San Ignacio de Moxos (The Breeders' Association of San Ignacio de Moxos) | Clovis Lison Barrero | Veterinary Administrator |
| 9 | Autonomous Municipal Government – San Ignacio de Moxos | Juana Rojas Gutiérrez | Officer of Fundraising Management |
| 10 | Sub-municipality of Mojeño Ignatian Indigenous Territory (Sub Alcaldía Territorio Indigena Mojeño Ignaciano) | Rubén Apase (Engineer) | Technician |
| 11 | Federación de Juntas Vecinales de San Ignacio de Moxos (Federation of Neighbourhood Councils of San Ignacio de Moxos) | Cristina Nolvani | President |
| 12 | Women's club "27 de Mayo" | Agustina Muñuni Guarua | President |
| 13 | Autonomous Municipal Government – San Ignacio de Moxos | Jhon Krudenesky (Engineer) | Director of Planning |
| 14 | Autonomous Municipal Government – San Ignacio de Moxos, Desengaño District | Miguel Ortiz Cobene | Sub mayor |
| 15 | Autonomous Municipal Government – San Ignacio de Moxos, San Francisco District | Seribriagkova Menacho Guzmán | Sub mayor |
| 16 | Autonomous Municipal Government – San Ignacio de Moxos | Serafín Marín Jare | Officer for Water and Sanitation |
| 17 | Asociación de Pequeños Ganaderos de San Ignacio de Moxos (Small Breeders' Association of San Ignacio de Moxos) | Sixto Zabala Jare | Vice President |
| 18 | "Tarope" (Non-governmental organization (NGO)) | Absalón Rojas | Technical Liaison Officer |
| 19 | Autonomous Municipal Government – San Ignacio de Moxos | Lorenzo Uche | Administrative and Financial Office |
| 20 | Farmers' Research and Promotion Centre (Centro de Investigacion y Promocion del Campesinado, CIPCA) | Oliver Vaca Ruiz | Head office – San Ignacio de Moxos |
| 21 | Municipal Council, Autonomous Municipal Government – San Ignacio de Moxos | Eddy Taborga Vaca | President |

| No. | Institution | Name | Position |
|---|---|---|---|
| 22 | National Protected Areas Service – Isiboro Sécure National Park and Indigenous Territory (TIPNIS) | Luis Noe Maza | Head Warden of Northern Zone Parks |
| 23 | Autonomous Departmental Government of Beni | Cristian Cámara | Director, Emergency Operations Committee (COE in Spanish) |
| 24 | Amazonian Navigation Improvement Service | Catherine Oliver Saavedra | Head of Geographical Surveying |
| 25 | Airports and Auxiliary Services for Air Navigation Agency (AASANA) | Jesús Hugo Leigue Shavid | National Coordinator of Meteorology |
| 26 | Autonomous Departmental Government of Beni – Secretariat for the Environment | Celia Pérez Chávez (Engineer) | Management Director of the Environment and Biodiversity |
| 27 | Autonomous Departmental Government of Beni – Secretariat for the Environment | María Alejandra Suárez (Engineer) | Technical Officer for Projects |
| 28 | Autonomous Departmental Government of Beni – Secretariat for the Environment | Roberto Carlos Pinto (Engineer) | Administrative Director |
| 29 | Autonomous Government of the Trinidad Beni Municipality | Arnoldo Barba Suárez | Head, UGR – M Municipality Trinidad |
| 30 | Autonomous Departmental Government of Beni | Berman Vaca Julio | Legal adviser, COE – Trinidad |
| 31 | Human Rights Assembly Trinidad | Juan Costa Callau | President of Human Rights Assembly Trinidad |
| 32 | Autonomous Departmental Government of Beni | Diana Soria Suárez | Head of Tourism |

*Source*: Own elaboration based on field assessment, 2016.

To complement the information obtained by the focal group on ancestral knowledge and traditions related to climate and disasters, a meeting with people from the community who had more knowledge of the territory and the climate was organized, in order to rescue and reevaluate their knowledge.

**Table 8. Interviews of the elderly and/or those with knowledge of the communities (Bolpebra)**

| No. | Name | Position |
|---|---|---|
| 1 | Alberto Roca Tibubay | Ancient Sage of San Pedro de Bolpebra |
| 2 | Francisco Flores Da Silva | Ancient Sage of San Miguel de Machineri |
| 3 | Ademar Humberto Merediz | Ancient Sage of Yaminahua |

*Source*: Own elaboration based on field assessment, 2016.

Table 9. Interviews of the elderly and/or those with knowledge of the communities (San Ignacio de Moxos)

| No. | Institution | Name | Position | Date |
|---|---|---|---|---|
| 1 | Abanessa (Women's organization) | Mari Nuni Micha | Traditional leader | 25 August 2016 |
| 2 | Abanessa (Women's organization) | | Traditional leader | 25 August 2016 |
| 3 | Lorenza Pomo (Women's artisanal organization) | Guillermina Cuervo | President | 25 August 2016 |
| 4 | San Ignacio Moxos Town Hall | | Technical adviser | 25 August 2016 |
| 5 | Indigenous Town Hall joint with Macheteros | Juan de Dios Caribe | First traditional leader | 25 August 2016 |
| 6 | "Salvador Chapi Mulba" Ignaciano-Mojeño Institute of Language and Culture | Estanislao Mulba Noza | Coordinator | 26 August 2016 |
| 7 | San Ignacio de Moxos Township | Mariano Matareco Cartagena | Administrator | 29 August 2016 |

*Source*: Own elaboration based on field assessment, 2016.

Table 10. Interviews of the elderly and/or those with knowledge of the communities (Santa Ana del Yacuma)

| No. | Name | Position |
|---|---|---|
| 1 | Ricardo Justiniano Cujuy | Ancient Sage of San Lorenzo |
| 2 | Osman Alvarado Carvallo | Administrator of Caricacho |
| 3 | Amulfo Aguilera L. | Ancient Sage of Mapajo La Rampa |
| 4 | Lidivina Justiniano Rodriguez | Ancient Sage of Puerto Junín |
| 5 | Roque Zelady Limaica | Ancient Sage of Soberanía |
| 6 | Celestino Mole Tonore | Ancient Sage of El Perú Río Apere |

*Source*: Own elaboration based on field assessment, 2016.

### 2.2.3. Focus groups

The focus groups were developed by the field researcher, who coordinated with the technicians of each one of the GAMs to form groups of people and carry out the participatory workshop that collectively managed to identify the organizational forms of the communities in relation to the themes addressed. Focus groups offered information regarding the following:

- The development of a talking map of community climate risks;
- Analysis of the community situation in relation to their livelihoods and economic activity;
- Analysis of the consequences of climate change in the community; and
- In the municipality of Bolpebra, due to the population size of the communities, three focus groups in which 33 people participated were held. In San Ignacio de Moxos, another three focus groups were held, in which 88 people participated. In the municipality of Santa Ana del Yacuma, there were three more focus groups with 81 participants.

Chapter

3

# Geographical and socioeconomic context of municipalities

In recent years, public management has consolidated a comprehensive vision of planning, based on the guidelines proposed in the so-called "living well". In February 2016, the methodology of PTDI was established, whose approach integrates development planning with territorial planning and is oriented towards the management of life systems, risk management and climate change. Under the premise that the biogeographic and climatic elements influence the development of anthropogenic actions and vice versa, the management of life systems seeks to reach the optimal conditions of development without damaging ecosystems, including structural measures for the prevention and reduction of adversities, risks and disasters caused by climate change.[40]

The most significant advance in conceptual planning terms is the symbiosis between integral development and climate change, where the former cannot ignore the effects of the latter and mitigate the same part of a development policy that promotes the conservation of the environment, reducing the vulnerability of both populations and life systems and laying the foundations for the solution of the climate crisis.

With this in mind, establishing the climate change–migration relationship that supports the formulation of municipal public policies requires a situational diagnosis of the municipality in terms of public management methodologies. The objective of this analysis is to generate a panoramic view of the municipality based on the collection of official data.

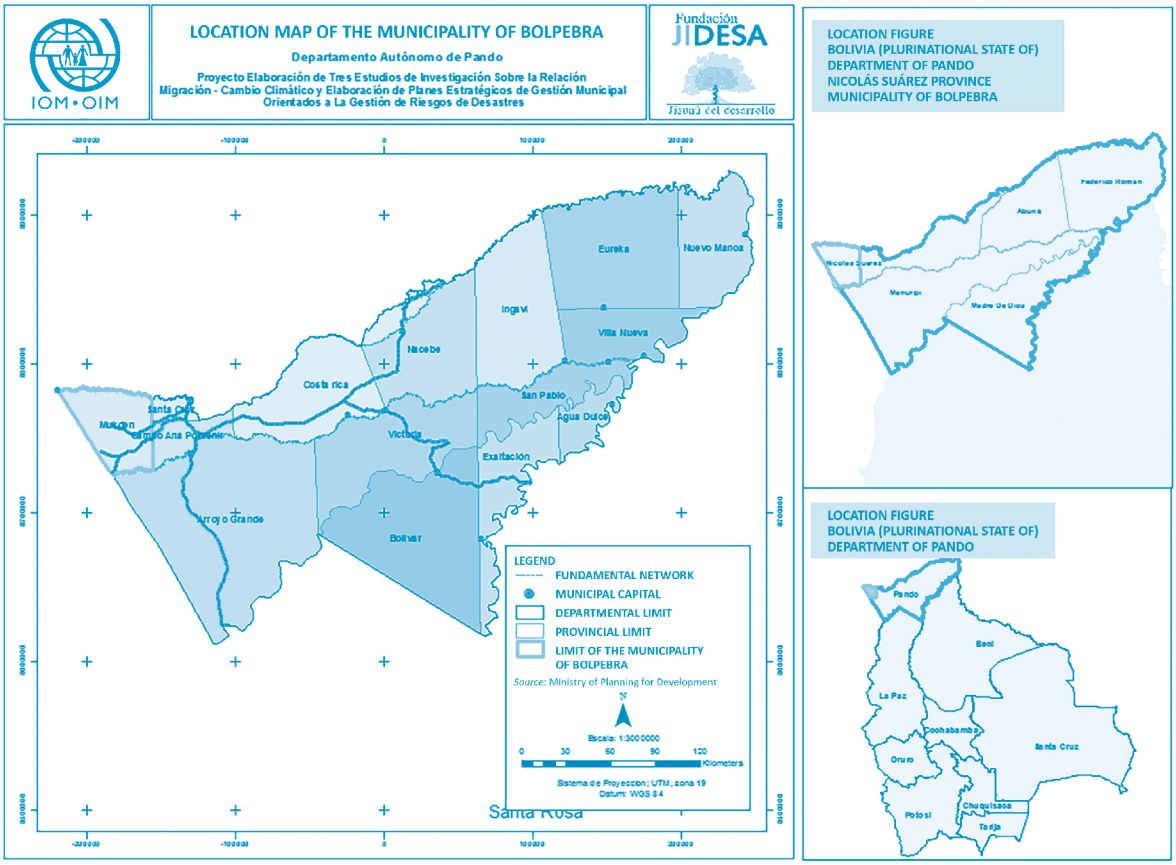
## 3.1. Geographical context of the municipalities of Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma

In this section, the geographical and socioeconomic context of the three municipalities is developed and divided into seven chapters, the order of the municipalities in the study is Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma.

[40] Ministry of Planning, 2016.

### 3.1.1. Natural physical aspects of Bolpebra: Location, limits, extension, ecosystems and climate

Map 1. Location of Bolpebra




*Source*: Own elaboration based on data collected by the author.

*Note*: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by IOM.

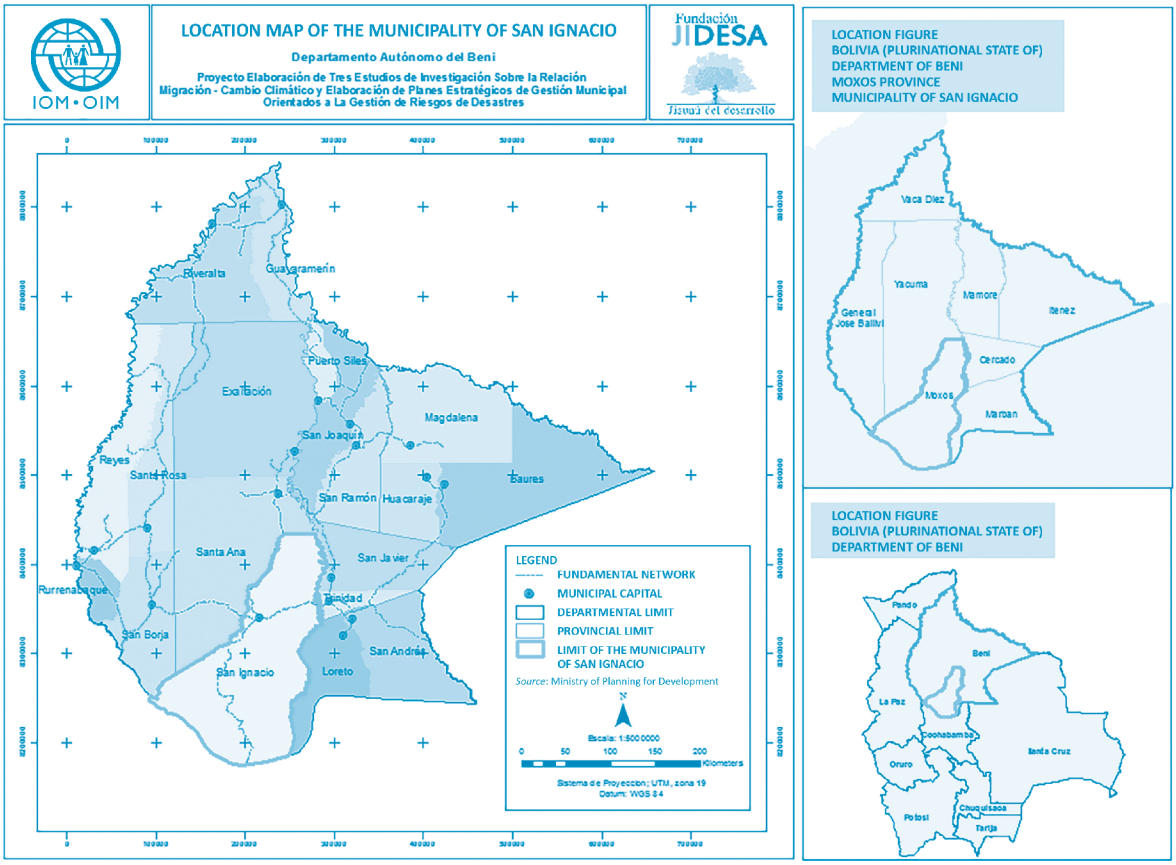
Table 11. Bolpebra location, limits, extension, ecosystems and climate

| Location | Actual surface area | Main ecosystems | Forests and climate in the region |
|---|---|---|---|
| To the north, it borders the state of Acre of Brazil; to the west with the Madre de Dios river of Peru; to the east with the municipalities of Cobija and Porvenir; and to the south with the municipality of Filadelfia. | It is 2,571.2 km$^2$ because there are sectors with undefined municipal limits, but this area may vary. | According to Nature Serve studies for the south-west region of Pando, they are: pressurized mainland forest in the south of the Amazon; evergreen seasonal forest of the peninsula of the south-western Amazon; bamboo forest of the south-west of the Amazon; forest of clear water streams of the south-west of Amazonia; flood-prone forest and riparian vegetation of mixed waters of the Amazon; bodies of water conformed by rivers and lagoons; and areas of anthropic influence. | It identifies the high biodiversity existing in tropical forests, both in the diversity of forest species and animals. Tropical warm climate, with annual average temperatures between 25.4 and 26°C, they vary at different times of the year depending on the change of the seasons. |

*Source*: Own elaboration based on Municipal Development Plan (PDM) – Bolpebra.

### 3.1.2. Natural physical aspects of San Ignacio de Moxos: Location, limits, extension, ecosystems and climate

Map 2. Location of San Ignacio de Moxos




*Source*: Own elaboration based on data collected by the author.

*Note*: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by IOM.

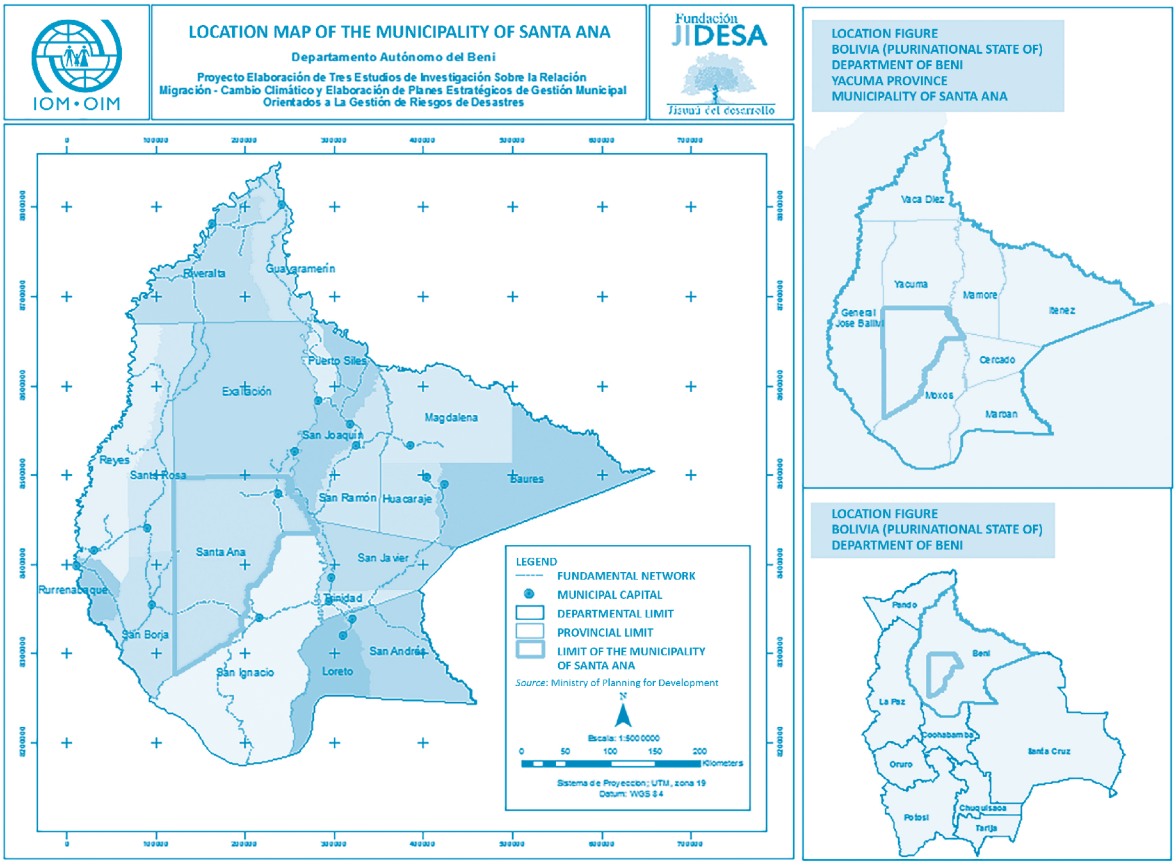
Table 12. San Ignacio de Moxos location, limits, extension, ecosystems and climate

| Location | Actual surface area | Main ecosystems | Forests and climate in the region |
|---|---|---|---|
| In the north, it borders the Cercado and Yacuma provinces; in the south, the department of Cochabamba; in the east, the Marbán and Cercado provinces; and in the west, with the provinces of Yacuma and Ballivián. | It extends over 33,616.1 km$^2$ for the province of Moxos, taking into account that it has only one municipal section. | Sub-Andean mountain range; intermountain alluvial valley; forests that cover 59 per cent of the natural flat savannas and 39 per cent of other areas such as crops and bodies of water, 2 per cent. | The existence of high biodiversity in tropical forests, both in the diversity of forest species and animals; tropical warm climate, with annual average temperatures between 25.4 and 27°C, where the lowest average values (in °C) are registered in the San Ignacio de Moxos region with 24.3°C, increasing towards the San Borja and Rurrenabaque side with 26°C; precipitation decreases from the mountains to the plains. |

*Source*: Own elaboration based on PDM – San Ignacio de Moxos.

### 3.1.3. Natural physical aspects of Santa del Yacuma: Location, limits, extension, ecosystems and climate

Map 3. Location of Santa Ana del Yacuma




*Source*: Own elaboration based on data collected by the author.

*Note*: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by IOM.

Table 13. Santa Ana de Yacuma location, limits, extension, ecosystems and climate

| Location | Actual surface area | Main ecosystems | Forests and climate in the region |
|---|---|---|---|
| In the north, it borders the Vaca Diez province of the municipality of Exaltación; in the south, it borders the province of Moxos; in the east, the province of Mamoré; and in the west, with that of the province of Ballivián. | It extends over 18,346 km$^2$, which constitutes 53.35% of the surface area of the entire province. | Its ecosystems are diverse, such as savannahs, tidal flats, curiches, forest areas, humid forests, rice fields and pastures. | High biodiversity of forest species as animals; warm humid tropical climate, in times of rain and well-marked droughts, as well as the winter thermal change. It has external temperatures of 40°C during hot summer seasons, between the months of August and December, and in the winter months, the temperatures vary between 13 and 18°C, accompanied by intermittent drizzles and high humidity. |

*Source*: Own elaboration based on PDM – Santa Ana del Yacuma.

## 3.2. Territorial planning

### 3.2.1. Districts and cantons of Bolpebra

The municipality of Bolpebra is the second section of the Nicolás Suárez province and divided into two cantons: Mukden and Chapacura. Its territory extends over 18 communities, which are detailed below:

Table 14. Communities of Bolpebra

| No. | Community | No. | Community | No. | Community |
|---|---|---|---|---|---|
| 1 | Extrema | 7 | Nueva Canaán | 13 | San Miguel de Machineri |
| 2 | Nareuda | 8 | San Jorge | 14 | Bioceánica |
| 3 | Vera Cruz | 9 | Arca de Noé | 15 | Canáan |
| 4 | Moliendo | 10 | Yaminahua | 16 | Mukden |
| 5 | Puerto Oro | 11 | San Pedro de Bolpebra | 17 | Villa Marleta |
| 6 | Tres Arroyos | 12 | Nohaya | 18 | Litoral |

*Source*: Own elaboration based on PDM Bolpebra.

#### *Protected areas of Bolpebra*

In the municipality of Bolpebra, there are no conservation areas of national importance, but there are provincial and municipal ones, the most notorious one being the EBT (Biological Station Tahuamanu), a research and training centre for human resources with an area of 50 ha. It is a place where different scientific studies of great academic importance for the region were carried out.

### 3.2.2. Districts and cantons of San Ignacio de Moxos

The territory of Moxos has become the largest municipality of Beni. Geographically and politically, the municipality of San Ignacio de Moxos is divided into seven cantons: San Ignacio, San Lorenzo, San Francisco, Desengaño, Multiethnic Indigenous Territory (Territorio Indígena Multiétnico or TIM), TIPNIS and TIM I.

Table 15. The creation of cantons in the municipality of San Ignacio Moxos

| No. | Community | Legal base for creation |
|---|---|---|
| 1 | San Ignacio de Moxos | D.S. 9-VIII-1856 |
| 2 | San Lorenzo | D.L. 20-XL-1914 |
| 3 | San Francisco | D.L. 9-XII-1937 |
| 4 | Desengaño | To be defined |
| 5 | TIM | To be defined |
| 6 | TIPNIS | To be defined |
| 7 | TIM I | Proposal |

*Source*: National Statistical Institute and Municipal Development Plan, 1997.

### *Protected areas of San Ignacio de Moxos*

In the municipality of San Ignacio de Moxos, there is a protected area of national importance: the Isiboro Sécure National Park and Indigenous Territory (TIPNIS), which has a management plan in accordance with the administration of the National Service of Protected Areas (Servicio Nacional de Áreas Protegidas or SERNAP). The TIPNIS is important, not only for its extension, geographic location and biodiversity, but also for its dual nature as a protected area and indigenous territory, which gives its management and planning a special character. This protected area was created under Decree Law No. 07401 of 22 November 1965 and has among its main objectives the conservation of watersheds, the sources of rivers for navigation, the richness of natural resources and scenic beauty.

## 3.2.3. Districts and cantons of Santa Ana del Yacuma

The municipality of Santa Ana del Yacuma has a canton (José Agustín Palacios) and is divided into six municipal districts, of which three are urban and the rest are rural. The most dispersed populations are found in districts 4, 5 and 6, and they are made up of farming communities and indigenous peoples with the following denominations:

**Table 16. Creation of cantons in Santa Ana del Yacuma**

| No. | Community | Legal base for creation |
|---|---|---|
| 1 | Bonchi | To be defined |
| 2 | El Sanjón | To be defined |
| 3 | Rapulo | To be defined |
| 4 | 10 November | To be defined |
| 5 | TIM | To be defined |
| 6 | Perú Rio Apere | To be defined |

*Source*: Consolidated Municipal Assessment, GAM – Santa Ana del Yacuma (2012).

### *Protected areas of Santa Ana del Yacuma*

In the municipality of Santa Ana del Yacuma, there is a protected area of national interest, which is shared with the municipality of San Borja in the extreme south-east. It is the Biological Station of Beni (Estación Biológica del Beni or EBB), which has a Biosphere Reserve division in the global context of conservation that was recognized by UNESCO in October 1986. The EBB is under the administration of the National Service of Protected Areas (SERNAP).

EBB was created by Supreme Decree No. 19191 of 5 October 1982 as a deconcentrated unit dependent on the National Academy of Sciences to protect the flora, fauna, general water resources and all the biota of the region through research, identification and cataloguing. The statutory framework defines its main objectives and aims as the protection of biodiversity and the generation of study activities. It also establishes its functioning and organization system, as well as the establishment of advisory and financing mechanisms.[41]

[41] SERNAP, 2010.

## 3.3. Means of transportation

Table 17. Means of transportation

| Means of transportation | | |
|---|---|---|
| **Land** | **River** | **Air** |
| **Bolpebra** | | |
| Road network that communicates with the capital from the department of the city of Cobija, as with the rest of the country and bordering populations of neighbouring countries. | For the main rivers: Acre and Tahuamanu form the two basins that run through the municipality and have been used for a long time for the transportation of various products, especially during the chestnut harvest season. | There is no airport, but the community of Extrema has a runway for small vessels that is only used in times of need. Likewise, the community of Bolpebra has an old airstrip which, to this date, is not enabled. |
| **San Ignacio de Moxos** | | |
| Road network that links the capital from the department of Beni-Trinidad; San Ignacio–Trinidad highway (under construction) of approximately 90 km.; San Ignacio to San Borja route of approximately 140 km. Both highways form Route no. 003, which is part of the national road network. | Transportation to the city of Trinidad is not permanent; it only works during the rainy season because conditions do not enable the rivers to allow the navigation of boats, whether they are medium-sized or small-sized, especially in the secondary tributaries, which are underutilized due to lack of cleanliness. | In San Ignacio de Moxos, there is no airport, but there are runways for small planes in the rural area that function occasionally. |
| **Santa Ana del Yacuma** | | |
| It has a network of trunk and neighbourhood roads that link 35% to the communities of the municipal jurisdiction with passenger and freight services. This means land transport is mostly used in the dry season, i.e. from July to November. | Fluvial transport is constant by means of the river Mamoré, which is navigable throughout the year. On the other hand, the inhabitants of the communities use the secondary rivers for transport and communication by use of small boats that mainly allow seasonal navigation, linking populated centres with isolated regions due to the lack of roads. The main connection is the Santa Ana–Trinidad and Santa Ana–Guayaramerín section, in addition to the connection with Brazil. Its purpose is mostly commercial in the transportation of fuel and cargo. | The air service operates at the José Chávez Suárez Airport, where around 30 aircraft with a fixed base operate and which mainly provide air taxi services to localities, residences and communities. It also provides freight and passenger transport. Transporte Aéreo Militar (TAM) is also operating with itineraries to Trinidad, with connections to Cochabamba, Santa Cruz, Potosí, Uyuni, Oruro and La Paz. |

## 3.4. Demographic aspects

### 3.4.1. Municipality of Bolpebra

The 2012 INE data on the municipality of Bolpebra shows a total population of 2,173 inhabitants, of which 923 are women (42.5%) and 1,250 are men (57.5%), which demonstrates that the population is predominantly male. Likewise, the same source indicates that the highest percentage of the population is young, of working age, and that the working ages refers to those older than 10 years old with 75.15 per cent.

The majority of the population is considered to be farmers from the lowlands who come from different communities of the Beni and Pando departments. One of their main characteristics is their knowledge of natural resources because they carry out extractive and collecting activities.

The **indigenous communities** are the Machineri and the Yaminahua, who occupy a territory of 26,675.16 ha provided by the National Institute of Agrarian Reform (Instituto Nacional de Reforma Agraria or INRA), with an approximate population of 60 families.

The **mortality rate** is mostly infantile and ranges between 65 and 91 per thousand births.

The **fertility rate** according to the 2012 paperwork is 128.8 women, which represents 60 per cent of births. There are 466 women of childbearing age per thousand women.

### 3.4.2. Municipality of San Ignacio de Moxos

The National Census shows that in the urban area of San Ignacio, there are 8,893 inhabitants and 1,453 homes, with an average of 6.1 members per household. The population data is 22,656 inhabitants, of which there is a total of 47.6 per cent of the population in the urban area, where 23.8 per cent are male and 23.8 per cent are female. 52.4 per cent of the population live in rural areas, where 29.1 per cent are men and 23.3 per cent are women, according to the 2012 National Institute for Statistics (Instituto Nacional de Estadística or INE) census.[42]

The **main indigenous communities** according to the 2012 INE Census are as follows: (a) Mojeño with 11,522 people; (b) Tsimane with 994; (c) Movima with 590; (d) Yuracaré with 539; and (e) Aymara with 208 people.

There is data from the 1992 administration which shows that the department's **infant mortality rate** was 90 dead children per thousand births.[43]

The **fertility rate** for women of childbearing age is 7 children per woman, and out of a total of 4,614 women, there are 636 births with 137.84 women.

### 3.4.3. Municipality of Santa Ana del Yacuma

Within its territorial jurisdiction, Santa Ana has neighbourhood councils, indigenous communities and farming communities, which all have legal status and are grouped into districts. It has 18,439 inhabitants and according to the 2012 Population and Housing Census (Censo de Población y Vivienda or CPV), the population is more urban than rural with 66.1 per cent, of which 33.9 per cent is female, while 32.2 per cent is male. 33.9 per cent of the population is located in the rural area, where 18.6 per cent is male while 15.3 per cent is female.

The Santa Ana department has 4,585 families distributed in 10 neighbourhood councils and 56 communities concentrated in 6 districts, taking the urban and rural areas into account. The city is classified as being small and has a little more than 12,000 inhabitants; however, it has a limited urban structure, according to the minimum requirements of basic services and trade and service infrastructure.[44]

The mortality rate for the municipality of Santa Ana is 54.15 per cent. In general, this number is the result of dividing the number of deaths of all ages that happened during a given period (usually one

[42] Data: National Institute for Statistics, Census 2012.
[43] Data: Consolidated Municipal Analysis of San Ignacio de Moxos, 2007.
[44] Planning Department of the Municipal Government of Santa Ana del Yacuma, Consolidated Municipal Diagnosis as of 31 May 2014.

calendar year), and the average population of the same period. On the other hand, life expectancy for the municipality of Santa Ana is 60 for men and 65 for women.

The fertility rate according to the 2012 CPV is lower than in 2001; the data shows that the fertility rate per thousand fertile women is 115.2 women who become mothers. In this sense, it can also be stated that the indicators of fertility and birth rates are closely related to the 509 births registered by the INE.

## 3.5. Integral human development

### 3.5.1. Education

Table 18. Integral human development

| Indicators/ Municipalities | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
|---|---|---|---|
| **Illiteracy rate** | The average illiteracy rate among the population is 92.3%; 92.9% corresponds to men and 91.3% to women, which as a result is a high percentage of illiterate people. | The illiteracy rate is 8.88%, with a difference between urban and rural areas of 5.79% and 16.31% respectively. In women, the index is higher than in men, and it should be pointed out that illiteracy is higher in rural areas. | The illiteracy rate in relation to the total population registered with the 2012 administration with 18,439 inhabitants is 11,309 illiterate people, of which 7,444 were women and 3,865 were men. |
| **School attendance** | Of the 79.4% of students that attend the educational units between the ages of 6 and 19, the majority are men. | The 2012 paperwork registered a population of 22,656 inhabitants, of which 47.6% were women and 52.4% were men. It shows only 5.56 average years of study, with higher attendance at the primary level in the last three years than at secondary school, because there are no educational units and students do not finish high school. | The percentage of high school students is 44.23%; 32.25% represent the primary level, followed by students with higher education with 10.97% in university. The students who attend institutes represent 4.34% and the percentage of the population without a level of education is 8.73%.<br>The average years of study is 8.2%, which corresponds to men from urban areas; in the rural areas, 6.3% have the opportunity to study compared to women who have an average of 7.9% years of study. |
| **Infrastructure** | There are 3 educational centres to serve 18 communities that are part of the municipality. There are 17 educational units in the municipality. | There are 108 educational units, of which some are public and some are by convention. There is no data regarding private educational units. | There are 60 educational units registered with the Administrative Resolution of the Ministry of Education, of which 57 are public and 3 are community-based. |

*Source*: Own elaboration based on field diagnosis, 2016.

### 3.5.2. Health

Table 19. Health facilities

| Municipalities/ Indicators | Number of health facilities | Human resources | Traditional medicine | Number of people with special needs |
|---|---|---|---|---|
| **Bolpebra** | In the Distrito II de Salud located in Porvenir, there are 9 first-level establishments; 3 health centres and 6 aid stations.<br>In the territory of Bolpebra, there are: the health centre of Intercultural Community and Family a health centre in the communities of Mukden, another in the community of Bolpebra and an aid station in the community of Biooceánica. | According to the National Health Information System (SNIS) data, the staff consists of:<br>• 1 doctor<br>• 5 nursing assistants | There was a high level of confidence in traditional midwives in the communities. | According to the 2012 INE data, 6 women and 4 men between the ages of 21 and 59 are classed as follows: 4 people with serious with physical disabilities; 4 people with multiple severe disabilities; and 2 people with moderate sensory disabilities. |
| **San Ignacio de Moxos** | There are 6 health centres, 16 aid stations and 2 vehicles including a modern ambulance donated by JICA. | According to the SNIS data, there are:<br>• 4 doctors<br>• 7 nursing assistants<br>• 2 office clerks<br>• 5 support workers and<br>• 2 chauffeurs | The town of Chimanes has conserved ancient knowledge on the use of plants. | There are 177 people registered but out of 110 registered people, there are 90 women, 87 men, 39 adolescents, 101 young adults (between 21 and 59 years old) and 29 adults older than 60.<br>There are 21 classified as having a mild disability, 35 classified with moderate disability, 86 with serious disability and 35 with very serious disability. 108 people are physically disabled, 29 people have intellectual disability, 19 people have sensory disability and 21 with multiple disabilities. Between the ages of 21 and 59, the majority have serious type of physical disability. |
| **Santa Ana del Yacuma** | There are 5 first-level establishments and 2 second-level establishments. | The Human Resources are under the supervision of the hospital of Dr Jacobo Abularach. | In light of the discontinuation of health services, the only alternative for the community is traditional medicine. The healers and indigenous and farming families have knowledge of the curative ability of medicinal plants and other natural products that are generalized as home remedies. | There are 88 people, but only 77 are registered; there are 47 women, 41 men, 19 adolescents, 48 young adults and 17 older adults. |

*Source*: Own elaboration based on field assessment, 2016.

### 3.5.3. Housing and basic services

Table 20. Housing and basic services

| Housing – Basic services and occupational category | | | | |
|---|---|---|---|---|
| **Municipalities** | **Construction material** | **Access to basic services** | **Communication** | **Occupational category** |
| **Bolpebra** | The main material used for 68% of housing is wood; the most used material for roofs is calamine (65% of housing) and the materials predominately used for floors are wooden planks (55% of housing).<br>The number of rooms in houses is no more than two rooms and one kitchen. | The community live in houses, huts or *pahuichis*. Only a few families live in detached rooms (22), in makeshift homes (11) and others (4).<br>Out of the total 508 people who live in houses, huts or *pahuichis*, more than half (289 homes) do not have electric power and only 14 homes are connected to a network. 67 homes have their own motor, 102 have solar panel and 36 have another form of electric power. | Communication on the national and international scale is poor due to problems with satellite links.<br>Some community members have private parabolic antennas for television that function on diesel and gasoline. | There are 1,040 people who are aged 10 and above, of which 656 (63%) work in the agricultural sector, do casual work, forestry or work in the poultry or fish industries. Out of this occupational group, 528 are men. Only 239 women work in any of the categories, as defined by the National Statistical Institute. |
| **San Ignacio de Moxos** | The urban area uses brick, cement, tiles and other materials for construction. The homes in the rural area have two rooms: one used as a bedroom and the other for family activities. Urban houses do not have many bedrooms and they have limited access to basic services. | Private homes (33.7%) have a bathroom inside with water through use of a pipe network. 36.3% have household gas and 69.4% have electric power services. 58.6% of the community in the urban area and 40.4% in the rural area have access to basic sanitation services, with the average being 33.7% of the municipality's population. | They have a significant radio communication system that provides personal services and is official for the organizations. Firstly, it is useful for communication between members of the community. Second of all, the system allows for the flow of information between organization leaders and members, according to the established schedule. | 4,054 people are involved in the agriculture, breeding, hunting, fishing and pisciculture sectors, of which 3,208 are men and 846 are women who are all involved in productive activities. Secondly, there are 1,936 people who are involved in unspecified activities, of which 1,243 are women and 693 are men. Thirdly, there is commerce, transport and stores with 1,077 people; 609 are men and 468 are women. |

| Housing – Basic services and occupational category | | | | |
|---|---|---|---|---|
| **Municipalities** | **Construction material** | **Access to basic services** | **Communication** | **Occupational category** |
| **Santa Ana del Yacuma** | 85% of the semi-urban population have built their homes with local materials, while 15% have used bricks, tiles or mud.<br>Homes have only three rooms, which demonstrated that there is a high level of overpopulation; 50% have access to water while 82.7% have access through pipes. | 82.7% have access to electric power, 87.6% have access to a bathroom, 33.4% have access to a sewer, 38.1% have a sewer at home and 56.6% have access to gas. | There are telephone network services for home and for mobile phones, as well as private Internet services. There are delegated cabins that provide departmental telephone services, both nationally and internationally. The majority has shortwave radio communication equipment and radio communication chains with sub-central for the indigenous communities Movimas Santa Ana (SPIM Santa Ana) sub-central for the multi-ethnic indigenous territory (TIM San Ignacio) and the Centre for Indigenous People of Beni (CE-PIB) in Trinidad. | For the economic activities, such as in the agricultural, hunting, fishing and pisciculture sectors, there are 2,944 people, of which 2,290 are men and 654 are women. In the mining and hydrocarbon sectors, there are 18 people, of which 13 are men and 5 are women. In the manufacturing industry, there are 595 people, of which 356 are men and 239 are women. For economic activities in the electricity, gas and water sectors, among others, there are 28 people, of which 19 are men and 9 are women. There are 530 people who work in construction, of which 512 are men and 18 are women, while in the trading and transport sectors, there are 1,286 people, of which 756 are men and 530 are women. Finally, there are 2,182 people, of which 736 are men and 1,446 are women, who work in other sectors. |

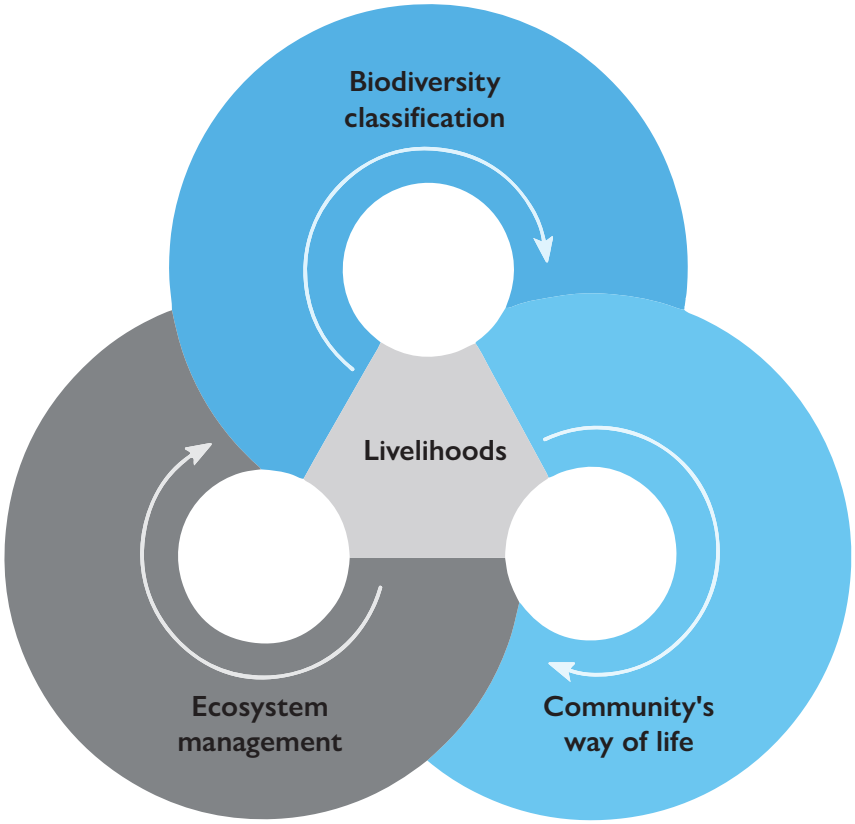
*Source*: Own elaboration based on field assessment, 2016.

## 3.6. Life systems

### 3.6.1. Life systems in Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma

The conceptualization of life systems encompasses the analysis of how biodiversity behaves in different ecosystems and their physiographic units (bodies of water, wetlands, forests, plains, alluvial plains and highlands) that interact to determine the life forms they have in the communities.

**Figure 3. Life systems as a centre of community interaction in Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma**




*Source*: Own elaboration based on data from Caritas – Plurinational State of Bolivia.

Table 21. Life systems in Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma

| Life systems | | | | |
|---|---|---|---|---|
| **Municipality** | **Life systems** | **Agricultural production** | **Livestock and fish production** | **Forestry production** |
| **Bolpebra** | The ecosystem faces different degrees of pressure on its conservation and use of natural resources. | One of the people's main activities in communities and individual lands is agriculture. The most important products grown are rice, cassava, banana, maize, beans and vegetables. The cultivated area in the municipality of Bolpebra ranges between 1 and 2.5 ha per family in the communities. For individual lands, in some cases, the area is larger, even reaching up to 5 ha. The traditional cultivation system is used, where the returns are lower because they depend on the soil conditions and availability of labour force. | Closely related to livestock farming by extensive use, low productivity and investment in infrastructure. This low investment is due to the fact that establishing cultivated pastures is a requirement because the pastures usually in the production zones are natural. | Logging companies and forest concessions, some private and community owners.<br>Domestic use oriented to the construction of houses and other buildings, farmyards and a small proportion of work tools of the inhabitants. |
| **San Ignacio de Moxos** | The systems face different degrees of pressure on their conservation and use of natural resources. | It is not on a large scale; it is more oriented towards self-supply. | It originates from the introduction of subsequent beef cattle by Jesuit missionaries in the plains of Moxos. Livestock in Beni supplies 60% of the country's consumption.<br>Pisciculture in the communities of Moxos is an alternative to food and trade. The communities involved in these activities are organized by the Indigenous Fish Farmers' Association of Moxos (Asociación de Piscicultores de Moxos or ASOPIM). It has around 200 families distributed in 24 communities of 2 indigenous territories who are members | It is important in the municipality due to the presence of logging companies who exploit the diversity of forest species and in this part of the territory they are abundant. |

| Life systems | | | | |
|---|---|---|---|---|
| **Municipality** | **Life systems** | **Agricultural production** | **Livestock and fish production** | **Forestry production** |
| **Santa Ana del Yacuma** | Immense floodplain areas of alluvial origin with a call for use in extensive farming, carried out mainly by cattle ranches. | The agricultural production system in all communities of the municipality are characterized by the use of the rustic, empirical and manual method that consists of slash-and-burn activities of four monocultures constituted by several varieties of rice, maize, banana and cassava. | With regards to livestock activity, there are two types of production: the small-scale diversified communal and familial type, and the corporate one. In the farming communities, given their economic conditions, activities such as rearing, fattening and animal reproduction are carried out using rustic methods. Reading livestock is in the open and without regular support of technical staff. Fishing activities are secondary for farming and indigenous communities, and its use is oriented more towards family consumption and occasional sale that is carried out to cover contingencies.<br>Fish production in the municipality is a prospective for biogeographic characteristics and the existence of abundant natural water sources in rivers, streams and lagoons. | There are two forestry production systems:<br>(a) The corporate system, under the responsibility of six concessionary logging companies, of which two are located in the jurisdiction, the other two have a concession area that also covers part of the Ballivián province. The remaining are in a similar situation to that of the Moxos province.<br>(b) The traditional and artisanal system occasionally used by community members or third parties. |

*Source*: Own elaboration based on field assessment, 2016.

## 3.7. Territorial administration

Table 22. Territorial organization

| Municipalities | | | |
|---|---|---|---|
| **Institutions** | **Bolpebra** | **San Ignacio de Moxos** | **Santa Ana del Yacuma** |
| **Central government** | • District Directorate of Health<br>• District Directorate of Education<br>• Bolivian Police (3 police posts)<br>• Armed Forces (Military Post of Bolpebra)<br>• Research and Production Center for the Amazon<br>• Servicio Nacional de Sanidad Agropecuaria e Inocuidad Alimentaria (SENASAG)/Programme for the eradication of foot-and-mouth disease | • District Directorate of Education<br>• Local Directorate of Health<br>• District Attorney's Office<br>• Civil Law Notary Public<br>• Civil Registrar<br>• Departmental Roads Service<br>• Children's Ombudsman<br>• Banco Union<br>• Technical University of Beni<br>• State Revenue Service<br>• SENASAG<br>• Bolivian Police<br>• Naval Force | • District Directorate of Education<br>• District Directorate of Health<br>• District Attorney's Office<br>• Civil Law Notary Public<br>• Children's Ombudsman<br>• Banco Union<br>• AASANA<br>• Yacimientos Petrolíferos Fiscales Bolivianos<br>• State Revenue Service<br>• SENASAG<br>• Bolivian Police<br>• Naval Force |
| **Municipal government** | Autonomous Municipal Government of Bolpebra (Functions in Cobija while plots are built in San Pedro de Bolpebra)<br>• Mayor<br>• Municipal Council<br>• Municipal Government Committee<br>• Municipal Institutional Development Committee<br>• Sustainable Human Development Committee<br>• Citizen and Territorial Development Committee<br>• Ethics Committee<br>• Association for the Municipalities of Pando, which functions in Cobija, but the municipality of Bolpebra is affiliated | Autonomous Municipal Government of San Ignacio de Moxos<br>• Mayor<br>• Municipal Council<br>• Municipal Secretary for Administrative Finances<br>• Municipal Technical Secretariat for Territorial Development<br>• Municipal Technical Secretariat for Human Development | Autonomous Municipal Government of Santa Ana del Yacuma<br>• Mayor<br>• Municipal Council<br>• Secretariat for Higher Financial Administration<br>• Secretariat for Human Development and Production |

| Municipalities | | | |
|---|---|---|---|
| **Institutions** | **Bolpebra** | **San Ignacio de Moxos** | **Santa Ana del Yacuma** |
| **Private institutions** | • World Wildlife Fund (WWF), international organization for wildlife conservation and endangered species<br>• Fundación Yangareko, a non-profit organization<br>• Fundacion Jose Manuel Pando<br>• Agro-Extractive Integrated Cooperative of Pando (Cooperativa Integral Agroextractivista de Pando or COINACAPA)<br>• Center for Legal Studies and Social Research (Centro de Estudios Jurídicos e Investigación Social or CEJIS) | • CIPCA<br>• Tarope (NGO)<br>• Farmers' Association of San Ignacio de Moxos<br>• Hoyan Moxos (NGO)<br>• Cooperation with the Canary Islands<br>• Bank of Promotion and Development of the Micro Enterprise PRODEM<br>• Bank for Small and Medium Enterprises (ECOFUTURO)<br>• Cooperative for Saving and Credit (CATRI Ltda) | • Cooperative for Electric Energy Services (Cooperativa de Servicios de Energía Eléctrica or COSEY)<br>• Cooperative for Water (Cooperativa de Agua or COPAGUA)<br>• Cooperative for Movima Telephones (Cooperativa de Teléfonos Movima or COTEMO)<br>• Cooperative for Saving and Credit (CACTRI Ltda)<br>• Polytechnic of the Technical University of Beni<br>• PRODEM<br>• Financial Development Institution CRECER<br>• Institute of Commerce (INCOS) Santa Ana<br>• Mobile Telephone Network (TIGO), Telecommunications Operator (VIVA)<br>• CIPCA |
| **Indigenous organizations** | • Indigenous People's Assembly of Pando (Central Indígena de Pueblos Originarios de Pando or CIPOAP)<br>• Branch office of the Union Federation of Bolivian Farmers (Sub central de Federación Sindical Única de Trabajadores Campesino de Bolivia or FSUTCB) | • Indigenous branch offices, new supra communal organizations, also called community associations, conformed by the affiliation of the communities through the town halls or indigenous leaders | • Branch office for the Movima Indigenous People (Subcentral de Pueblos Indígenas Movimas or SPIM)<br>• Confederation of Farmers in the Province of Yacuma<br>• Indigenous town hall<br>• Indigenous leaders of TIM |
| **International organizations** | • Amazon Cooperation Treaty Organization – Madre de Dios (Peru) Acre (Brazil) Pando (Bolivia) | • Food and Agriculture Organization of the United Nations | |

*Source*: Own elaboration based on field assessment, 2016.

Chapter

4

# Diagnosis of the relationship between migration and climate change

Climate change, as a global problem studied from a rather abstract scientific perspective, is considered a problem in the municipalities of this study in the context of public management and knowledge.

## 4.1. Climate change in Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma

### 4.1.1. Climatological data and climate change

Climate change is not a precise meteorological reference, since it is the product of the use of climatological data and analyses aimed at establishing climatic trends in a given space and period of time. In this sense, climatological analyses are presented on the historical evolution of temperatures and its trends, as well as on precipitation. Subsequently, based on information from the State Integral Planning System Information Platform (Plataforma de Información del Sistema de Planificación del Estado or INFO-SPIE), the climatic classification of the municipalities involved in the study and their main meteorological indicators recorded in the area are determined.

It should be noted that climate analysis is a highly complex scientific field because it articulates numerous scattered and individual scientific contributions, taking into account an immense amount of data, models and studies that determine trends and what they are used for, including networks of high-capacity teams. For these reasons and for the scientific rigour of this study, it should also be noted that their data are important for each municipality, but they also have a relative connotation in the processing of climate change knowledge. It is important to assume the information obtained, as a particular analysis that offers a graphic approximation of the climate situation in the municipality and not definitive data that "demonstrate" climate change.

In the Plurinational State of Bolivia, SENAMHI is the entity in charge of carrying out the control and technical management of meteorological activities, creating specialized products in the areas of hydrology, agro-meteorology, climatology and forecasting.

In the **municipality of Bolpebra** located in the department of Pando, there is no meteorological station, so data from Cobija Airport – located at latitude -11.0397, longitude -68.7803 and altitude 233 – was used.

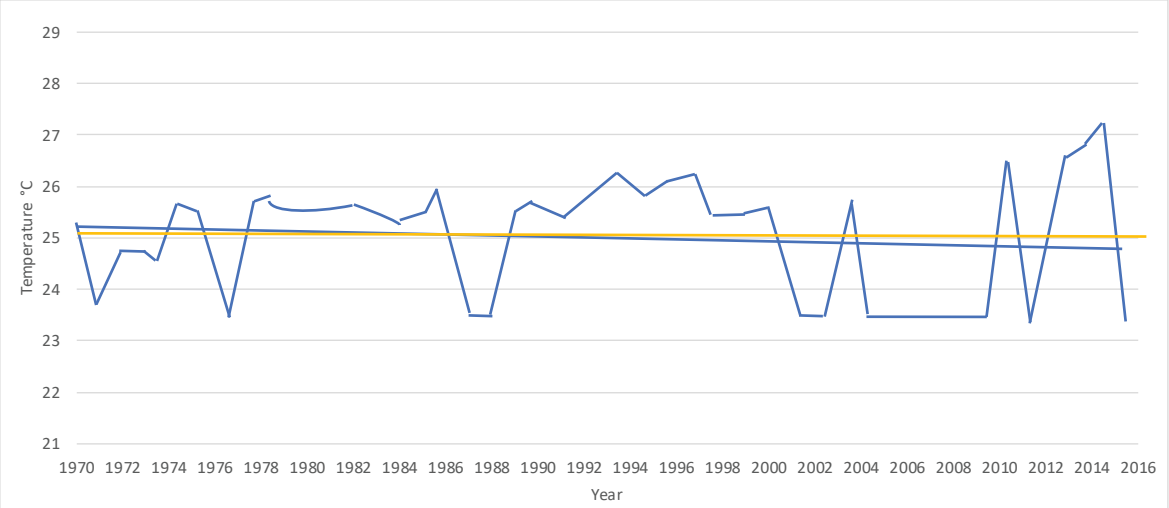
In the **municipality of San Ignacio de Moxos** located in the department of Beni, there is also no meteorological station so data was taken from San Ignacio Airport, located at latitude -14° -80'19", longitude 65°-63'22" and altitude 160 m above sea level.

Finally, with regards to the **municipality of Santa Ana del Yacuma** located in the department of Beni, the data was used from the meteorological station Santa Ana Airport at the following location: latitude -13.7617, longitude -658.4344 and altitude 144.

### 4.1.2. Analysis of climate change in the municipalities

The analysis of the historical evolution of temperature in the municipalities is essential. To carry out this study, the data recorded at the meteorological station in the area and the annual figures offered by SENAMHI were taken into account, analysing the general trend of the temperature. As it can be observed, there is a slight declining trend; this is significant because low temperatures are extended for a longer period of time than high temperatures.

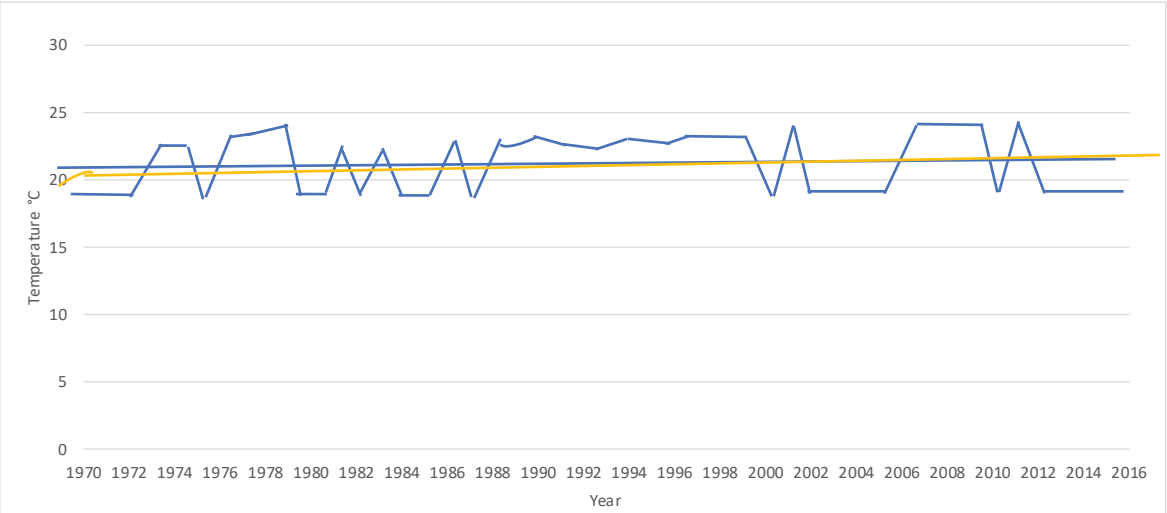
**Figure 4. Average change in the average temperature in Bolpebra during the period 1970–2016**




*Source*: Own elaboration based on data collected by the author.

In the case of this municipality, the graphical data is significant; the temperature in the thirties from 1986 to 2015 is higher than in the twenties from 1970 to 1989. Furthermore, taking the last 5 years of the first 30 years mentioned, it can be seen that it is greater than the average of 30 years; this is because the temperature of the last five years is so high that even exceeds the average of its group of 30 years. Temperatures in November, December, January and February decline and remain unchanged until June, and then the temperature rises from July to October.

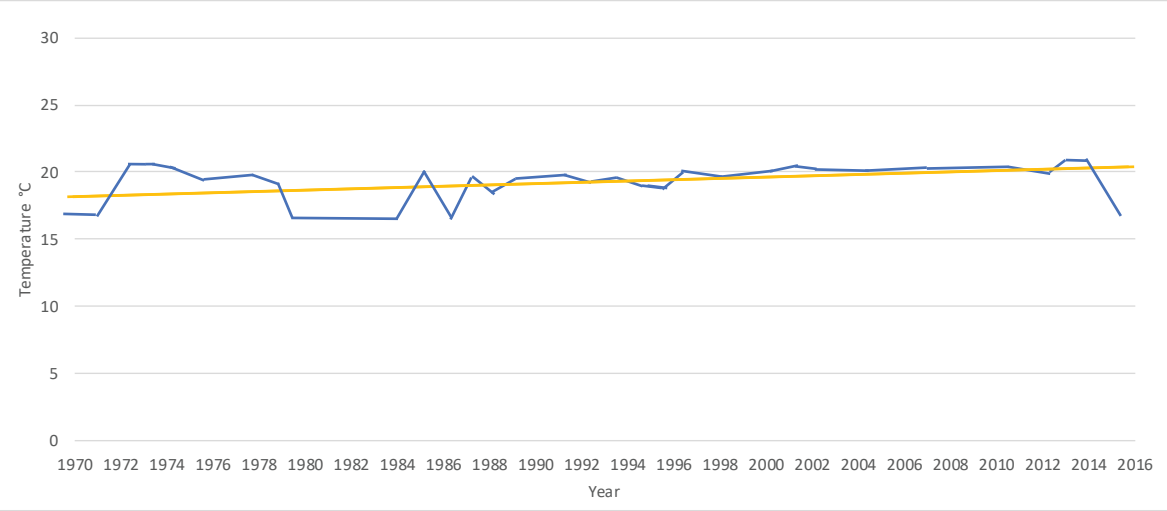
**Figure 5. Average change in the maximum temperature in San Ignacio de Moxos during the period 1970–2016**




*Source*: Own elaboration based on data collected by the author.

In the case of San Ignacio de Moxos, the graphical data is significant; the temperature in the thirties from 1986 to 2015 is greater than that of the twenties from 1974 to 1993. Moreover, taking the last 5 years of the thirties 1986 to 2015, it can be seen that it is greater than the average of 30 years; this is because the temperature of the last five years is so high that even exceeds the average. On the other hand, the analysis that emerges from the temperatures in the wet season highlights that in November, December, January and February temperatures fall, and remain low until June, then increase from July to October.

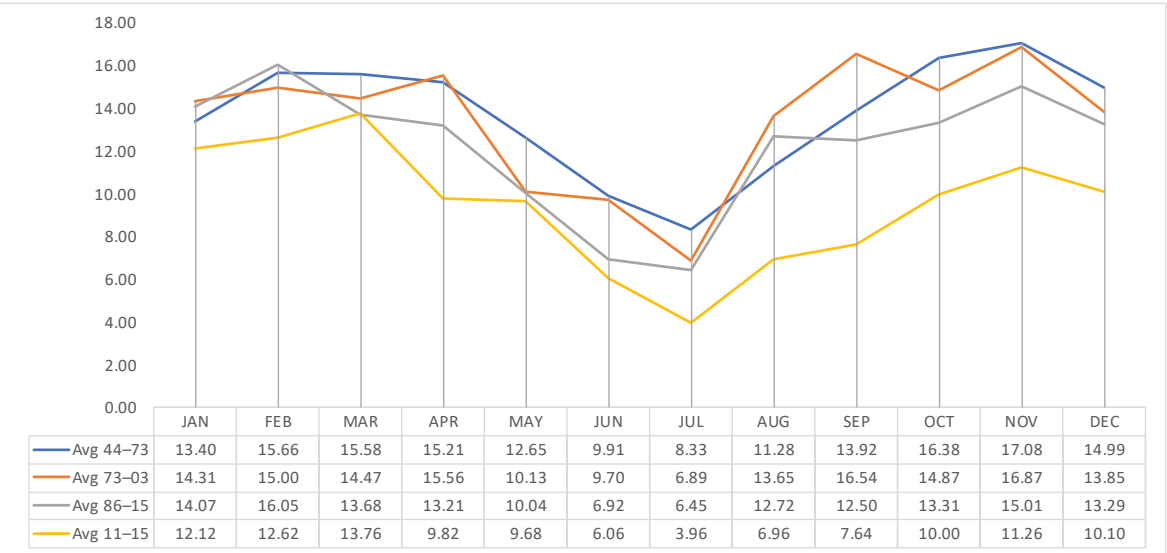
**Figure 6. Change in the average temperature in Santa Ana del Yacuma for the period 1970–2016**




*Source*: Own elaboration based on data collected by the author.

The graphical data is significant; the temperature in the thirties from 1986 to 2015 is greater than that of the twenties from 1974 to 1993. Moreover, taking the last 5 years of the 30-year period from 1986 to 2015, it can be seen that it is greater than the average of 30 years, this is because the temperature of the last five years is so high that even exceeds the average. As in the other cases, the temperature analysis shows that they fall from April to August and increase from September to April.

**Figure 7. Variation in the average rainfall in Bolpebra, 1973–2003; 1986–2015; 2011–2015**

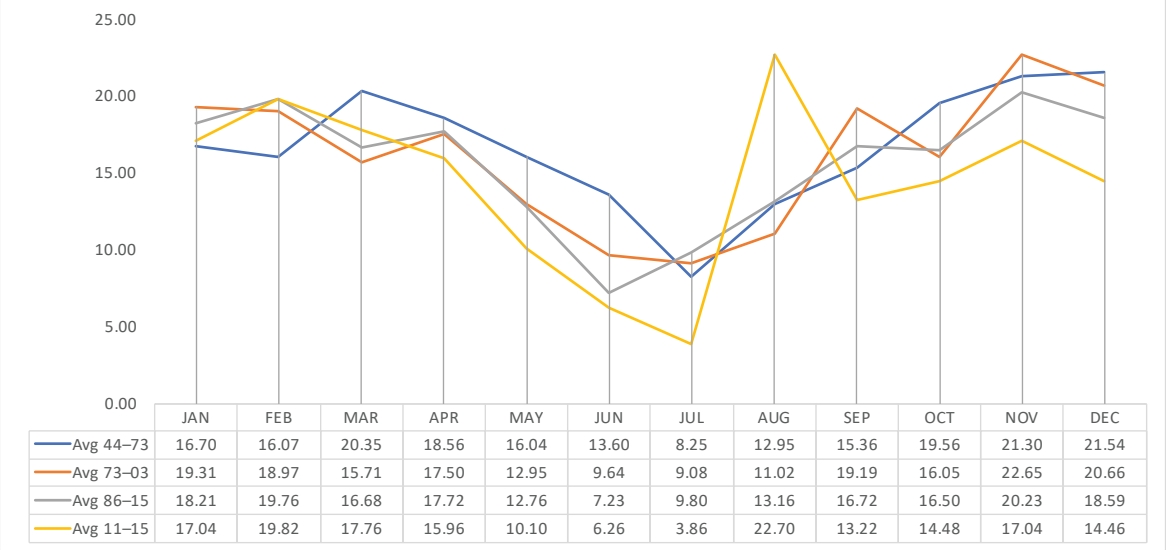



| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg 44–73 | 13.40 | 15.66 | 15.58 | 15.21 | 12.65 | 9.91 | 8.33 | 11.28 | 13.92 | 16.38 | 17.08 | 14.99 |
| Avg 73–03 | 14.31 | 15.00 | 14.47 | 15.56 | 10.13 | 9.70 | 6.89 | 13.65 | 16.54 | 14.87 | 16.87 | 13.85 |
| Avg 86–15 | 14.07 | 16.05 | 13.68 | 13.21 | 10.04 | 6.92 | 6.45 | 12.72 | 12.50 | 13.31 | 15.01 | 13.29 |
| Avg 11–15 | 12.12 | 12.62 | 13.76 | 9.82 | 9.68 | 6.06 | 3.96 | 6.96 | 7.64 | 10.00 | 11.26 | 10.10 |

*Source*: SENAMHI-Cobija meteorological station.

The analysis of the average rainfall in the municipality also has temperature data, between the periods 1944 and 1973; 1973 and 2003; 1986 and 2015; and from 2011 to 2015. The last five years of rainfall that can be compared with the three thirteenths have a very particular dynamic – they are smaller in relation to the three periods compared; this is mainly due to the fact that the highest rainfall occurs from July to August, decreasing in September and then remaining relatively constant until March and decreasing abruptly until July.

**Figure 8. Variation in average precipitation in Santa Ana del Yacuma, 1944–1973; 1973–2003; 1986–2015; and 2011–2015**

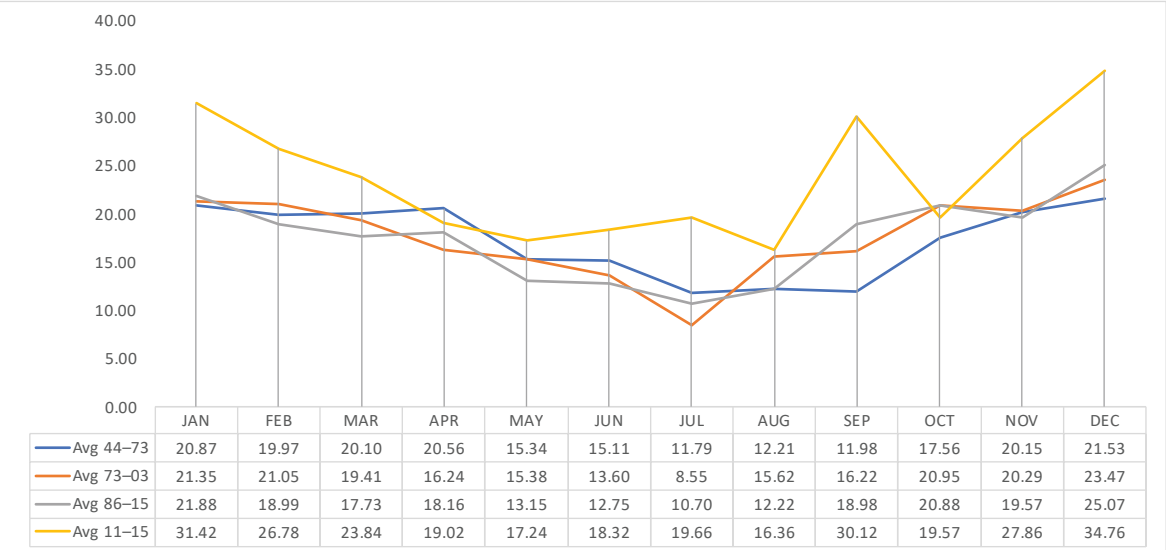



| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg 44–73 | 16.70 | 16.07 | 20.35 | 18.56 | 16.04 | 13.60 | 8.25 | 12.95 | 15.36 | 19.56 | 21.30 | 21.54 |
| Avg 73–03 | 19.31 | 18.97 | 15.71 | 17.50 | 12.95 | 9.64 | 9.08 | 11.02 | 19.19 | 16.05 | 22.65 | 20.66 |
| Avg 86–15 | 18.21 | 19.76 | 16.68 | 17.72 | 12.76 | 7.23 | 9.80 | 13.16 | 16.72 | 16.50 | 20.23 | 18.59 |
| Avg 11–15 | 17.04 | 19.82 | 17.76 | 15.96 | 10.10 | 6.26 | 3.86 | 22.70 | 13.22 | 14.48 | 17.04 | 14.46 |

*Source*: SENAMHI – Santa Ana del Yacuma meteorological station.

The dynamics of the rainfall occur between October and April, while between May and August, they decrease. The last five years, compared to the three thirteenths, have much more irregular trends, since the highest rainfall occurs from July to August, decreasing in September and remaining relatively constant until March, before falling abruptly until July. There is a radical variation of this period compared to the three thirty-year periods chosen, in addition to a greater rainy season in the humid months and then rainfall in the dry months.

**Figure 9. Variation of the average precipitation in San Ignacio, 1944–1973; 1973–2003; 1986–2015; and 2011–2015**




| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg 44–73 | 20.87 | 19.97 | 20.10 | 20.56 | 15.34 | 15.11 | 11.79 | 12.21 | 11.98 | 17.56 | 20.15 | 21.53 |
| Avg 73–03 | 21.35 | 21.05 | 19.41 | 16.24 | 15.38 | 13.60 | 8.55 | 15.62 | 16.22 | 20.95 | 20.29 | 23.47 |
| Avg 86–15 | 21.88 | 18.99 | 17.73 | 18.16 | 13.15 | 12.75 | 10.70 | 12.22 | 18.98 | 20.88 | 19.57 | 25.07 |
| Avg 11–15 | 31.42 | 26.78 | 23.84 | 19.02 | 17.24 | 18.32 | 19.66 | 16.36 | 30.12 | 19.57 | 27.86 | 34.76 |

*Source*: SENAMHI – San Ignacio Meteorological Station.

The trends show that the highest rainfall occurs from October to April, then decreases from May to August. There is a radical variation in the increase in rainfall over the three selected thirteenths; likewise, there is greater precipitation in the humid months and then smaller precipitations in the dry ones.

### *Vulnerability indicators of the municipality*

The vulnerability index that will be used[45] is formulated by UDAPE and relates the vulnerability indexes of each municipality with the whole country, to locate it at a point in the spectrum of possible situations; in other words, the vulnerability index is the relative position of the municipality in each one of the indicators, with respect to the other municipalities of the country.

There are two types of vulnerability: (a) physical vulnerability; and (b) socioeconomic vulnerability. Regarding the first case, it is identified with the exposure that allows to understand the degree of population exposure to disasters. In the second case, its dimensions are seen in the following: (a) people who require assistance; (b) insufficient living conditions; (c) infrastructure; (d) differences between groups; and (e) information on prevention.

**Table 23. Vulnerability in the municipality**

| Aggregate vulnerability population | | | | | |
|---|---|---|---|---|---|
| Socioeconomic vulnerability | | | | | Vulnerability |
| Prevention information | Difference between groups | Infrastructure | Insufficient living conditions | People who require assistance | Exposure |
| Households without telephone | Female head of household | Educational establishment | Unemployment | Children | Childbearing |
| Households without Internet | Self-identification as indigenous | Health establishment | Financial access | Rate of dependence | Housing per $km^2$ |
| Households without TV | Native language | | Poverty | Older adults | Road density |
| Households without radio | | | Car | Disabled people | Population density |
| | | | Education | | Agricultural activities |
| | | | Poor housing | | |

*Source*: Ministerio de Planificación del Desarrollo (MPD), Fondo de Población de las Naciones Unidas (UNFPA) and UDAPE, 2015.

Poverty is not only measured by GDP per capita, income, inequality or the Gini, but by means of various economic and social indicators. For this reason, vulnerability is related to poverty.[46]

For this study, vulnerability is the determination of the factors of these indicators for the municipality, whose ranges are defined in five segments at the national level. Therefore, in this category, the actions of the same communities and individuals are not taken into account to respond to climatic events, although they are later assumed at the point of resilience.

[45] Ministerio de Planificación del Desarrollo (MPD), Fondo de Población de las Naciones Unidas (UNFPA) and UDAPE, 2015.
[46] Castaño Mesa, 2007.

According to this methodology,[47] the municipal vulnerability indexes are as follows:

**Table 24. Consolidated vulnerability of floods, droughts and forest fires of Bolpebra, San Ignacio de Moxos and Santa Ana del Yacuma**

| Exposition | Gobierno Autónomo Municipal de Bolpebra | Gobierno Autónomo Municipal de San Ignacio de Moxos | Gobierno Autónomo Municipal de Santa Ana de Yacuma | Low | Medium low | Medium | Medium high | High |
|---|---|---|---|---|---|---|---|---|
| Agricultural community (%) | 62.3 | 42.82 | 33.54 | 36.91 | 51.05 | 61.39 | 71.55 | 88.83 |
| Population density (inhabitants/km$^2$) | 0.82 | 1.03 | 0.89 | 2.65 | 6.29 | 13.94 | 30.22 | 2 407.70 |
| Road density (km. of paved roads per km$^2$) | 0 | 0.006 | 0.003 | 0 | 0.011 | 0.025 | 0.046 | 12 386 |
| Crude birth rate (number of births per year/total population *1,000) | 20.57 | 21.2 | 22.6 | 21.07 | 22.54 | 23.92 | 25.53 | 31.10 |
| **People who require assistance** | | | | | | | | |
| Population rate of people with a disability | 3.22 | 2.42 | 2.7 | 2.3 | 2.77 | 3.14 | 4.02 | 6.96 |
| Dependency rate (number of people between 0 and 14 years old/number of people between 15 and 64 years old *100) | 45.19 | 53.12 | 50.37 | 43.94 | 45.9 | 47.52 | 20.22 | 56.48 |
| Dependency rate (number of people between 0 and 14 years old/number of people between 15 and 64 years old *100) | 3.36 | 5.21 | 5.32 | 4.7 | 6.72 | 8.48 | 10.56 | 2.47 |
| Percentage of the child population | 36.08 | 40.61 | 37.29 | 29.03 | 31.9 | 34.71 | 37.41 | 44.83 |
| **Living conditions** | | | | | | | | |
| Percentage of poor housing | 95.64 | 70.1 | 54.88 | 61.6 | 82.64 | 92.13 | 95.96 | 99.75 |
| Percentage of the population with secondary level of education (based on people aged 4 and over) | 40.1 | 49.5 | 47.3 | 51.66 | 45.75 | 39.86 | 35.5 | 30.10 |
| Percentage of households without a car | 86.39 | 93.59 | 90.6 | 79.22 | 85.15 | 89.88 | 93.33 | 98.36 |

[47] MPD, UNFPA and UDAPE, 2015.

| Exposition | Gobierno Autónomo Municipal de Bolpebra | Gobierno Autónomo Municipal de San Ignacio de Moxos | Gobierno Autónomo Municipal de Santa Ana de Yacuma | Low | Medium low | Medium | Medium high | High |
|---|---|---|---|---|---|---|---|---|
| Unsatisfied basic needs (UBN) | 75.84 | 75.26 | 55.54 | 55.12 | 69.03 | 79.13 | 87.07 | 97.94 |
| Financial access rate | 0 | 0.2 | 0.17 | 1 | 0.31 | 0.15 | 0.04 | 0 |
| Number of unemployed people/active population | 1.34 | 0.71 | 1 | 0.55 | 0.75 | 0.97 | 1.4 | 9.05 |
| **Establishment** | | | | | | | | |
| People by health establishment | 543.25 | 659.81 | 3073.17 | 961.77 | 1370.6 | 1893.67 | 2854 | 13 620.00 |
| People by educational establishment | 61.53 | 97.51 | 206.02 | 113.4 | 146.81 | 196.97 | 322.25 | 4 169.20 |
| **Differences between social groups** | | | | | | | | |
| Percentage of people who speak an indigenous language | 10.72 | 14.81 | 5.69 | 9.73 | 26.16 | 55.3 | 75.73 | 90.83 |
| Percentage of people who speak an indigenous language since childhood | 11.44 | 15.64 | 5.96 | 10.23 | 27.34 | 57.53 | 78.08 | 94.20 |
| Percentage of people who self-identify as indigenous | 29.08 | 79.04 | 71.47 | 42.9 | 71.43 | 86.12 | 91.96 | 98.12 |
| Percentage of female heads of households | 17.82 | 27.12 | 31.37 | 26.37 | 30.55 | 33.87 | 37.94 | 46.14 |
| **Prevention information** | | | | | | | | |
| Percentage of households without radio | 53.54 | 36.65 | 38.58 | 19.92 | 25.81 | 31.72 | 41.91 | 77.31 |
| Percentage of households without television | 82.21 | 55.01 | 37.98 | 38.75 | 55.68 | 67.72 | 79.77 | 97.33 |
| Percentage of households without Internet | 100 | 98.43 | 97.74 | 96.44 | 98.69 | 99.46 | 99.76 | 100.00 |
| Percentage of households without telephone | 97.28 | 54.57 | 42.32 | 39.11 | 54.84 | 62.51 | 75.58 | 97.28 |

*Note*: The education data was taken from the enrolment in secondary education rate as there was no conclusive data on secondary education.

*Source*: Own elaboration based on the UNFPA-UDAPE methodology, 2015.

### *Bolpebra*

In the municipality of Bolpebra, physical vulnerability is low with respect to population density, road density, housing per square kilometre and birth rate, since they do not show a large concentration of the population, nor is there an accelerated population growth that generates difficulties for planning and assistance in emergencies. However, the percentage of population dedicated to agricultural activities is high, which translates into a significant sector of the population that is mostly exposed to the loss of their livelihoods, which in turn has an impact on physical vulnerability, causing it to rise from a low to a medium range.

Regarding the number of people that require assistance, the percentage of the population with a disability and the percentage of older adults generate a low vulnerability. However, the higher percentage of children increases this vulnerability, which implies an increase in the percentage of the dependency rate. This means that there is a population margin that is not only particularly vulnerable in terms of response capacity, but also increases the vulnerability of the people on whom they depend.

In the dimension of insufficient conditions, it is shown that the percentage of precariousness of housing, financial access and the unemployment rate show a degree of medium-high vulnerability; this is mainly due to the fact that the materials of the houses are less resistant to threats, while the percentage of the population and the unemployment rate indicate that it affects the capacities of risk management and recovery from disasters. On the other hand, although the percentage of households without cars and the UBN (poverty) indicate high percentages, the comparative methodology reduces its impact by demonstrating a medium level of vulnerability.

Regarding the infrastructure indicators, it can be seen that the number of people per educational establishment is balanced and coherent to a low vulnerability due to the functions it performs in the framework of risk management. On the contrary, the number of people per health establishment is alarming, considering the level of these establishments; however, the comparative level again decreases the impact, representing the degree of vulnerability at a low level.

In the same sense, the dimension of differences between social groups indicates that the percentages of population refer both to indigenous groups, as for female heads of household, they represent a low level of vulnerability; that is, they do not influence the socioeconomic vulnerability of the municipality. However, it can be seen that the data does not reflect this categorization; on the contrary, they are important indicators for risk management and development planning.

Finally, the dimension of information for prevention shows a critical situation, since all the indicators point to a very high degree of vulnerability. In practical terms, this implies that the flow of information is difficult, which has an impact on the effectiveness of disaster prevention and emergency response measures.

*San Ignacio de Moxos*

In the municipality of San Ignacio de Moxos, physical vulnerability is low with respect to population density, road density, housing per square kilometre and birth rate, since they do not show a large concentration of the population, nor is there an accelerated population growth that generates difficulties for planning and assistance in emergencies. Although the percentage of population dedicated to agricultural activities is significant, the comparative methodology relegates the sector to a low level of vulnerability.

On the other hand, socioeconomic vulnerability – which includes the following categories: people requiring assistance; living conditions; infrastructure; differences between social groups; and information for prevention – show the following results.

Regarding the number of people that require assistance, the percentage of the population with a disability and the percentage of older adults generate a low vulnerability. However, the higher percentage of children increases this vulnerability, which implies an increase in the percentage of the dependency rate.

In the dimension of insufficient conditions, all the indicators are between the medium-low, medium and high average, with the most significant rates being low financial access and the high rate of population without car.

In infrastructure, vulnerability by health facilities is low and that of people due to educational establishment is high. The differences of the indicators are in the medium-low scale, except for the indigenous self-identification that is in the average scale.

The information for prevention according to the indicators are medium and medium-high scale in the indicator of households with radio.

### *Santa Ana del Yacuma*

In this municipality, the exposure dimension relative to physical vulnerability shows that it is in a low range in relation to population density, road density, housing per square kilometre, birth rate and agricultural activities. On the other hand, socioeconomic vulnerability indicates that the number of people requiring assistance is medium-low, as is the vulnerability of older persons, while the dependency rate is medium-high. In the dimension of life conditions, housing vulnerability is low; education and UBN are average, while vulnerability for households without cars, unemployment and financial access are medium-high, infrastructure vulnerability in health facilities is high and education is medium-high. In differences between groups, the scale is low and medium.

Regarding the information for prevention, the indicator of households without radio is medium-high, while the others are between low and medium-low.

## *Livelihood vulnerability*

The average land tenure in the communities where the surveys were conducted is 72 per cent, while almost all the people consulted have forest access.

**Table 25. Land tenure – Access to forests**

| Bolpebra | | | San Ignacio de Moxos | | | Santa Ana del Yacuma | | |
|---|---|---|---|---|---|---|---|---|
| Land tenure | Yes | 27 | Land tenure | Yes | 61 | Land tenure | Yes | 68 |
| | No | 10 | | No | 10 | | No | 5 |
| Forest access | Yes | 35 | Forest access | Yes | 60 | Forest access | Yes | 33 |
| | No | 2 | | No | 11 | | No | 40 |
| The average land tenure in the communities where the surveys were conducted is 72%, while almost all the people consulted have access to the forest. | | | Of all the people surveyed in all the communities of the municipality, around 85% indicated that they own the land they work on and only 14% do not have land. Likewise, 80% of people have access to the forest, and the remaining 20% state that they do not have access. | | | 93% of the people surveyed in all the communities of the municipality indicated that they own the land they work on; only 7% do not have land. Conversely, 45% have access to the forest, and the remaining 55% state that they do not have access. | | |

*Source*: Own elaboration based on field assessment, 2016.

## Table 26. Main economic activity – Family participation in production

| Bolpebra | | | | San Ignacio de Moxos | | | | Santa Ana del Yacuma | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main economic activity** | | **Family participation in production** | | **Main economic activity** | | **Family participation in production** | | **Main economic activity** | | **Family participation in production** | |
| Agriculture | 27 | Wife | 8 | Agriculture | 38 | Agriculture | 17 | Agriculture | 57 | Wife | 26 |
| Farming | 3 | Children | 8 | Farming | 4 | Farming | 46 | Farming | 0 | Children | 1 |
| Hunting and gathering | 3 | Other relatives | 17 | Hunting and gathering | 34 | Hunting and gathering | 0 | Hunting and gathering | 4 | Other relatives | 42 |
| Other | 4 | None | 4 | Other | 24 | Other | 8 | Other | 12 | None | 4 |
| 72% of people are engaged in agriculture, which is the main activity in the three communities surveyed. The whole family participates in production; only four people surveyed indicated that they do not receive any help from relatives. | | | | The main economic activity of the communities surveyed is agriculture, followed by hunting and gathering. However, there is a high percentage of people dedicated to other activities. The wife and children are involved in the productive process, which accounts for around 90% of family participation. Only 10% indicated that they do not receive help from anyone. | | | | The main economic activity carried out by the surveyed communities is agriculture, followed by hunting and gathering, as well as other activities, but at a lower level. According to 95% of the respondents, the whole family participates in the productive process, with the support coming mainly from relatives, and then the wife. There is only one case where support is provided by the children. | | | |

*Source*: Own elaboration based on field assessment, 2016.

## Table 27. Water supply and agricultural work conditions

| Bolpebra | | | | San Ignacio de Moxos | | | | Santa Ana del Yacuma | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Water supply** | | **Work conditions** | | **Water supply** | | **Work conditions** | | **Water supply** | | **Work conditions** | |
| Small reservoir | 8 | Yes | 34 | Small reservoir | 62 | Yes | 62 | Small reservoir | 4 | Yes | 63 |
| Well | 16 | No | 3 | Well | 9 | No | 9 | Well | 0 | No | 10 |
| Pipe | 10 | | | Pipe | | | | Pipe | 9 | | |
| Channel | 3 | | | Channel | | | | Channel | 60 | | |
| The water required for the work activities is obtained as follows: 22% by small reservoir, 44% by well, 27% by pipe and 8% by channel. 92% of the people surveyed assure that they have sufficient conditions for agricultural work. | | | | 59% of the supply of water is by small reservoir, 35% is supplied by well and 6% by channels. More than 85% indicate that their working conditions are sufficient, while less than 15% indicate the opposite. | | | | 84% indicate that the supply of water is by pipeline, while 11% is supplied by well and 5% is supplied by small reservoir. The majority indicates that they have sufficient conditions for agricultural work. | | | |

*Source*: Own elaboration based on field assessment, 2016.

Table 28. Improvements in production

| Bolpebra | | San Ignacio de Moxos | | Santa Ana del Yacuma | |
|---|---|---|---|---|---|
| Improvements in production | | Improvements in production | | Improvements in production | |
| Soil | 15 | Soil | 4 | Soil | 21 |
| Seed | 3 | Seed | 17 | Seed | 17 |
| Machinery/equipment | 3 | Machinery/equipment | 20 | Machinery/equipment | 0 |
| Training | 8 | Training | 5 | Training | 28 |
| Market | 8 | Capital | 25 | Capital | 6 |
| Better climate | 0 | Market | 0 | Market | 0 |
| Water | 0 | Better climate | 0 | Better climate | 0 |
| | | Water | 0 | Water | 1 |
| The majority of the respondents state that they need improvements in the soil; the rest considers that there should be more strengthening in training and in the market. | | The majority of respondents state that improvements in capital, i.e. financial products are necessary. This is linked to acquiring machinery and provision of agricultural inputs. | | The majority of respondents agree that there should be greater intervention in the strengthening of capacities than in the funding of agricultural inputs. | |

*Source*: Own elaboration based on field assessment, 2016.

### 4.1.3. Territorial risk management

#### *Municipal risk index*

Bolpebra: The municipal risk index (MRI) is 0.49665 on a scale ranging from 0 to 1. It only identifies one type of risk (floods) with an index of 0.31527 and a risk degree of 3 in a range from 1 to 5.

San Ignacio de Moxos: The MRI is 0.9471 on a scale ranging from 0 to 1, which is a very high degree of risk. Three types of risks are identified: forest fire (very high), drought (very low) and flood (very high).

Santa Ana del Yacuma: The MRI is 0.538 on a scale ranging from 0 to 1, which is a medium-risk degree. Three types of risks are identified: forest fire (medium), drought (low) and flood (very high).

Table 29. Municipal risk index

| Variable | Descriptor | | |
|---|---|---|---|
| | Bolpebra | San Ignacio de Mocos | Santa Ana del Yacuma |
| Number of risks | 1 | 3 | 3 |
| Forest fire risk index | 0 | 0.75366 | 0.29554 |
| Forest fire risk group | 1 | 5 | 3 |
| Degree of forest fire risk | Very low | Very high | Medium |
| Risk index for hail | 0 | 0 | 0 |
| Hail risk group | 1 | 1 | 1 |
| Degree of hail risk | Very low | Very low | Very low |
| Frost risk index | 0 | 0.04997 | |
| Frost risk group | 1 | 1 | |
| Degree of frost risk | Very low | Very low | |
| Drought risk index | 0 | 1 | 0.09159 |
| Drought risk group | 1 | 5 | 2 |
| Degree of frost risk | Very low | Very high | Low |

| Variable | Descriptor | | |
|---|---|---|---|
| | Bolpebra | San Ignacio de Mocos | Santa Ana del Yacuma |
| Flood risk index | 0.31527 | 0.9471 | 0.63744 |
| Flood risk group | 3 | 5 | 5 |
| Degree of flood risk | Medium | Very high | Very high |
| MRI | 0.49665 | 3 | 0.538 |
| Municipal risk group | 3 | 0.75366 | 3 |
| Degree of municipal risk | Medium | | Medium |

*Source*: Info-SPIE, 2016.

### *Analysis of the risk management situation in the municipalities*

#### *Installed institutional capacities*

VIDECI has installed a monitoring system on threats based on cross-information, mainly from SENAMHI, which allows it to issue alerts eight days in advance of a disaster, accurately identifying the territorial extent, as well as the number of families and hectares affected. In the training tasks, VIDECI also has a positive development. Its communication with the departmental and municipal levels is good, despite management difficulties that still exist in the budget area in general and in the planning mechanisms linked to prevention.

In the municipality of Bolpebra, the Risk Management Unit (UGR) has not been implemented because it is a small municipality; in this sense, the Directorate of Production and Environment takes charge of this task in permanent coordination with the communities. In the case of Santa Ana del Yacuma and San Ignacio de Moxos, because these are areas affected by floods, UGR was created in 2009 prior to the approval of the regulations. COMURADEs were also created through municipal regulations that establish their powers and functions.

#### *Disaster response*

Municipalities must develop their own prediction and forecasting systems, although these depend on information generated by other entities, as well as the processing and evaluation. Each municipality needs to work and have an educational communication strategy to influence, inform and disseminate alerts, as part of training in risk management.

#### *Budget for risk management in the municipalities*

**Bolpebra**. According to the budget analysis of the 2014 fiscal management, the Municipal Autonomous Government of Bolpebra budgeted Bs 55,415.00 in the No. 31 (0000-00) risk management programme for subprogramme No. 31–Disaster response (0000-01). This amount represents only 0.91 per cent of the total budget according to direct tax on hydrocarbons (DTH), while it means 0.68 per cent of the total municipal budget. 50 per cent of this specific budget was allocated transport, 18 per cent to equipment, 16 per cent for food in cases of emergencies and 8 per cent for training during the corresponding management.

**San Ignacio de Moxos**. This municipality, for risk management corresponding to 2016, had a budget ceiling of Bs 232,347.97, of which 44 per cent was used for the operation of UGR, while for transport, due to the characteristics of the municipality, the remaining 56 per cent was invested.

**Santa Ana del Yacuma**. The UGR of the Municipal Government of Santa Ana del Yacuma, in 2016, had a total budget of Bs 467,808.00, taking into account the adjustment of the DTH for that year due to the reduction in the prices of the hydrocarbons. This amount means 2 per cent of the DTH budget. Of its total, 21 per cent is for its operation, another 21 per cent for assistance to victims of disasters and 58.5 per cent is for the repair of Santa Ana's protective ring.

### *Preventive actions*

Progress in preventive actions at the municipal level is very limited at all levels of government: central, departmental and municipal. Risk management is currently geared towards facing a disaster, but not to prevent it. The municipal governments are in a position to encourage greater citizen participation to make their risk management systems more effective due to the proximity of the technicians to the communities.

## *Field work findings*

For research purposes, life stories were recorded to obtain opinions and experiences of people linked to risk management in the municipalities, plus their perception of climate changes.

### *Perception of climate change in the communities*

Out of the total number of people surveyed in the communities of the three municipalities, 183 (97%) indicated that they perceived changes in the climate while the remaining 3 per cent pointed out that they did not perceive these changes.

**Table 30. Perception of climate change in the communities**

| Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
|---|---|---|
| Yes: 35 | Yes: 58 | Yes: 71 |
| No: 2 | No: 1 | No: 2 |
| 38% of people surveyed were women and the remaining 62% were men. Out of the 37 people surveyed, 97% indicated that they perceived changes in the climate and/or in the seasons and 3% indicated that they did not notice changes in the climate. | 35% of the people surveyed were women and 65% were men. Out of the 71 people surveyed, 82% indicated that they perceived changes in the climate and 13% did not notice changes. | 41% of people surveyed were women and 59% were men. Out of the 73 people surveyed, 97% indicated that they perceived changes in the climate and/or the seasons, while 3% did not notice changes. |

*Source*: Own elaboration based on field assessment, 2016.

**Table 31. Droughts and floods**

| Bolpebra | | | San Ignacio de Moxos | | | Santa Ana del Yacuma | | |
|---|---|---|---|---|---|---|---|---|
| Recollection of droughts | Recollection of floods | Worse flood | Recollection of droughts | Recollection of floods | Worse flood | Recollection of droughts | Recollection of floods | Worse flood |
| 92% of people indicated that they had experienced floods. According to collective memory, these happened in 2010, 2011, 2012 and 2014.<br><br>59% indicate that they experienced droughts, the largest of which was in 2016. | | | According to collective memory, floods were recorded in the following years: 1982, 1984, 2004, 2008 and 2014.<br><br>34% of people suffered from droughts in the following years: 2003, 2007, 2012 and 2015. | | | According to collective memory, floods were recorded in the following years: 1982, 1984, 2004, 2005, 2012 and 2014.<br><br>34% of people suffered from droughts recorded in the following years: 2003, 2007, 2008, 2009, 2012, 2013 and 2016. | | |

*Source*: Own elaboration based on field assessment, 2016.

*Perception of the municipality with regards to disaster risk management*

In the **municipality of Bolpebra**, there is no risk management unit, so the task is assumed by the UGR of the governmental department.

> I've lived here since 1987 and at that time, the Interoceanica did not exist, but now we are connected to other regions, but with development comes more problems. Climate change has resulted in floods in 2012 and 2015. [...] We have been declared a risk zone ... with an environmental policy we can confront climate change. With regards to migration, the situation in Brazil has made Brazilians come to Peru to work, while with regards to Bolivians, they are starting families with Peruvians and vice versa. Joint actions … here in Peru, a meteorological station has been reactivated and the information is disseminated to the three countries, but there is a lack of information and reforest sources to cushion river currents.[48]

In the **municipality of San Ignacio de Moxos**, UGR has been implemented and it continuously carries out prevention actions, as well as response actions, such as during the 2014 flood.

> The institutions are operated by a code of conduct to connect the most vulnerable communities in the municipalities of Bolivia; the institutions want to go to a community near the city with water, light, etc., and this is not accomplishing the tasks because they will not be able to reflect that reality experienced by vulnerable communities. We also benefit from leaving seeds in the communities because it is not simple to enter due to the cost of transport.[49]

In the case of the **municipality of Santa Ana del Yacuma**, the communities identified by UGR as being the most vulnerable were as follows: "The communities of the Mamoré, who are the most vulnerable, have worked with NGOs to mitigate the impacts. When there is prevention, they prefer to stay in the same community; for example, they have created ecological bathrooms, they provide seeds and give assistance to protect their crops, and they pull them up before the flood arrives."[50]

*Participation and community organization*

During the visit conducted for this study, the people surveyed in the communities expressed the importance they give to community organization with regards to climate disasters.

**Table 32. Community organization during the floods**

| Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
|---|---|---|
| Yes: 33 | Yes: 63 | Yes: 73 |
| No: 4 | No: 8 | No: 0 |

*Source*: Own elaboration based on field assessment, 2016.

[48] Interview with Engineer Luis Guaribana Sorich, a technician from the Risk Management Unit (UGR)-M GAM San Ignacio de Moxos.
[49] Ibid.
[50] Interview with Mirko Núñez Fernández, head of UGR.

*Importance of women's participation*

Women are very important in the organization of daily life. However, the functions they carry out with regards to citizen participation are not acknowledged or valued by the same communities. However, it is paradoxical that with regards to the displacement situation experienced by communities as a result of the 2012 flood, the members of the community acknowledge women's role in the organization of life in the camps.

With regards to women's political participation, it is very important to highlight the change that is happening in the indigenous communities of the municipality. For example, there are two female councillors, and one of them is even the president of the municipal council.

**Table 33. The role of women in the camps**

| Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
|---|---|---|
| Yes: 15 | Yes: 60 | Yes: 55 |
| No: 1 | No: 4 | No: 10 |
| No response: 21 | No response: 7 | No response: 8 |

*Source*: Own elaboration based on field assessment, 2016.

Among the people who were surveyed, an average of 16.15 recognize the importance of women in community organization in order to face disasters and situations of displacement.

*Communication and information*

The people surveyed expressed that warning communications for disasters employed in the affected communities was mainly through word of mouth. Later, televised, radio and cellular means of communication were used. Radio telephony was used to a lesser extent.

According to the perception of people surveyed, the large majority indicates that there is no early warning, and a smaller percentage indicates that they were guided by their own climate predictions. This situation is supposedly contradictory between receiving personal warnings and via means of communication; it is not explained due to the lack of warnings, but rather due to the fact they probably assume the need to receive them in a direct and institutional manner.

**Table 34. Warning communication systems – Existence of warning signals**

| Bolpebra | | San Ignacio de Moxos | | Santa Ana del Yacuma | |
|---|---|---|---|---|---|
| **Alerts via means of communication** | | | | | |
| Personal | 1 | Personal | 1 | Personal | 1 |
| Radio, TV | 11 | Radio, TV | 6 | Radio, TV | 60 |
| Landline phone | 0 | Landline phone | 0 | Landline phone | 0 |
| Cell phone | 10 | Cell phone | 1 | Cell phone | 1 |
| Radio wave | 5 | Radio wave | 9 | Radio wave | 11 |
| **Alerts via means of communication** | | | | | |
| None | 31 | None | 6 | None | 1 |
| Authorized alert | 0 | Authorized alert | 9 | Authorized alert | |
| Weather forecast | 6 | Weather forecast | 2 | Weather forecast | 3 |

*Source*: Own elaboration based on field assessment, 2016.

*Training in risk management capacities*

In spite of all the efforts that institutions bring forward, capacity training does not reach everyone; as shown in the following table.

Table 35. Disaster training

| Bolpebra | | San Ignacio de Moxos | | Santa Ana del Yacuma | |
|---|---|---|---|---|---|
| Yes | 4 | Yes | 4 | Yes | 16 |
| No | 33 | No | 13 | No | 1 |

*Source:* Own elaboration based on field assessment, 2016.

## 4.2. History of displacement

Table 36. Displacements, disasters and settlements

| Situation | Effect | Municipalities | | |
|---|---|---|---|---|
| | | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
| Displacement | Yes | 16 | 8 | 17 |
| | No | 21 | 9 | 56 |
| Disasters | Flood | 17 | 17 | 11 |
| | Droughts | 2 | 0 | 0 |
| | Fires | 3 | 0 | 1 |
| Settlement | Families | 0 | 1 | 2 |
| | Schools | 2 | 12 | 0 |
| | Hostels/Hotels | 0 | 0 | 2 |
| | Churches | 0 | 2 | 11 |
| | Camps | 9 | 2 | 0 |

*Source:* Own elaboration based on field assessment, 2016.

Table 37. Special care and water supply

| Special care | Water access | Municipalities | | |
|---|---|---|---|---|
| | | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
| Water supply | Yes | 12 | 17 | 14 |
| | No | 4 | 0 | 3 |
| Means of storage | Pits | 3 | 12 | 3 |
| | Tanks | 0 | 0 | 3 |
| | Watersheds | 5 | 3 | 3 |
| | Bottled water | 8 | 2 | 11 |

*Source:* Own elaboration based on field assessment, 2016.

Out of the people surveyed in the communities, the majority indicated that they received specialized care. Regarding the water supply during displacement, this was mainly with well water and bottled water.

### 4.2.1. Identified problems during displacement

Table 38. Illnesses and medicines

| Special care | Water access | Municipalities | | |
|---|---|---|---|---|
| | | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
| Illnesses | Acute respiratory infections | 12 | 10 | 16 |
| | Acute diarrheal diseases | 2 | 7 | 0 |
| | Skin-related | 0 | 0 | 0 |
| | Others | 3 | 0 | 1 |
| Medicines | Yes | 3 | 3 | 12 |
| | No | 13 | 14 | 4 |

*Source*: Own elaboration based on field assessment, 2016.

The main health problems identified among the people surveyed were acute respiratory infections and diarrheic diseases. Most respondents indicated that medicines during displacement were insufficient.

Table 39. Other displacement problems – Waste management

| Displacement causes | Problems for displacements | Municipalities | | |
|---|---|---|---|---|
| | | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
| Modes of transport | Transport | 3 | 3 | 10 |
| | Food | 3 | 4 | 3 |
| | Health | 3 | 10 | 1 |
| | Studies | 2 | 0 | 0 |
| | Incomes | 5 | 0 | 3 |
| | Treatment of people | 0 | 0 | 0 |
| Waste elimination | Thrown to river | 0 | 10 | 0 |
| | Burning | 12 | 3 | 14 |
| | Burying in pits | 1 | 1 | 0 |
| | Landfills | 3 | 3 | 1 |

*Source*: Own elaboration based on field assessment, 2016.

The problem identified by majority of the people was related to their economic incomes that were directly affected during displacements, due to them not being able to carry out their activities in a normal way and also because of the losses that this implies. They were also affected in the following areas: transport, nutrition, health and study. Similarly, they were also affected by management of solid waste during displacement – which was usually handled by burning – the construction of improvised pits and burying it underground.

Table 40. Resettlement–recovery

| Disaster training | Bolpebra | San Ignacio de Moxos | Santa Ana del Yacuma |
|---|---|---|---|
| **Same place** | 1 | 16 | 17 |
| **Relocation** | 5 | 1 | 0 |
| **Easy** | 0 | 1 | 0 |
| **Difficult** | 12 | 10 | 11 |
| **Very difficult** | 4 | 6 | 6 |

*Source*: Own elaboration based on field assessment, 2016.

According to Table 40, the majority of respondents find the recovery process difficult, understandably as those affected, depending on the magnitude of the disaster, must start over from the bottom. On the other hand, it is important to point out that the majority begins this recovery process in the same place.

## 4.3. Migration and climate change

### 4.3.1. Migration from the communities and municipalities to other places

According to the findings, in the municipalities, there is seasonal migration during the wet months when part of the community population leaves for other places located in higher zones that are less prone to flooding. During this period, they often work as labourers and migrate to the municipal capital or other regions during these months. The rest of the population stock up and prepare to withstand the wet months in their places of origin.

A type of permanent migration was detected; in other words, after the disasters caused by flooding that forced the people from affected communities to move, many families did not return and stayed in displacement areas, such as nearby communities and the capital city of the municipality; or in permanent terms, they look for other regions that are further away to establish themselves according to the possibilities of accessing land or employment.

Finally, a permanent type of general migration was established by causes that are not directly connected to climate change. It is described as migration that occurs permanently for various reasons: vulnerability, search for employment or better opportunities, studying and others. The development and analysis of these types of migration can be found in the concluding paragraph.

### 4.3.2. Migration to the municipalities

One of the characteristics of people who migrate to the municipalities are young people, as well as people with a higher level of education or similar to the level of education of those who leave the municipality. Out of the population that lived in the municipality, more than 90 per cent have their own home, while the people who arrived during the last five years (70%) have no home. This is one of the most important indicators to explain why Bolpebra, San Ignacio de Moxos and Santa Anta de Yacuma have a positive migration rate.

Among the people surveyed who migrated to the municipalities, several indicated that unemployment and lack of housing in their previous place of residence were the main causes for their displacement. They mentioned floods again as the third cause.

### 4.3.3. Migration rate prediction for the municipalities

**Bolpebra** has a migration rate of 10.8,[51] which is expressed in the population increase. According to the INE predictions, the average growth rate will be 0.06 per cent with a slight increase in absolute terms that is pessimistic in relation to the number from recent years.

**San Ignacio de Moxos** has a negative migration rate (-1.8) that signifies a decrease in its growth rate. According to the INE predictions, the average growth rate will be 0.45 per cent with a slight increase in the population in absolute terms or what could be called a relative decrease in relation to the average growth of the country.

**Santa Ana del Yacuma** has a negative migration rate that signifies a continuous population decrease; in the last five years, it has decreased to 1,046 inhabitants. If taking into account the INE prediction, which predicts a decrease in the annual rate of an average of 0.52 per cent, in the municipality, the population will continue to decrease at an accelerated rate, while the national average increases.

In the following tables, an analysis of emigration and immigration is presented, as well as the main destinations.

Table 41. Analysis of migration in the municipalities

| Summary | |
|---|---|
| **Bolpebra** | **Emigration**<br>90.63% of emigrants go to the same department; mainly the municipalities of Cojiba, Puerto Rico, Filadelfia and Santa Rosa. 6.25% of those who emigrate go to the department of Beni, especially to Riberalta.<br><br>**Immigration**<br>Likewise, 61.87% of immigrants arrive from the department of Pando, especially from Cobija and Porvenir. 14.79% arrive from the department of Beni, mainly from Riberalta and a lower percentage from Trinidad, while 12% come from the north of the department of La Paz.<br><br>**Migration rate**<br>There is a positive migration rate of 10.8, which signifies that there are more immigrants than emigrants. Although it implies diverse opportunities for the municipality, there are also greater challenges, as an accelerated increase stemming from immigration also requires greater needs for public management.<br><br>**Main causes**<br>In general, migration demonstrates problem areas mostly in the housing and employment sectors, as so many immigrants and emigrants are motivated by the search for better living conditions. |

[51] The migration rate is understood as the percentage of people that enter and leave per each 1,000 inhabitants.

| Summary | |
|---|---|
| **San Ignacio de Moxos** | **Emigration**<br>53.86% of emigrants from the municipality go to the department of Beni. 25.74% to Trinidad and the rest of the municipalities, among them Exaltación, San Borja, San Joaquin and others. 28.85% of emigrants go to the department of Santa Cruz and 6.5% go to Cochabamba.<br><br>**Immigration**<br>There is a similar dynamic with regards to immigration, as 66.26% of immigration comes from the department of Beni, while 18.56% comes from the department of Santa Cruz and 6.5% comes from the department of Cochabamba.<br><br>**Migration rate**<br>It should be emphasized that the net migration rate is negative, which is concerning, considering that the demographic increase is 0.49%, a figure that is considered low or null in comparison with the growth of the country.<br><br>**Main causes**<br>In general, migration demonstrates problem areas mostly in the housing and employment sectors, as so many immigrants and emigrants are motivated by the search for better living conditions. |
| **Santa Ana del Yacuma** | **Emigration**<br>61.12% of emigrants from the municipality go to the department of Beni. 22.81% to Trinidad and the rest of the municipalities, among them Exaltación, San Ignacio de Moxos, San Joaquin, while the department of Santa Cruz with 29.79% is the second destination of emigrants.<br><br>**Immigration**<br>On the other hand, 61.37% of immigrants come from the department of Beni, 22.32% from the department of Santa Cruz and a lower percentage comes from the west of the country and from outside.<br><br>**Migration rate**<br>The migration rate is negative, which means that there are more emigrants than immigrants. This amounts to a negative demographic growth of -0.5%, which creates a decrease in the population.<br><br>**Main causes**<br>Emigration and the negative growth is evidence of significant problems on living conditions, mainly focused on employment opportunities. |

*Source*: Own elaboration based on field assessment, 2016.

Table 42 Migration from the municipality according to place lived in the last five years for the departments of Beni and Pando

| Santa Ana del Yacuma | | | | | | |
|---|---|---|---|---|---|---|
| **Beni (interior of the department)** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Trinidad | 562 | 295 | -267 | 22.81% | 20.83% | 25.48% |
| Exaltacion | 216 | 64 | -152 | 8.77% | 4.52% | 14.50% |
| San Ignacio de Moxos | 143 | 149 | 6 | 5.80% | 10.52% | -0.57% |
| Others with less migration | 585 | 361 | -224 | 23.74% | 25.49% | 21.37% |
| **Total Beni** | **1 506** | **869** | **-637** | **61.12%** | **61.37%** | **60.78%** |
| **Santa Cruz** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Santa Cruz de la Sierra | 467 | 247 | -220 | 18.95% | 17.44% | 20.99% |
| Pailon | 39 | 2 | -37 | 1.58% | 0.14% | 3.53% |
| Others with less migration | 228 | 67 | -161 | 9.25% | 4.73% | 15.36% |
| **Total Santa Cruz** | **734** | **316** | **-418** | **29.79%** | **22.32%** | **39.89%** |
| **San Ignacio de Moxos** | | | | | | |
| **Beni (in the department)** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Trinidad | 671 | 782 | 111 | 25.74% | 34.22% | -34.47% |
| San Borja | 128 | 197 | 69 | 4.91% | 8.62% | -21.43% |
| Santa Ana del Yacuma | 149 | 143 | -6 | 5.72% | 6.26% | 1.86% |
| Others with less migration | 456 | 392 | -64 | 17.49% | 17.16% | 19.88% |
| **Total Beni** | **1 404** | **1 514** | **110** | **53.86%** | **66.26%** | **-34.16%** |
| **Santa Cruz** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Santa Cruz de la Sierra | 387 | 320 | -67 | 14.84% | 14.00% | 20.81% |
| San Ignacio de Velasco | 41 | 20 | -21 | 1.57% | 0.88% | 6.52% |
| Ascension de Guarayos | 34 | 17 | -17 | 1.30% | 0.74% | 5.28% |
| Others with less migration | 290 | 67 | -233 | 11.12% | 2.93% | 69.25% |
| **Total Santa Cruz** | **752** | **424** | **-328** | **28.85%** | **18.56%** | **101.86%** |
| **Bolpebra** | | | | | | |
| **Pando (in the department)** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Cobija | 24 | 88 | 64 | 37.50% | 34.24% | 33.16% |
| Puerto Rico | 16 | 4 | -12 | 25.00% | 1.56% | -6.22% |
| Filadelfia | 12 | 2 | -10 | 18.75% | 0.78% | -5.18% |
| Others with less migration | 6 | 65 | 59 | 9.38% | 25.29% | 30.57% |
| **Total Pando** | **58** | **159** | **101** | **90.63%** | **61.87%** | **52.33%** |
| **Beni** | **Leave** | **Arrive** | **Difference** | **Leave** | **Arrive** | **Difference** |
| Riberalta | 3 | 26 | 23 | 4.69% | 10.12% | 11.92% |
| Others with less migration | 1 | 12 | 11 | 1.56% | 4.67% | 5.70% |
| **Total Beni** | **4** | **38** | **34** | **6.25%** | **14.79%** | **17.62%** |

*Source*: INE Database of demographic predictions 2012–2020.

### 4.3.4. Analysis of the relation between migration and climate change

Migration influenced by climate change in the municipalities of this study, manifest as a result of the occurrence of adverse climate events. This process consists of the following phases:

**First phase**: Faced with floods, many families decide to stay in their houses as it occurs, as long as the flood is not more serious than expected and they are not forced to leave their homes. Depending on how big the effects are, the families must leave their homes to move to temporary camps.

**Second phase**: Leaving one's home due to floods is considered climate-induced forced displacement. There are two probabilities: (a) the family or the people who directly emigrate to another region; and (b) they are displaced and settle in a temporary camp.

**Third phase**: Displacement leading to a camp allows for the possibility of the following: (a) the family or person can return to the community after leaving the camp; or (b) they emigrate to another region, in such a way that they continue to be displaced for climate reasons.

**Fourth phase**: Returning to their community and a lack of livelihoods also allows for other possibilities: (a) the persons stay to confront the lack of livelihoods and tries to project themselves back into their community; or (b) they emigrate to another region due to the lack of livelihoods. In the last case, it is not considered a direct forced displacement as a result of climate disasters because there is temporary mediation that is more or less short, among the decision of migration linked to their livelihoods and the search for new opportunities.

**Fifth phase**: Migration to another region in search of opportunities and to obtain livelihoods is measured by a wider time frame between the climate disaster and the decision to migrate, including when the signs of negative impact caused by the climate disasters have significantly reduced. This is definitely not considered climate-induced displacement, but rather migration influenced by climate change, depending on the family and the specific case, or in other words, the level of influence that climate change has on this time of migration.

# Chapter 5

# Conclusions

The study on the link between migration and climate change is a complicated topic due to the multidimensional characteristics that require both the relation of the variables (migration–climate change), as well as the orientation to devising guidelines on public policies. The characteristics of the study's objective determine the following:

(a) The study of the factors that intervene in the multiple dimension of the life of the municipality's population;

(b) The link between social sciences and natural sciences;

(c) The simultaneous study – which is not linked – of three municipalities or three different realities;

(d) The methodology of the case study for a better, in-depth understanding oriented towards territorial planning; and

(e) Rigorous analysis for the creation of guidelines for public policies, which links the investigative dimension with the strategic planning dimension.

## 5.1. The objective of studying the relation between migration and climate change

The predictions for migration related to the effects of climate change for the rest of the twenty-first century are alarming. Climate change has become the first cause of massive migrations, significantly surpassing other causes such as conflict. "When global warming gains momentum, there may be up to 200 million people affected by changes in the monsoonal systems and other types of precipitations, harsh droughts with unprecedented ends, and due to the increase in sea levels and floods in coastal zones", states Professor Myers.[52]

Understanding the current dynamic of these migrations and the causes of climate change that provoke them are fundamental elements for the economic, social and political order of societies, but also for the territorial and demographic organization that is linked to the availability of natural resources and ecosystems that allow the reproduction of life. In this sense, the *main problem* faced is: How can we contribute to understanding migration caused by climate change in order to create guidelines for

[52] IOM, 2008.

public policies; in a way that this study may be able to provide for the implementation of efficient actions to reduce forced displacements and improve the conditions of migration?

The response to this question is the final product of this study. However, it cannot be dealt with from a linear perspective in the relation between climate change and migration, for it is subject to a series of factors that indirectly affect the population. In other words, the proponents that influence climate change also generate, in a different field, effects that can be added to others being proponents of migration. Similarly, providing adequate orientations to the study that permit its usefulness as a planning tool, it has required the coordination from technical managers from the municipality, who are the one who understand the extent of the problem and the flaws in the information, as well as other institutions for example: the Vice Minister of Civil Defence, the Vice Minister of the Environment and Climate Change and APMT, dependent of the Ministry of the Environment and Water, all of whom require this profound local knowledge for the strengthening of their policies. Therefore, the study acquired a more technical character than a scientific one, due to the fact that its specific approach was oriented by political decisions in a determined space.

## 5.2. Aspects that guide the study

In this study, due to its characteristics, the study did not work in function with a hypothesis to prove but rather based on questions that guided it.

(a) What are the main theories (state of the art) in relation to migration caused by climate change?

Based on this question, the theoretical–analytical inputs that exist in relation to this topic are analysed and systemized, addressing three axes: (a) climate change; (b) risk management; and (c) migration on two levels: an abstract theory and an empirical theory, which are established in their relation with the Bolivian situation.

(b) What is the current state of the relation between migration and climate change in the municipality?

From the conceptual framework, a definite characterization of what is understood of climate change, migration, vulnerability and risk management is created. With this understanding, a territorial diagnosis to have the information available is organized that would allow to determine the situation of migration in the municipalities and at the same time, a field assessment that empowers to understand the characteristics of this problem in detail is developed.

(c) What actions can be taken in order to create an efficient strategy to address the relation between migration and climate change?

The diagnosis does not only give an image of the situation in the municipality regarding the study's objective, but it also generated important inputs to determine lines of action. It has been very important to study the initiatives that exist to improve the adaptation and resilience of communities and institutions; understanding the practices that the communities and the population carry forward and analysing the level of investment and public expenditure of the municipality.

## 5.3. Results obtained

### 5.3.1. Bolpebra

According to the data provided by SENAMHI on the historical evolution of the temperature in the municipality of Bolpebra, it is superior in the period between 1986 and 2015 in relation to the one from the period 1974–1993. Especially during the last five years of the first period mentioned, whose numbers are greater than the average. On the other hand, the analysis of the average precipitation in the municipality shows that in the last five years the precipitations are less when compared to the average of the periods from 1944 to 1973, 1973 to 2003 and from 1986 to 2016.

This average climatic variability demonstrates that the impacts caused by climate change are a possibility and a reality in the case of floods, droughts and to a lesser extent, fires. In spite of the fact that the fire risk index is 0, Bolpebra had some medium-sized fires in the last seven years. It is precisely these unpredictable adverse effects that must be prevented and mitigated.

Likewise, a higher threat of flood index was observed but not for fires. In spite of this, the municipal risk rises to approximately 0.50. This risk is estimated as high, considering that at least 36 per cent of the population are in a situation of poverty and they cannot cover their basic needs. This fact shows the high vulnerability of the population of Bolpebra because its mitigation risk capacity is reduced due to the lack of institutionalism.

The inexistence of a Municipal UGR derives from the dependence of the population on the Emergency Operation Committee of the Autonomous Departmental Government of Pando, which is responsible for this task. Although it is certain that the capital of the department, Cobija, is just two hours away, faced with a risk, accesses are reduced and the capacity of the departmental Emergency Operations Committee (COE) is overwhelmed with the disaster response.

The communities acknowledge the humanitarian assistance work that has been brought forward in these complicated times of disaster and displacement. They value the participation of the Ministry of Defence, international aid, and to a lesser extent, from the Government and the Municipal Government. In spite of the appreciation on behalf of the citizens, during the field study, the active participation of the Bolpebra Autonomous Municipal Government (GAMB) and the governorship was verified in all tasks. However, it is presumed that a large part of the negative perception is related to the expectations and hysteresis created by an adverse climate event.

The communities visited have suffered from disasters, mainly floods that have created the following consequences: flooding of homes, water contamination, loss of plantations and livestock, health conditions and respiratory infections in children. All these effects are considered proponents of migration.

As an exemplary case, faced with the displacement situation as a result of the floods in 2012, the communities valued the importance of women in risk management, community organization, and the majority of the population had access to means of communication (television and radio) to receive alerts.

In addition, the organization and management of the territory in function with their native communities by positively collecting ancestral knowledge and techniques to confront traditional floods was highlighted as a mechanism of resilience. Awareness has also been created regarding the necessity of employing new technologies, as the traditional ways are not enough to face the rigidities of climate change. Likewise, ancestral and traditional knowledge is valuable because they help to predict the weather via bio indicators and knowledge of the climate seasons. In addition, they have great potential to be implemented in conjunction with the municipality's general alert system.

Regarding migration, two dynamics were observed: expulsion and reception of migrants. There are three types of observable expulsive migration:

(a) **Seasonal climate migration** in the wet months when a part of the population from the communities goes to other places located in higher zones that are less prone to floods. There, the people usually work as labourers or they migrate to the capital city of the municipality or other regions during that time.

(b) **Permanent climate migration**, which is observed after flood-related disasters and which makes the population of the affected communities to move. Many of the families do not return and they remain in displacement points.

(c) **General permanent migration** related to vulnerabilities, the search for employment or better opportunities, studying and others.

Migrants, in a way consistent with theory, choose the nearby communities as they face migration option, followed by an urban centre, among these Riberalta, Trinidad or Cobija (36.9% migrate to Cobija and in general 90.63% of migrants move to other municipalities of Pando). However, it is very difficult to affirm that this is climate migration or whether it is just migration. Historically, the Plurinational State of Bolivia has experienced countryside–city migration.

As an opposite effect, Bolpebra is a municipality that receives migrants coming from Trinidad and Cobija, but also from abroad, given its special position on the border with two countries: Peru and Brazil. As a result, its migration rate is positive (10.8), but every time the socioeconomic conditions reduce, a clear example that during the last five years, 70 per cent of migrants do not own their own home, they lack work opportunities, health services and education.

Considering that the average demographic growth rate of the municipality is relatively low (0.54%) in relation to the national rate (1.45%) for the same period or compared with it, the improvement of living conditions and preventative disaster risk actions are necessary with the objective of safeguarding ancestral cultures.

The predicted future scenarios through the different models in the Plurinational State of Bolivia indicate an average temperature increase between 1.3 and 1.6°C for the year 2030 for the entire country, and between 4.8 and 6°C for the year 2100, compared with the average temperature during the period 1961–1990,[53] depending on the assumed scenarios. If the temperature increases as it is predicted, according to the analysed models, it signifies that the precipitations will be more intense during a period of shorter months, increasing the threat of floods, while the dry season will be even longer among the months of the entire year. The scenarios for floods as a result of precipitations predict an increase of between 7 and 10 per cent for the year 2050 in relation to the period 1961–1990.

This situation justifies the appropriate intervention with regards to disaster risk prevention and the need to protect vulnerable populations, whether they are vulnerable due to their socioeconomic conditions, infrastructure or for being an indigenous minority. With this understanding, considering all the findings and lessons learned throughout the development of the study project and analysis, a number of preliminary strategic lines were created that will be presented in the next section.

[53] Centre D'Estudis Amazònics (CEAM), 2011.

### 5.3.2. San Ignacio de Moxos

The analysis carried out for the municipality of San Ignacio de Moxos provides evidence of its high vulnerability level as 100 per cent of its inhabitants have been affected by floods, mainly in 2014. Analysing the risk over the years, it has been observed that the flood risk index is 0.9294 and the fire risk index is 1 and the Municipality Risk Index is very high at 0.9471.[54]

As a result of the floods, material and personal losses were reported; damage to public health, damage to livelihoods and subsistence and others, without a doubt, it was a tragedy for the population as a whole. Regarding vulnerability and in accordance with what is stipulated by Law no. 602 on Disaster Risk Management and its regulatory Supreme Decree, the Autonomous Municipal Government of San Ignacio de Moxos implemented UGR, which has its strength in the following areas: commitment of officials and authorities, professional experience, a developed risk management system, the organization of the COMURADE, as well as preventative actions and alerts that have improved over time. However, one of its weaknesses is the lack of budget in relation to the work it needs to carry out.

As a consequence of the insufficient economic resources and vulnerability, the humanitarian assistance organizations took control of rescue works, help with displacements, training and technical support when it was necessary. The appropriate participation of the Ministry of Defence was also noted, international aid and to a lesser extent, the Governorship and the Municipal Government, due to the lack of resources. In spite of this, the authorities' commitment is clear and they have brought forward coordination work so that external actions were able to be successful.

An aspect that calls attention and is highly valued is the community organization and the role of women who have been key in resilience actions.[55] It is a municipality where a large part of the communities are indigenous and have knowledge of the territory that contributes to overcoming a disaster situation caused by flooding. However, when this surpasses traditional management, alerts are communicated and the relevant authorities, the Municipal COE, the Disaster Management Unit (UGR) and humanitarian assistance convene.

Among the **permanent migration destinations**, which refers to permanent migration influenced by climate as well as general permanent migration, two locations were found: other communities and cities. The first case refers to communities that are mostly in the same department (54%).[56] However, a phenomenon titled countryside–city migration was also observed given that in Santa Cruz de la Sierra, the rate is almost 15 per cent,[57] while in Trinidad, it is 25.74 per cent. However, the opposite phenomenon, city–countryside migration, also occurs and is still higher than the latter by almost 10 per cent more than the average as the immigration from the same cities is 14 per cent in the case of Santa Cruz de la Sierra[58] and 34.22 per cent in the case of Trinidad.

Immigration is characterized by the search for land and work opportunities and mainly comprised of indigenous youth (between 19 and 25 years of age). Although 66.26 per cent of these come from the same department, almost 7 per cent come from Cochabamba. Among these immigrants, there are professionals, postgraduates, superior technicians and teachers; however, they are unable to change the structure of municipal education levels, which means that there are more professionals in the same amount than those who arrive to this place.

[54] Regarding the average, if the risk is close to 1, vulnerability is higher.
[55] A strong potential of the municipality is the ancestral and traditional knowledge that help to predict the weather via bioindicators as well as knowledge of the seasonal characteristics of the climate, which also contributes to the development of early warnings.
[56] 53.86% of emigration from the municipality go to the same department of Beni; 25.74% to Trinidad and the rest go to other municipalities, among them Exaltación, San Joaquín and others.
[57] Migration to the department of Santa Cruz amounts to 28.85%, of which 14.84% migrates to Santa Cruz de la Sierra and the remaining 14.01% go to other municipalities in the department.
[58] 18.56% of immigration comes from the department of Santa Cruz; 14% comes from Santa Cruz de la Sierra and the rest from other municipalities.

To conclude, the municipality of San Ignacio de Moxos experiences migration due to proximity and accessibility. This process does not occur from Andean zones.

The land tenure and housing is an important root element in spite of the climate disasters. There are many families whose head of house work as labourers and do not have their own housing; this is a factor that contributes to searching for other alternatives and establishing themselves in other places where the living conditions are more favourable, as it is pointed out that the municipality has a high unemployment rate and there is a lack of opportunities to have one's own home.

The mentioned factors possibly determine a negative migration rate (-1.8), expressed by the populational decrease, with the projections from the INE of 0.45 per cent in population growth, which is one of the lowest in the Plurinational State of Bolivia.

In this highly vulnerable municipality, climate disasters have been one of the causes of continuous emigration. Now that climate change is accentuated, the situation has a tendency to increase. This stands out in terms of reducing the climate disaster risks, mainly floods, in way that is necessary for preventive actions.

### 5.3.3. Santa Ana del Yacuma

The study carried out found that the communities of Santa Ana del Yacuma perceive climate changes as an increase in temperature and greater frequency of natural disasters such as floods and fires. However, they refer to changes in the last five years that refer to climate variability and not to climate change.

This climate variability is reflected in the average precipitation increase but for less time and longer periods of drought during the dry months, negatively influencing food security, but also increasing the risk of fires due to the high temperatures and lack of water.

In this context, 73 per cent of the municipality of Santa Ana experienced floods, a percentage that is slightly higher than the municipal average.[59] According to collective memory, these events occurred in the following years: 1982, 1984, 2004, 2005, 2012 and 2014.[60] An interesting and notable figure is that 93 per cent of the respondents in all the communities of the municipality indicated that they own the land they work on and only 7 per cent do not own land due to the fact that owning land comes with deeper roots and therefore more investment possibilities to overcome the crisis.

With regards to the forest, 45 per cent of people have access and the remaining 55 per cent do not. The arrival to forests represents an opportunity for the development of agroforestry systems, absorb employment and fulfil an amiable activity with nature.

According to OND data, between 2002 and 2012, there were 5,146 registered climate events, of which 4,911 were floods that harmed 23 communities; 1,271 families affected and another 4,796 injured. Support for the families in proportion to the affected familiar is low.

[59] Very high threat of flooding (Index: 0.7941) and high threat of fires (0.54762). The Municipal Risk Index is 0.538, which is in the medium-high range, naturally due to the weight of the floods.

[60] The visited communities experienced floods that created the following consequences: (a) loss of housing; (b) water contamination; (c) loss of plantations and livestock; (d) health problems; and (e) respiratory infections in children. In the community of Soberanía, there was also an invasion of rats, a direct and indirect effect of climate change and affected ecosystems.

The Autonomous Municipal Government of Santa Ana implemented UGR, whose staff has strong expertise, a preventative and alert system that improved with time and also helps the city with the construction of the protective ring. However, among its weaknesses is the lack of budget in relation to the work that must be carried out. The result of the lack of conditions means that the prospective tasks are rather weak and neglected, awaiting disaster response where help from the governorship is fundamental and in case the situation is more serious, the Ministry of Defence.

In spite of the fact that humanitarian aid has been effective and efficient, the population does not acknowledge the municipality with regards to risk management, as the Ministry of Defence points out as the more important actor. It probably refers to a conceptual valuation because there was municipal management, but perhaps the lack of resources meant that the perception was not wholly positive.

An aspect that calls attention and is highly valued is the community organization and the role of women who have been key in resilience actions.[61] It is a municipality where a large part of the communities are indigenous and have knowledge of the territory that contributes to overcoming a disaster situation caused by flooding. However, when this surpasses traditional management, alerts are communicated and the relevant authorities, the Municipal COE, UGR and humanitarian assistance convene.

With regards to migration, it is seasonal climate migration that occurs during wet months when part of the population of the communities leave for other communities located in higher zones that are less flood-prone and where the people usually work as labourers, or they migrate to the capital city of the municipality or other regions during this period. The rest of the population stock up and prepare to withstand the wet months in the places they are located.

Another type of migration is permanent climate migration that occurs after flood disasters and forces the population of the affected communities to move. Many of the families do not return and they stay in displacement zones such as nearby communities, the capital city of the municipality or they look for regions that are closer to establish themselves according to the possibilities of accessing land or finding employment.

Finally, there is permanent migration, but it occurs for reasons that are not directly related to climate change. Migration is referred to as one that occurs continuously for various reasons: vulnerability, search for employment, better opportunities, studying and more.[62]

Permanent migration, motivated by climate reasons as well as general reasons, has two destinations: other communities and cities. In the first case, they are communities that are mostly located in the same department and sometimes located in another. Migration to the city of Santa Cruz is almost 18.95 per cent and to Trinidad, it is 22.81 per cent, which signifies a countryside–city migration process that is very high, but to cities from the same eastern region. On the other hand, there also exists a city–countryside migratory process that is slightly lower than the opposite process, therefore countryside–city migration with regards to the migratory balance is neutralized. Immigration to the city of Santa Cruz is 17.44 per cent and 20.83 per cent for Trinidad.

The municipalities have a negative migration rate that is expressed by the continuous population decrease, only in the last five years it has decreased by 1,048 inhabitants. If the projection from the INE that the annual rate will decrease by an average of 0.52 per cent is considered, the municipality's population will continue to decrease at an accelerated rate, while the national population average increases.

[61] A strong potential of the municipality is the ancestral and traditional knowledge that help to predict the weather via bio indicators as well as knowledge of the seasonal characteristics of the climate, which also contributes to the development of early warnings.

[62] Coincidentally, immigration to Santa Ana occurs as a result of people searching work opportunities and settlement, mainly in the age cohort of 19–25 year olds.

Thirty (30) per cent of emigration goes to the department of Santa Cruz, slightly higher than half of this percentage (16%) moves to the city of Santa Cruz and the remaining 12 per cent to other municipalities of this department. Only 12.82 per cent arrive from this department to Santa Ana, 10 per cent from the city and 2 per cent from other Santa Cruz municipalities. 22.32 per cent of immigration comes from the department of Santa Cruz.

However, 61.12 per cent of the municipality's emigration goes to the same department of Beni; 22.81 per cent to Trinidad and the rest to other municipalities such as Exaltación, San Ignacio de Moxos, San Joaquín and others, while 61.37 per cent of immigration also comes from the same department.

More than 90 per cent of the migration can be explained by the movement between these two departments. This means that, in this case, there is not a massive movement of migration from the Andean region to this municipality, rather the mobility can be explained by its proximity to the east and its vicinity to the roads that connect it mainly with Trinidad or with the large city of Santa Cruz.

In this highly vulnerable municipality, climate disasters have been one of the causes of continuous emigration. Now that climate change is accentuated, the situation has a tendency to increase. This stands out in terms of reducing the climate disaster risks, mainly floods, in a way that is necessary for preventive actions.

On the other hand, immigration is an indication of some problems that should also be taken into account because it refers to the population that arrives in search of housing, employment and living conditions.

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