AN APPROACH TO UNDERSTANDING COMMUNITY MEMBERS' PERCEPTIONS OF CLIMATE CHANGE IN THREE RURAL INDIGENOUS MEXICAN COMMUNITIES

By

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Abstract

This case study describes an approach to understanding community members' perceptions of climate change in three rural indigenous communities in the Tehuacan-Cuicatlan Biosphere Reserve in the state of Oaxaca, Mexico. Seven participatory tools were applied to assess community members' experience of current climate change conditions, the challenges posed by changing conditions, and their communities' efforts to adapt. Tools, such as the Stratified Timeline, that provided community members time to work in groups and reflect on the questions they were asked allowed them to better express their knowledge of climate change than tools that isolated community members or used technical language such as the Pre and Post- Test. Although community members were generally aware of changes in their climate, they were unfamiliar with the concept of adaptation or of how certain activities could help them adapt.

Through their responses to these seven tools, community members expressed their belief that the climate is in fact changing in their region of Oaxaca. The biggest concern in all three communities was the lack of seasonal rains, which was affecting their ability to farm and ensure food security. Some adaptations, provided through soil and water conservation projects, were being undertaken in the region through governmental entities such as the Tehuacan-Cuicatlan Biosphere Reserve, but there is great need and much interest in having more of these types of projects implemented, to help communities adapt to climate change.

Table of Contents

Page

List of Figures

Page

List of Tables

Page

List of Appendices

Page

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Chapter 1 Setting

1.1 Introduction

This case study describes the participatory tools used and experiences I gained while working as a Peace Corps Volunteer with three rural indigenous communities in the Tehuacán-Cuicatlán Biosphere Reserve of southern Mexico. It also outlines the process we followed in gathering information about climate change adaptation for those communities. Unfortunately, civil unrest led the Peace Corps to evacuate all its volunteers from Oaxaca before we were able to implement the outreach campaign. In spite of this, the case study, as far as it's been completed, can serve as a guideline for people working with rural communities on climate change adaptation in Mexico and as a tool kit for developing and implementing an outreach campaign about climate change issues. The case study describes unique experiences in one particular protected area of Mexico, but the lessons learned are transferable and likely relevant for researchers working with rural communities elsewhere.

From May 2014 to July of 2017 I served as an Environmental Education Volunteer with Peace Corps Mexico. My site was the Tehuacán-Cuicatlán Biosphere Reserve, which is located in the south-central part of the country and is one of the largest national protected areas in Mexico. I was assigned to the community of Cuicatlán, Oaxaca, a small town of about 9,000 located in the southern portion of the reserve. Although Cuicatlán was my home base, I worked in many communities across the entire Biosphere Reserve. While Cuicatlán did not participate directly in the case study, it was an important hub for meetings and activities associated with the project and, because I was headquartered there, I was able to accompany other Biosphere Reserve staff on visits to neighboring communities. Through these visits I met community leaders interested in and/or able to participate in environmental education-related projects. These leaders formed the core of my worker network.

I learned a lot of Spanish on the visits to rural communities by sitting in and listening to how Biosphere Reserve staff interacted with community leaders and the types of projects they carried out. Often, the most important part of working with the communities was sitting and chatting after we completed the required task of the day such as taking GPS points, visiting their wildlife monitoring cameras, or giving environmental workshops. During these chats the same topics came up time and again: politics, local leaders' families, the newest gossip out of Oaxaca City and, of course: the weather.

Seasonal rains were coming outside their normal season or not at all, temperatures were much hotter than usual, hailstorms were killing crops, and landslides were forcing entire communities to relocate. Local leaders would even go as far as to mention that "those climate changes are to blame," which led me to ask what the local leaders were doing about the changes. The answer was usually very little, due to time, money, or knowledge about the topic of climate change adaptation.

Climate change was one of the most important topics that we focused on during my courses at the University of Alaska Fairbanks, and it was evident that the changes were being felt not just in the reduction of sea ice and retreating glaciers in Alaska, but also in the interrupted rainy seasons in hot, water-scarce communities like those in southern rural Mexico.

After presenting the idea of taking climate change adaptation to the communities, my counterpart in the Biosphere Reserve commented that it was already a priority for all protected areas across Mexico, according to the SEMARNAT 2020 – 2040 plan. Thus, this project became an opportunity for the Reserve staff to experiment with climate change outreach in order to meet Biosphere Reserve goals: accordingly, my project was accepted.

Work on this case study started in February of 2015 with a literature review, planning meetings with Biosphere Reserve staff, and community visits. Community workshops began in summer 2015 and the outreach campaign was scheduled to take off in the summer of 2016. Unfortunately, civil unrest broke out in the capital city of Oaxaca and other locations around the state in June of 2016. The state was deemed unsafe for American citizens and I was pulled out of my site, San Juan Bautista Cuicatlán. The participatory analysis tools and the planned outreach campaign plan will stay within the Biosphere Reserve for their reference and future use. Due to budget cuts and staffing shortages, there was insufficient manpower to carry out the outreach campaign during my time in Mexico.

The path to developing the outreach campaign was not straight forward or well-defined, and it had many set-backs that yielded important lessons to help guide future efforts. In many ways, this case study reflects my experience as a Peace Corps volunteer with all its moments of ambiguity, false starts, highs and lows, and frustrations. Despite the hard lessons learned, I feel I got much more out of the project than what stayed behind in the communities: I learned about climate change, of course, and working with communities, but also the importance of teamwork, communicating clearly and concisely, being flexible and, above all, having a sense of humor.

My target audience with this case study is other Peace Corps Mexico Volunteers, aid workers, and Mexican protected area staff, who is working on climate change adaptation. The following case study describes the participatory tools we used, our experiences working with rural indigenous communities, and suggestions for turning this information into an outreach campaign.

1.2 National and Legal Context

Before beginning my study, I needed to understand if there were any special conditions involved in working with communities in the Reserve. Protected areas must manage their land according to certain laws, and comply with federal regulations. At the local level, how this management scheme is carried out depends heavily on the resources found there and local leadership. Relevant questions (López & Sandoval, p. 14) were investigated in order to better understand current policies and initiatives with respect to climate change adaptation and preparedness. The questions were divided into four categories: resilient livelihoods, disaster risk reduction, capacity development, and addressing underlying causes of vulnerability.

1.2.1 Resilient Livelihoods

Predictions have been made not only for climate change, but also for its impacts on society. In the agriculture sector, a reduction in the productivity of corn is predicted by 2050 and a loss in soil fertility and productivity for the majority of cultivars is predicted for 2030. Higher risk of drought in some areas and flooding in other areas is predicted, especially coastal communities. Increase in intensity and frequency of storms and severe climatic events are predicted: These could have critical social and economic impacts. Additionally, changes in ecosystems, such as loss of forest cover and change in ocean temperatures, could affect individuals and families whose livelihoods depend on the natural resources they extract from these ecosystems (SEMARNAT, 2014, p. 24).

In 2013, the Mexican government enacted The General Law of Climate Change (LGCC) which created a series of financial, regulatory, technical, planning, evaluation, and monitoring instruments with regard to climate change. The LGCC also calls for greenhouse gas emissions inventory, a climate change fund, laws, and risk assessments (SEMARNAT, 2013b, p. 16). Later, the Strategy to Reduce Climate Change Risks to

Rural and Urban Populations was created which involves multiple agencies in the effort to reduce the risks of climate change to cities and communities (SEMARNAT, 2014, p. 35).

1.2.2 Disaster Risk Reduction

Tropical cyclones (climate-related) and earthquakes (not climate-related) are the most important hazards that Mexico currently faces (The World Bank, 2012, p. 212), Hazards are monitored through the Hazard Tracking System for Tropical Cyclones, also known as R-AVISA. This information is obtained from the National Hurricane Center of the U.S. National Oceanic and Atmospheric Administration (NOAA) and then disseminated by the National Civil Protection System, which sends alerts to the state offices of Civil Protection (*Protección Civil*) (The World Bank, 2012, p. 218).

The Mexican government took its first steps towards managing disaster risk with the founding of the National Civil Protection System (*SINAPROC*) in 1986, right on the heels of the 1985 earthquake, which was the worst natural disaster in recent Mexican history. This system is funded by the Natural Disaster Fund (*FONDEN*) and the Natural Disaster Prevention Fund (*FOPREDEN*) (The World Bank, 2012, p. 211).

Disaster risk management in Mexico has been broadly defined as the process of planning, participation, intervention, decision-making, and implementation of sustainable development policies aimed at (a) understanding the causes of risks, (b) controlling and reducing risks, (c) reversing the social causes for associated risks, and (d) strengthening the resilience of government and society against natural disasters (The World Bank, 2012, p. 214). There are several agencies that monitor and communicate natural disasters. Each system sends out advisories before the event happens, some up to 72 hours ahead of time like the Tropical Cyclone Early Warning System (SIAT-CT) (CENAPRED, 2013, p. 2), which helps give people time to evacuate before a cyclone occurs.

1.2.3 Capacity Development

The institutions involved in adaptation strategies for climate change including the Secretary of the Environment and Natural Resources (SEMARNAT), the National Institute of Ecology and Climate Change

(INECC), the Inter-secretarial Commission for Climate Change (CICC), the Federal Public Administration (APF), the Board of Sustainable Development, representatives from civil society, representatives from the academic sector, private sector, social sector, specialists in climate change and the Board of Climate Change (SEMARNAT, 2013b, p. 19).

Additionally, there are government structures that enable collaboration for creation of climate change policy. This structure, known as the National System for Climate Change (SNCC), is a cross sectorial system this includes: Federative Entities, Associations of Municipal Authorities, Congress, The Climate Change Board (C3), The National Institute of Ecology and Climate Change (INECC) and the Inter-Secretarial Commission of Climate Change (CICC). This system is in place to manage climate change vulnerability and risks that face the country.

There are several sources of monetary support for climate change adaptation initiatives. The Climate Change Fund, which is laid out in the LGCC, allocates resources to manage climate change with a priority on adaptation. Federal money is used to support the fund, as well as international donations (LGCC, 2012, p. 34). The money that has been received as of 2016 totals $1.062 billion USD (Climate Funds Update, 2016).

Due to limited resources, the Mexican government prioritizes adaptation for the most at-risk communities. This means that the community is both ranked high for exposure (large population, investments in agriculture or livestock, and robust infrastructure) and high vulnerability. Vulnerability is calculated considering population age and health, historic climate data, available water, farming activity and number of homes (SEMARNAT, 2013a, pp. 10-17). This plan aims first to reduce the vulnerability of the most at-risk communities, and then move on to other communities afterwards.

Building capacity and resilience are other objectives of the Mexican government as laid out in the mid- and long-term goals and objectives of the PECC and the LGCC. These documents call for capacity-building on diverse topics including financing, greenhouse gas emission inventorying, systematic observation, emission, climatic, and investigation scenarios, outreach, and identification of technological barriers (CICC, 2012, p. 394).

According to the World Bank, a crucial step towards future success in this initiative is the cooperation and interaction between the Federal Government with States and Municipal governments with regard to climate change adaptation. To achieve such cooperation, tools to help local governments design their own

risk management strategies are already available. Local government databases are being produced under federal criteria, so as to have consistent information, and are intended to be used in the design of risk transfer pools for several states within each infrastructure sector (mainly roads and water). (The World Bank, 2012, p. 221)

1.2.4 Addressing Underlying Causes of Vulnerability

According to the SEMARNAT, the most vulnerable citizens to climate change are the poorest subsistence farmers who will encounter more challenges due to changes in climate. The Climate Change Strategy 10-20-40 mentions that one of its objectives is to make rural communities, with a majority of subsistence farmers, less vulnerable to climate change (SEMARNAT, 2013a, p. 23). The federal government also recognizes women as vulnerable to climate change due to marginalization and elevated cases of single motherhood. Federal programs such as PROIGUALIDAD seek to reduce the gap in conditions between men and women (SEMARNAT, 2014, p. 14).

1.3. The Protected Areas of Mexico

In Mexico, protected areas are defined as zones of national territory over which the country has jurisdiction, where the natural environments have not been significantly altered by human activity and require preservation and restoration and are subject to the regimen laid out in the The Ecological Balance and Environmental Protection Law (Secretaria General, 2000, p. 1).

The National Commission of Protected Areas (CONANP), a commission of the Secretary of the Environment and Natural Resources (SEMARNAT) manages the protected areas of Mexico. These protected areas include national parks, national monuments, biosphere reserves, areas of protection of natural resources, areas of protection of flora and fauna, and sanctuaries: 176 in total which cover more than 25,394,779 hectares of the country (CONANP, 2014).

This project took place in one of Mexico's largest protected areas called the Tehuacan-Cuicatlan Biosphere Reserve. Protected areas generally are sources of great biodiversity or strategically located as

biological corridors, which means that these areas have priority with regard to climate change adaptation not only for human residents but also ecosystem adaptation, compared with non-protected areas.

1.4. Regional Context: The Tehuacán–Cuicatlán Biosphere Reserve

The Tehuacán – Cuicatlán Biosphere Reserve (RBTC) is a category IV natural protected area, according to the IUCN classification system of IUNC: preservation with active management (IUNC, 2014). The reserve comprises 490,186 hectares, located in the southeast portion of Puebla State and the northern portion of Oaxaca State, as seen in Figure 1.1. The RBTC is home to more than 35,000 people, including 51 municipalities and 16 ethnic groups. Its general objective is:

[*Conserve the biodiversity of the Floristic Province of Tehuacán – Cuicatlán, maintaining the continuity of the ecological and evolutionary processes that develop there.*

So that its cultural and historical heritage, through implementation of policies of protection, management, restoration, education, environmental culture that allow for the sustainable development of the communities that exist there] (SEMARNAT, 2013b, p. 15).

In other words, communication and education are essential themes for the RBTC and its management, and these activities are carried out within all age groups and at all education levels.

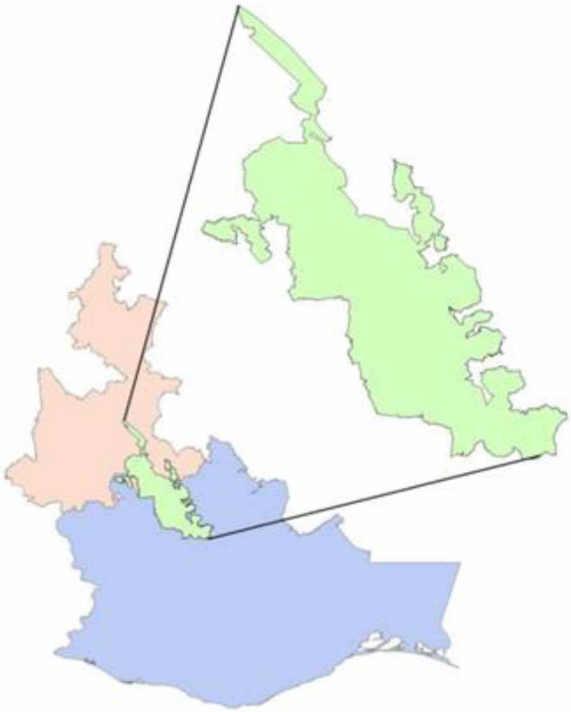

Figure 1.1. Map showing the location of the Tehuacan – Cuicatlan Biosphere Reserve in green. Puebla state is shown in pink and Oaxaca, blue.

1.5. Background: Demographic and Environmental Factors of three sub regional communities.

1.5.1. Concepción Pápalo

Concepción Pápalo is located in the municipality of the same name, and has a population of 674 people (INEGI, 2010). The predominant vegetation types in Concepción Pápalo are coniferous forests, pine-oak forests, and juniper forests (SEMARNAT, 2013b, p. 37) There are two hydrological resources: the rivers Rio San Lorenzo and Rio Grande, and total territory includes 94.4 km^2. According to the weather station data, the temperature in Concepción Pápalo reached a maximum of 45ºC in July 1949 and a minimum of -4ºC in March 1950. Normally the temperature ranges from 13 ºC to 19 ºC throughout the year with the highest temperatures occurring in May and the lowest in December and January. The rainy season begins in May and lasts until October and usually brings, on average, less than 200 mm of precipitation. In September 1949 the record accumulated precipitation was observed at 800 mm (Fernandez Eguiarte, Romero Centeno, Zavala Hidalgo, Trejo Vazquez, & Conde Alvarez, 2012, p. 45). There are six types of

climates within the municipality of Pápalo: semi-hot dry, semi-hot temperate humid, semi-hot temperate sub-humid, temperate humid, temperate semi-cold, semi-arid hot (SEMARNAT, 2013b, p. 35). In 1998, a forest fire destroyed a great portion of the forests of Concepción Pápalo (CDI, 2005, p. 8), near one of the community's greatest tourist attractions: la Cueva Cheve. This event was one of the most impactful natural disasters in recent history.

1.5.2. San Pedro Jocotipac

The community of San Pedro Jocotipac is located in the municipality known by the same name and has a population of 775 people. The vegetation types found there includes predominantly tropical deciduous forest, oak forest, and palm groves of *Brahea dulcis (SEMARNAT, 2013b, p. 37)*. Total territory covers 40.83 km^2. According to the weather station data, the climate of San Pedro Jocotipac reached a maximum of 36ºC in April 1955. Normally the highest temperatures occur in May and the lowest in December and January. The rainy season lasts from July until September and precipitation accumulation is on average 100 mm. In September 1949 record precipitation accumulation was noted at 500 mm (Fernandez Eguiarte et al., 2012, p. 47). The municipality of Jocotipac includes arid dry and semi-arid temperate climates (SEMARNAT, 2013b, p. 35).

1.5.3. Valerio Trujano

Valerio Trujano is located in the municipality of the same name (INAFED, 2013) and has a population of 1371 people (INEGI, 2010). Valerio Trujano's main hydrographic resource is the river Rio Grande. There are two access routes via federal highway 135, which connects Valerio with Tehuacán to the north and Oaxaca to the south. Its climate is dry and receives less than 400 mm annual precipitation. The vegetation is tropical deciduous forest which is dominated by deciduous trees that shed their leaves during the dry season (SEMARNAT, 2013b, p. 37). According to data from the nearest weather station in San Juan Bautista Cuicatlán, Valerio Trujano reached a maximum of 50ºC in October of 2002 and a minimum of 1ºC in November of 1984. Normally the temperature ranges from 21ºC to 29ºC during the year with the highest temperatures occurring in May and the lowest in December and January. The rainy season presents itself in Valerio Trujano between June and October in which less than 100 mm of water is accumulated.

The record accumulation of 400 mm of precipitation was recorded in August, 1969 (Fernandez Eguiarte et al., 2012, p. 45).

1.6. Background: Current Manifestations of Climate Change in the State of Oaxaca

Climate change predictions and models are available through the state of Oaxaca, for the years 2030 and 2050 using the HADGEM1 A2, HADGEM1 B2, MPI ECHAM5 A2 and MPI ECHAM5 B2 models. Temperature predictions are available for every month, but my investigation focused on data for January and May, the coldest and hottest months, respectively. The predicted temperatures do not show a significant difference from current conditions according to the data available, but this does not paint the complete picture of potential climate change impact. The data available does not provide average temperatures but rather what the source calls a 'media' in which the maximum temperature plus minimum temperature are divided by two. The 'media' temperature does not capture the real average temperature nor does it accurately reflect an increased frequency in extreme temperatures, which is also predicted as a result of climate change (Magaña, Méndez, Morales, & Millán, 2004).

Precipitation predictions are also available using the same models. Data is available for every month, but my investigation focused on March and September: the driest and wettest months respectively. There is no significant difference between actual precipitation and average predicted levels for the region. However, it is important to keep in mind that these maps cannot reflect an increased frequency of extreme hydrological events such as drought or hurricanes, which are also predicted. (Fernandez Eguiarte et al., 2012, pp. 167-168, 171-172; IPCC, 2007).

Although there are data and climate change projections for the state of Oaxaca, predictions are general and not region specific: It is not known how changes will manifest specifically across the canyon due to the great topographical and ecosystem diversity of the region (Fernandez Eguiarte et al., 2012): Even between neighboring communities the impacts of climate change may vary. This is important to remember as adaptation techniques used should be related to the specific changes being felt by the communities.

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neighboring communities the impacts of climate change may vary. This is important to remember as adaptation techniques used should be related to the specific changes being felt by the communities.

1.7 Environmental Education / Communication in Mexico

At the federal, state, and natural protected area levels, the Mexican government has started climate change education and communication initiatives (del Carmen Ayala, Duran Fernandez, Ruiz Perez, & Guevara Zayago, 2012, p. 124).

1.7.1 Federal Level

At the national level, portions of the National Climate Change Law (*Ley General de Cambio Climático)* reinforce the importance of education and outreach about climate change:

[*Article 7 XI. Promote education and outreach of climate change materials and culture at all educational levels through educational campaigns and information to bring awareness of the effects of variation of climate on the population]* (LGCC, 2012, p. 5).

In other words, climate change education for both youth and adults is an important objective for the Mexican federal government at all age levels. This includes meteorological and biological concepts of climate change issues, as well as personal values and environmental aptitudes that allow community members to make responsible decisions that affect themselves and the environment (Ortiz & Velasco, 2012, p. 223). Noting that adults are the population that normally makes decisions for the community, environmental education for adults is critical to make sure that they are informed about climate change and how it can affect the decisions they make for the population. It is interesting to observe that the law mentions educating the population about the effects of climate change, but does not include any aspects of adaptation.

1.7.2. State Level

Climate change communication and diffusion campaigns are found in the state climate change action plan for the state of Oaxaca as a whole. The three communities that participated in this project are located in the state of Oaxaca, but not one of them is mentioned explicitly in the action plan. The plan calls for a creative campaign that considers the cultural diversity of the state and the needs of all of the different groups, because one generic plan will not be appropriate for communicating to the diverse populations of Oaxaca (León Diez, Neri, Noriega Navarrete, Morán Romero, & Molina Munguía, 2011, p. 9). No further information has been found on climate change adaptation for the state of Oaxaca.

1.7.3. Inside Natural Protected Areas

Education and outreach related to climate change are also management goals of the Natural Protected Areas of Mexico, which pertains to specific regions of Mexico. These regions are often smaller than states, larger than municipalities, and may cross state or municipal borders. Protected Areas must follow the laws and regulations of their corresponding states and municipalities, in addition to the federal regulations placed on them. In the Climate Change Strategy for Protected Areas (*Estrategia de Cambio Climático para Áreas Protegidas)* by the SEMARNAT, six strategies are mentioned for improving climate change communication and environmental culture in protected areas. Specifically, two strategies (2 and 6) discuss education:

[*Strategy 2: Bring awareness to involved actors in conservation and restoration processes for protected areas with regard to climate change impacts in order to stimulate more active participation.*

Strategy 6: Develop institutional capacity to strengthen communication and outreach campaigns in climate change related topics in protected areas] (SEMARNAT, 2011, p. 18).

Educating local community members and leaders that pertain to the protected areas is an essential strategy to confront climate change in protected areas for its ability to transform vulnerable communities into resilient communities through knowledge.

International aid is working within some protected areas to promote climate change adaptation. The German agency: Gesellschaft für Internationale Zusammenarbeit (GIZ), has worked in the development of the Special Climate Change Program (*Programa Especial de Cambio Climático)* (PECC 2014-2018), specifically in the area of climate change mitigation and adaptation, as well as the National Climate

Change Strategy (*Estrategia Nacional de Cambio Climático)*, in which it revised and contributed to the methods of adaptation and mitigation (INECC, 2012). Also the Mexican Fund for Nature Conservation (*Fondo Mexicano para la Conservación de la Naturaleza*), along with the GIZ have contributed to several pilot climate change adaptation projects in four protected area complexes. These projects focus on wildlife monitoring and conservation of natural resources in the face of climate change. (March et al., 2011).

1.8 Goals of the Research

In this case study, we set out to better understand community members' perceptions of climate change and their stage of climate change adaptation, in three rural communities of the Tehuacan-Cuicatlan Biosphere Reserve. We set out to do this by applying seven different tools to community members, local leaders, and Biosphere Reserve staff that had worked in the region. This case study will describe the tools that we used, how effective they were at collecting information, and the information gathered through this investigation.

Chapter 2 Methods

2.1 Introduction

In order to best understand how climate change was affecting local communities and adaptation, we first needed to develop a dialogue with these communities. We collected information from many different sources, which included doing a thorough review of the literature, and interviews with local authorities, community members, and Biosphere Reserve staff in order to cross-reference information and compare perceptions. We also chose to use a participatory approach to include active participation by the communities in the campaign. We included 7 active participation tools, which will be described below.

2.2 Participatory Analysis Investigation

Participatory investigative analysis allows study participants to be actively involved in the investigative process. In many development organizations, participatory analysis is used as a tool to better understand the study subjects or 'actors' (whether they are individuals or communities), to empower people, and to facilitate communication between actors. The degree of actor participation depends on the organization of the actors, the flexibility of the investigators, and the likelihood of change and learning between the actors and the investigators (Geilfus, 2008, p. 2). The highest level of actor participation is called "Self Development" in which the actors self-organize, take initiative on an action, allowing the investigators to assume the role of advisor or companion. Projects tend to be more successful and sustainable when actors participate more because the actors become more committed to the vision and objective of the project (Geilfus, 2008, p. 3).

One goal of participatory analysis is to generate a high level of participation in order to empower the group, increase the sustainability of the project, and encourage actors to look for solutions to their problems. Using participatory analysis tools, actors can analyze results, make decisions, mobilize, self-organize, prioritize, and increase self-esteem (Baird, Plummer, Haug, & Huitema, 2014) (Geilfus, 2008, p. 4). Participants who are already motivated and self-organized perform at these high levels. The participants that we worked with were not at that level at the time, but we hoped their participation would encourage later mobilization (Geilfus, 2008, p. 3).

Participatory analysis tools also allow us to better understand where community members stand on climate change adaptation. Knowing the community members' stage of the decision making process orients us in preparing adaptation information and resources that are relevant and useful for community members. According to the climate change adaptation process (Figure 2.1) the earliest stage is understanding the problem, and the last stage is managing an adaptation project (Ekstrom and Moser, 2014, p. 3). We wanted to understand community members' stage in the process of using this information to identify their barriers to adaptation and provide the most appropriate support for overcoming them.(MOSER & Ekstrom, 2010).

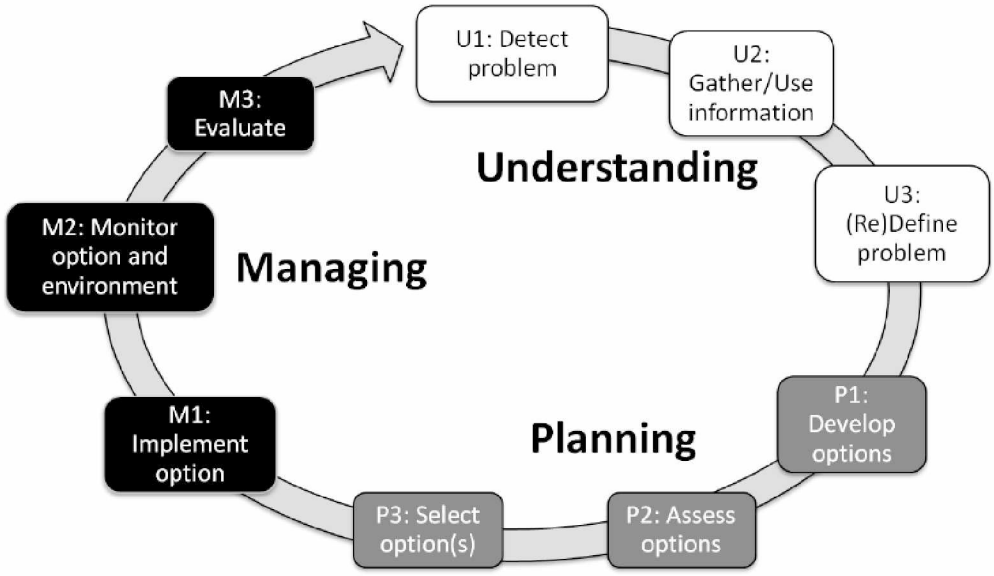


Figure 2.1. Ideal stages of the decision making process for climate change adaptation.. (Ekstrom & Moser, 2014, p. 3).

2.2.1. Participatory Analysis Research in Mexico's Protected Areas

In accordance with the policies of vulnerability assessment and climate change adaptation for protected areas under the direction of the CONANP, participatory analysis was the methodology used in this case study. Specifically, the study followed the methodology laid out in the 'Climate Vulnerability and Climate Analysis' (CVCA) handbook created by the organization CARE, and followed by protected area staff who are working in community development and climate change. This methodology places an emphasis on self-analysis, collaborative learning, and open dialogue between actors and investigators. In other words, it promotes local communication about climate change and better understanding of adaptation options (Daze,

Ambrose, & Ehrhart, 2009, p. 2). This project uses the CVCA methodology, including some investigation techniques, tools, and suggestions for working with communities.

2.3 Investigation Tools and Techniques

Seven different tools (Table 2.1) were used to collect data for our outreach campaign. This section will describe in detail the tools used and what we hoped to learn by using them.

Table 2.1. List of tools used in this project, the page number on which they are discussed, associated images, and their appendices.

Number	Name	Page Number	Image	Appendix
1	Guiding Questions at Local Level	62	Table 2.2	-
2	Stratified Timeline	69	Figure 2.1	-
3	Pairwise Ranking	74	Table 2.4 - 2.7	-
4	Majority Vote	78	-	-
5	Pre- and Post- Test	80	-	3
6	Drought Survey	81	-	4
7	Interview with Biosphere Reserve Staff	83	-	6-10

2.3.1 Tool 1: Guiding Questions: Local Levels

The first investigative tool involved the use of interviews (López & Sandoval, p. 11) which used the questions provided in the CVCA called "Guided Questions Local Government/ Community Level" (Table 2.3) (Daze et al., 2009, p. 16). These interviews were used to establish baseline information about the climate change situation and local policy regarding climate change adaptation before working with the communities. The questions were modified somewhat, inserting simpler language in some cases in order to make them more accessible for local leaders.

Table 2.2. Second analysis instrument from the CVCA: Guiding Questions Local Government Level (Daze et al., 2009, p. 16).

Guiding Questions Local Government/Community Level	
Resilient Livelihoods	- Are scaled-down climate projections available? - If so, what are the observed and predicted impacts of climate change for the region and/or ecological zone? - Do local institutions have access to information on current and future climate risks? - What livelihood groups or economic sectors are most vulnerable to climate change? - Do local plans or policies support climate-resilient livelihoods? - Do local government and NGO extension workers understand climate risks and promote adaptation strategies?
Disaster Risk Reduction	- What are the most important climate-related hazards the region and/or ecological zone faces? Non-climate related? - How are hazards likely to change over time as a result of climate change? - What groups within the community are most vulnerable to disasters? - Do local institutions have access to disaster risk information? - Are local disaster risk management plans being implemented? - Are functional early warning systems in place at the local level? - Does the local government have the capacity to respond to disasters? - Which other institutions are engaged disaster risk management at local level?
Capacity Development	- What institutions (governmental and non-governmental) are involved in research, planning and implementation of adaptation? - What are the most important institutions in facilitating or constraining adaptation? - Do local institutions (governmental and non-governmental) have capacity to monitor and analyze information on current and future climate risks? - Are mechanisms in place to disseminate this information? - Do local institutions have capacity to plan and implement adaptation activities? - Are resources allocated for implementation of adaptation-related policies? What is the budget? Where are the resources coming from? - What are the existing capacity and resource needs and/or gaps for climate change adaptation? - What new capacities may be needed to address changing circumstances due to climate change?
Addressing Underlying Causes of Vulnerability	- What social groups within the community are most vulnerable to climate change? - Are local planning processes participatory? - Do women and other marginalized groups have a voice in local planning processes? - Do local policies provide access to and control over critical livelihoods resources for all? - What are the other factors constraining adaptive capacity of the most vulnerable groups? Do vulnerable communities and groups have any influence over these factors?

2.3.2 Tool 2: Stratified Timeline

The second tool used was created during a participatory workshop with community members who were enrolled in the government funded PROCODES project in 2015. These projects are small grants given to communities in order to carry out soil and water conservation works. These groups are self-enrolled and self-motivated, usually organized by the community *comisariado*, and open to the public. This group was identified by Biosphere Reserve staff as the appropriate group to work with because of their involvement in conservation works and familiarity with Reserve staff. Participants in PROCODES receive a small stipend

for their participation, and attaching our workshop to the PROCODES requirements helped to ensure attendance. The lesson plan that we used for this workshop can be found in Appendix 1.

We knew that in order to get a better picture of the communities' experiences with climate we needed to look at not only the changes but also how these changes were affecting the community members. The stratified timeline was identified as the best tool for collecting this data because as seen in Figure 2.1, it includes historical events, climatic events, the impacts that these events had on the community, and adaptations that community members took in response to the impacts. This tool was particularly interesting to us because it was used in climate change workshops in the region Mixteca of Oaxaca, which also forms part of the Tehuacan-Cuicatlan Biosphere Reserve (Roge, Freidman, Astier, & Altieri, 2014, p. 795), as a means of better understanding the climate history of communities in the region.

A participatory workshop was held in the summer of 2015 in each of the three communities with the beneficiaries of the government subsidized soil and water conservation projects (PROCODES). The Biosphere Reserve presented the project to participants and asked for help in constructing a climate history of the community. Groups were formed depending on the amount of participants present at the workshops, usually about 5 people per group. Participants were given a piece of flip chart paper and markers and instructed to create each level of the timeline starting with historical events, and only focusing on one topic at a time. After the four parts of the timelines were complete, the groups presented their timelines to the other group(s), which was important for validating dates and events.

2.3.3 Tool 3: Pairwise Ranking

The third tool used was a Pairwise Ranking to determine which climate change impact was affecting the community the most. The lesson plan for this workshop can be found in Appendix 2. The Pairwise Ranking is one of Peace Corps' Participatory Analysis for Community Action tools, and is a matrix that is used in order to identify priorities from a large list, especially when working with groups. The pairwise ranking matrix is filled on both the horizontal and vertical axes with the same items. For each cell, community members vote on their priority between the horizontal item and the vertical item. Often these items are community priorities, concerns, or opportunities that the community wants to pursue. At the end of the activity, each item is totaled, and then ranked (Table 2.4). The item that appears most frequently receives the highest ranking, and this is then interpreted as the top priority for the participants.

The purpose of the Pairwise Ranking tool is to identify the most important issue. We used the tool in that way with the goal of focusing our outreach campaign on this one most important issue that is concerning community members. Because our Pairwise Ranking required participants to mention all of their climate change concerns, the information collected addressed issues that we would not include in the outreach campaign because of resources and timing and some of them were not related to climate change. These other concerns were documented and shared with Biosphere Reserve staff to consider in their project planning.

2.3.4 Tool 4: Majority Vote

The fourth tool we used during the participatory workshops was a majority vote to select communication media. We explained to participants that the goal of this project was to design an outreach campaign about climate change adaptation in order to share this information with the entire community. We then shared that outreach campaigns can take on a lot of different forms depending on how the community preferred to receive information and shared some examples of communication media such as posters, flyers, radio spots, and a video. Participants were then asked about how information was usually communicated in the community, and we generated a list of these types of media. Afterwards, participants were instructed to think about how they and their fellow community members would best like to receive information about climate change adaptation. Using the list generated by the group, we took a vote of which was the best method for communicating information to the community.

2.3.5 Tool 5: Pre and Post-Test

The fifth tool that we developed for this project was the Climate Change Pre and Post-Test (Appendix 5) which was a short quiz that was designed to be administered to the participants in the workshops before and after in order to gauge their level of understanding coming into the workshops and how/if it had changed after attending the workshops. The questions used included: what is climate change; mention one example of how climate change manifests itself; mention one example of how climate change could affect the community; why is climate change adaptation important; and mention one activity that is an adaptation to climate change.

When working on adult environmental education, it is important to honor the experiences and previous knowledge that all participants bring to the classroom. Additionally, it is important to set a baseline and a metric to measure participants' learning. We hoped to achieve this through a five question quiz that would be given both before and after the workshops and compare the results.

2.3.6 Tool 6: Drought Survey

The sixth tool used was a community survey about drought. This tool was created to answer the question: "what does drought mean for community members?" We designed and conducted a survey that asked community members about their perceptions and opinions of drought using the following questions: for you, what is drought; give an example of how drought is manifested in your community; give an example of how drought can affect your community; why do you think it is important for your community to adapt to drought; name a means of adapting to drought that families already use in your community. This tool was only applied to two communities: Concepcion Papalo and San Pedro Jocotipac because Valerio Trujano withdrew from the project before the survey was carried out.

Surveys were multiple choice and five questions long. Surveys were designed by Biosphere Reserve personnel to be used as teaching tools for those administering them to community members. Every one of the choices to answer the questions was correct, with the exception of two: give an example of how drought is manifested in your community and why do you think it is important for your community to adapt to drought. These two questions were the only ones to include some wrong answers because Biosphere Reserve staff decided that making four correct answers for these questions would not provide us with more useful information about drought perceptions in the communities. This survey design allowed us to simplify result analysis to say that the more positively identified answers community members picked, the more preexisting knowledge they had about drought. Surveys were carried out verbally with 10% of the population of each community. Individuals were chosen for interviews based on their availability and willingness to participate. Surveys were all carried out by personnel of the Biosphere Reserve. Because Valerio Trujano dropped out of the project, only the communities of San Pedro Jocotipac and Concepción Pápalo participated in the surveys, which were applied on two different days about two weeks apart.

2.3.7 Tool 7: Interview with Tehuacan-Cuicatlan Biosphere Reserve Staff

The seventh tool used was an interview with the RBTC staff. In our investigation, we created one survey form that was sent to all Biosphere Reserve staff that had experience working in the canyon region. We hoped to gather the observations of staff with regard to the changing climate, local environmental stressors, previous projects that address adaptation to climate change, and causes of vulnerability. We then compared their observations with those of community members for a more complete idea of how climate change was affecting local communities and vulnerabilities that they faced. Staff members bring years of expertise in their fields of biology, geography, engineering, and agriculture and we hoped that by combining staff expertise and observations of community members we could gain a better understanding of the changing climate.

Among Tehuacan-Cuicatlan Biosphere Reserve staff, several individuals have worked on projects in the canyon region. Their experience and observation of the communities is important to include because they provide expert opinions in the fields with respect to the climate change and communities. This is not to say that staff are experts in the topic of climate change, but rather that they have an intimate understanding of the vulnerabilities of the communities and provide important reference information on how the communities have changed with time. Nearly all Reserve staff has held their position for at least ten years, which gives us important historical reference because many community members had stated that climate started changing within the past ten years. Also, because Reserve staff did not help work on the development of this project it was important to get their opinions before creating the outreach campaign.

Five staff members from the Tehuacán-Cuicatlán Biosphere Reserve were interviewed. All had experience working with communities in the canyon region, and included: Geographer Rafael Arzate Aguierre, Technician Maribel Ramirez Garcia, Biologist Leticia Soriano Flores, Veterinarian Juan Manuel Salazar Torres, Agricultural Engineer Martin Antonio Perez Trinidad. My counterpart and I developed these interviews to capture observations that personnel had made of climate change in the region, vulnerability of communities, and climate change adaptation projects that had been completed.

Chapter 3 Results

3.1 Introduction

We visited the four communities from October 2014 until December 2015 to implement the investigation tools described in the previous chapter. Community members' responses were recorded and used to compare perceptions of climate change in the communities, historic climate information, interest in future adaptation, and potential local leadership. The results collected are presented below.

3.2 Tool 1: Guiding Questions at Local Level

Conversations revealed that all three communities' communal landholding body leaders, also known as *comisariados*, lacked climate change and disaster preparedness plans, and local leaders did not see merit in creating disaster preparedness plans, nor investigating climate predictions for the regions, based on their answers to the interview questions used in Tool 1

Comisariados also struggled with the guiding questions, due to the technicality of words such as adaptation, climate change, and natural disasters. Many local leaders in Oaxaca lack higher education and technical experience with environmental issues, and are saturated with short-term activities that leave no time for long-term planning. Long-term plans are often seen as a waste of time for *comisariados* who only serve three years in office. Together, these factors are hurdles to long-term planning in the rural communities of the canyon region of Oaxaca.

3.2.1 Local Resilient Livelihoods

The three communities of Concepción Pápalo, San Pedro Jocotipac, and Valerio Trujano were all similarly lacking awareness and preparedness with regards to climate change preparedness and access to climate information. Local authorities of all three communities were not aware of any scaled down climate projections available to them, nor were they aware of any information on current and future climate risks for their region.

Subsistence farmers were identified by all three *comisariados* as the community members most vulnerable to climate change due to their need for regular precipitation in order to plant and harvest their crops. Subsistence farmers generally have no other source of income and few other options for sustenance, making a predictable harvest essential for their wellbeing and the wellbeing of their families. Local officials were not aware of any NGOs in their communities working on climate change adaptation with any groups. Government agencies such as the Forest Service (CONAFOR), the Biosphere Reserve, and the Water Commission (CONAGUA) were identified as providers of projects such as reforestations, but such projects were not seen as climate change adaptations.

As of September 2015, none of the three communities had plans or policies that support climate-resilient livelihoods. In Concepción Pápalo, there is an ecotourism initiative that helps to support climate-resilient livelihoods by providing an alternative source of income for local people through cabin and equipment rentals and entrance fees. There is little planning or policy associated with this project which is managed by the local tourism committee. In San Pedro Jocotipac, local people generate supplementary income through the sale of woven palm goods. There is little organization and planning associated with the harvest of palm and sale of goods which could be vulnerable to climate change due to the fact that palm leaves are harvested from local groves.

Local government officials' perception of climate change includes their direct observations of a decrease in precipitation from historic levels and an increase in temperature. *Comisariados* also seem to consider changes in temperature from day to day, or even within the same 24 hour period to be climate change, as well, which is incorrect. *Comisariados* repeatedly confused weather changes (change in temperature over the course of one day) with climate change (change in typical patterns), by making comments such as "climate change is when it is cold in the morning and then hot in the afternoon" or "climate change is when it is rains all of a sudden, and later a strong wind starts to blow." These types of comments reflect the dangerous misconception that climate change is a fleeting temporary phenomenon.

3.2.2 Local Disaster Risk Reduction

The local authorities for all three communities mentioned, in the interviews, concerns over the lack of rains as their main climate related concern. Other concerns mentioned were higher temperatures and more

intense storms during hurricane season. Additionally, all three communities mentioned the appearance of infestations present in almost all types of crops as a non-climate related concern.

Furthermore, local institutions do not have access to information on disaster risks in general for their communities. The *comisariado* from San Pedro Jocotipac commented that information about disasters is usually received via radio broadcasts from larger cities such as Tehuacán, Puebla or Oaxaca City, Oaxaca. No early warning systems were reported from any of the three communities, though they all have functioning loudspeakers that are used to communicate announcements with residents.

None of the local governments interviewed had disaster risk management plans, nor the resources, equipment, or personnel to respond to disasters. All three communities have historically depended on support from state and federal government in order to rebuild after natural disasters. Aside from government aid, there was no mention of other sources of funding or institutions working on disaster risk management at the local level.

3.2.3 Local Capacity Development

Local authorities were not aware of any institutions involved in research, planning, and implementation of adaptation. Further investigation showed that agencies such as the Natural Protected Areas Commission (CONANP), the Forest Commission (CONAFOR), Water Commission (CONAGUA), the Agriculture Department (SAGARPA) and Indigenous Persons Commission (CDI) sponsor reforestation and soil conservation projects which support climate change adaptation. These groups are the most important facilitators of adaptation for the communities due to the funding and training they provide on adaptation topics. No evidence of research and planning at the local level were found.

Local institutions do not have the capacity to monitor and analyze information on current and future climate risks. There are no existing mechanisms in place to disseminate disaster related information such as an Early Warning System. Federally funded projects are only allocated to a few communities within the Tehuacan–Cuicatlan Biosphere Reserve, and the amount of funding is often only enough to cover a week's income.

Local leadership from all three communities were interested in receiving more training and information about climate change and adaptation, reasoning that it would help them understand the issues associated

with climate change more. They commented that any training would either have to take place in the community, or be fully funded to make it worth their while.. As of early spring 2015, they had all already attended a workshop hosted by CONAFOR on climate change. The workshop was one day in length and focused on the current REDD + which is a climate change mitigation initiative for Mexico. *Comisariados* from all three communities commented that they did not feel comfortable or familiar enough with the material discussed in the CONAFOR workshop to share with community members.

3.2.4 Addressing Local Causes of Vulnerability

Local authorities from all three communities, unanimously named subsistence farmers as the community members who are most vulnerable to climate change. Subsistence farmers normally do not have irrigation systems and rely on seasonal rains to plant and harvest. In the community Valerio Trujano, it was mentioned that farmers who have their fields on the banks of the river in particular are the most vulnerable to climate change because in the event of a flood their crops are almost always destroyed.

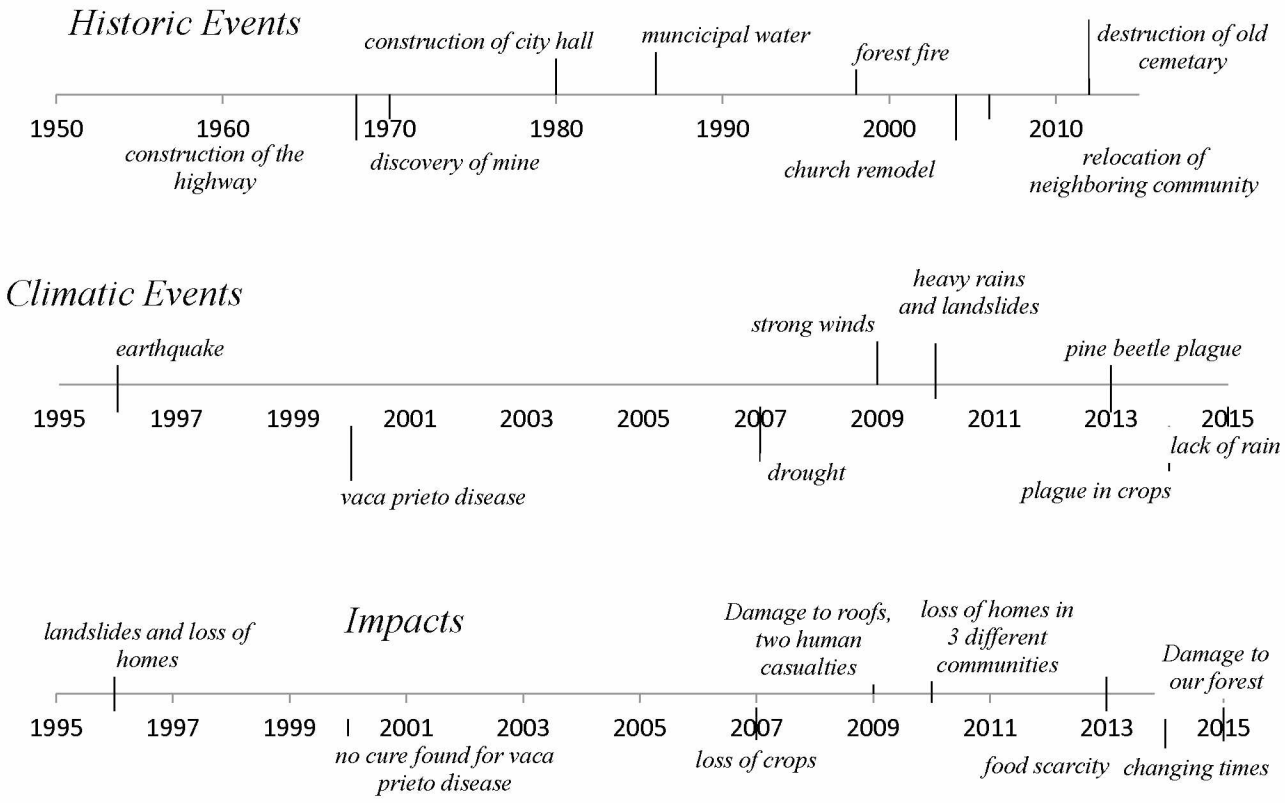
Local planning processes are participatory and normally include marginalized groups such as women and senior citizens. It should be noted, though, that all three *comisariados'* committees were made up of middle aged men. Many of the activities associated with climate change adaptation (soil conservation, reforestation, dam construction, etc.) would typically be the responsibility of men because of their heavy, rigorous nature. All work in the field is usually done by men, making men the most likely group to observe climate changes and its effects on harvests. Local policies do not seem to address access to and control over critical livelihoods resources for all people, meaning that the poorest individuals do not have a safety net in case of a natural disaster.

Lack of education is also a common factor that limits the adaptation ability of subsistence farmers. Across the Tehuacán –Cuicatlán Biosphere Reserve, the average education level for adults in about 4^{th} grade. Lack of education means that community members have less capacity to understand complex topics such as climate change, which requires an advanced understanding of how climate functions. Due to local people's misconception of climate change, adaptation is not seen as a priority, or even as a possibility.

3.3 Tool 2: Stratified Timeline

The results of the second tool: the Stratified Timeline from Concepción Pápalo can be found in Figure 3.1. Participants in this workshop were all members of the cabinet of the *comisariado* and all adults over the age of 30. This group was used to working together and got along well, though the fact that they were not a more complete cross section of the population could mean deficiencies in the climatic and historical information collected. The other Stratified Timeline created can be found in Appendix 3.

In terms of communities' participation, in Concepcion Papalo, the participants in Concepcion Pápalo needed very little encouragement to complete the timelines compared to the other communities that participated in this case study. This may have been due to the fact that participants were members of the local leadership board and have had experience with participating in workshops put on by other government offices, such as the Forest Service.



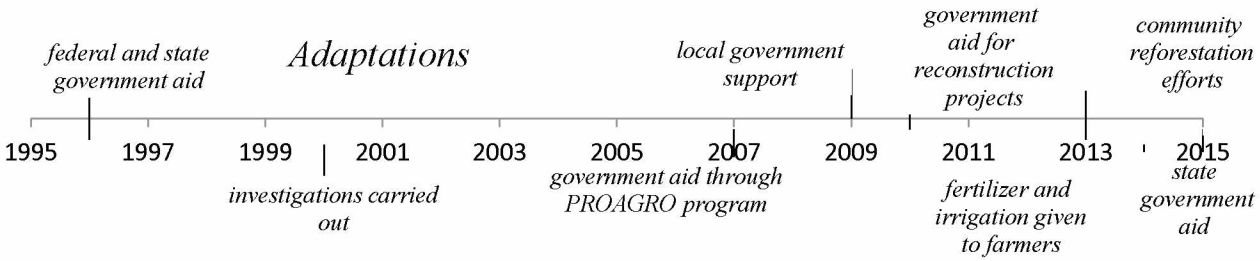


Figure 3.1. A Stratified Timeline created in Concepción Pápalo. In order from top to bottom the timelines discuss Historic Events, Climatic Events, Impacts of the Climatic Events, and Adaptations/Actions that were taken in response to the Impacts.

It was mentioned that some of the biggest struggles they face as a community is an infestation of bark beetles in their forests, occasional extreme rains that cause landslides, droughts, and a lack of proper waste management system. Though their concerns about waste management were not brought up during the sharing of the timelines, several participants voiced their concern afterward that if the idea of the project was to share an environmental message with the community, they would like it to be waste management related because the excess of untreated waste hurts the image they are trying to convey to tourists.

In San Pedro Jocotipac there was an exceptionally large turnout of participants, so they were split into four groups. One group was composed of all older community members and struggled with the directions and the information that was requested for each timeline.

Timelines revealed that the community of Jocotipac has experienced drought, heavy rains, plagues that affected their crops, and forest fires (Appendix 4). It is interesting to note that participants also included earthquakes and eclipses in their timelines. Participants also shared that the community always depends heavily on aid from state or federal funds in the event of a disaster.

In Valerio Trujano, the most commonly referenced climatic events that affected the community were cyclones and hurricanes, which destroyed fields and crops (Appendix 5). One interesting example of adaptation was that after a destructive cyclone, community members adapted to low maize supplies by adding ground green bananas into their tortilla dough. It was also mentioned that currently, the community is facing an extreme drought, and has not been able to plant anything. This is an issue for the local economy, which relies on agriculture for its main food and income source.

3.4 Tool 3: Pairwise Ranking

The third tool: Pairwise Ranking was carried out using the environmental events and concerns that were mentioned by participants in Workshop 1. These options included drought, plague, heavy rains, forest fires, waste management, extreme temperatures, and poor harvests. Participants had little trouble understanding the pairwise ranking table and gave opinions openly, though disagreed on some points such as the gravity of the waste management issue for the community. Results can be found in Table 3.1 below.

Table 3.1. The results of the Pairwise Ranking created in Concepción Pápalo. The matrix was used first to identify environmental concerns of the participants and then the table was created to organize results. As seen in the bottom table, drought was identified as the biggest environmental concern for participants.

	Drought	Plague	Heavy rains	Forest fires	Improper waste management	Extreme temperatures	Low harvests
Drought							
Plague	Drought						
Heavy rains	Drought	Plague					
Forest firest	Drought	Plague/ forest fire	Forest fire				
Improper waste management	Drought	Plague	Waste gmt.	Waste mgmt.			
Extreme temperatures	Drought	Extreme temp.	Extreme temp.	Extreme temp.	Waste mgmt.		
Low harvest	Drought	Plague	Low harvest	Low harvest	Low harvest	Low harvest	

Problem	Frequency	Rank
Drought	6	1

Plague	4	2
Low Harvests	4	2
Improper Waste Management	3	3
Extreme Temperatures	3	3
Forest Fire	2	4

In San Pedro Jocotipac, the Pairwise Ranking included drought, plague, heavy rains, and forest fires. The selection process proved to be impossible for participants and many comments were made such as "Both options have terrible impacts on the community." Due to this response, the entire pairwise ranking table was considered a four-way tie between drought, plague, heavy rains, and forest fires. It was then shared with participants that the outreach campaign would try to address adaptation strategies for all four impacts to the community. Results can be found in Table 3.2 below.

Table 3.2. Results of Pairwise Ranking Activity from San Pedro Jocotipac

Problem	Frequency	Rank
Drought	3	1
Plague	3	1
Heavy Rains	3	1
Forest Fire	3	1

Participants in Valerio Trujano chose hurricanes, cyclones, drought, and waste management as the elements for their Pairwise Ranking. The participants were quick to select drought as their greatest concern for the community as they had been currently in the midst a several-year drought. They also shared that historically the rainy season started in June, but as of September 2015, they were still waiting for the season to start. Participants commented that hurricanes and cyclones have historically impacted the community,

but within the past five years they had not been affected and that their immediate concern was drought. Results can be found in Table 3.3 below.

Table 3.3: Results of Pairwise Ranking Activity from Valerio Trujano

Problem	Frequency	Rank
Drought	3	1
Improper Waste Management	2	2
Hurricane	1	3
Cyclone	0	4

3.5 Tool 4: Majority Vote

In Concepcion Papalo, participants volunteered that media used in the community includes announcements (*perifoneo*), calendars (*calendarios*), workshops (*talleres*), pamphlets (*folletos*), Facebook, and murals (*bardas*). Participants were invited to describe each media and how the community now uses it. The feasibility for communicating climate change information was discussed in the group, and the workshop ended with a vote for the most appropriate media for sharing the message of adaptation with fellow community members (Table 3.4).

In San Pedro Jocotipac, soliciting comments and opinions proved to be very difficult during this activity, and only four young women participated fully during this portion of the workshop. When other participants were asked to share their opinion it was commented that either they did not hear well or did not understand. It should be noted that there were many senior citizens present at this workshop and in the future extra care needs to be taken to find a smaller space, microphone, or the facilitator must stand closer to those participants.

The four young women who participated fully offered pamphlets (*folletos*), posters (*posters/cartels*), videos (*videos*), announcements (*anuncios*), and banners (*manteles*) as other ways of sharing messages with the community. About half the group participated in the vote, at first because older participants could not

hear that they were supposed to be voting. Another vote was posed, after explaining the vote to these participants, and they unanimously chose announcements. It should be noted, though, that one of the young women participants who participated fully throughout the entire workshops took me aside after the vote to comment that the second vote among senior citizen participants was still not explained well to them, and that they thought they were voting on methods for inviting community members to workshops. Therefore, the option of including both posters and announcements for the community of San Pedro Jocotipac could be considered as the winner of the vote.

Participants in Valerio Trujano suggested types of media such as workshops, posters, murals, radio spots, announcements, and by word of mouth. The feasibility of each media was discussed in the group, and the workshop ended with a vote for the most appropriate media, posters, for sharing the message of climate change adaptation, with workshops coming in second.

Table 3.4. Results of the Popular Vote tool for preferred media for all three communities.

Media	Votes in Concepcion Papalo	Votes in San Pedro Jocotipac	Votes in Valerio Trujano
Video	6	6	-
Workshop	3	-	11
Poster	2	7	12
Announcements	1	10	8
Facebook	5	-	-
Radio	6	-	5
Calendar	4	-	-
Pamphlets	-	6	-
Face to Face Interactions	-	-	6

Between discussion and voting community members changed their opinions several times on what the best media would be for communicating climate change. Comments were made that just one media type would not reach the entire population because of where some people live with respect to the municipal office, community members' ability to read, interest in the topic, and age. The biggest limiting factor of these was interest of community members, to which participants stated that the most passive form of reception would be the most important. Participation in workshops was stated as nearly impossible to guarantee, but posters or murals that people could review on their own time and in their own way were seen as more culturally appropriate when trying to share information with the greatest number of people.

3.6 Tool 5: Pre and Post-Test

This tool, though theoretically important, proved difficult to implement with the community members in every community. Individual testing is not a culturally appropriate way to gauge understanding. Participants feel uncomfortable being asked to answer questions individually and naturally formed groups to answer questions. Even after it was explained that their grade did not matter, participants insisted on staying in their groups so as to not turn in blank sheets of paper.

The issues that we faced overall using this tool included: illiteracy among participants, fear of "answering incorrectly" which led participants to work in small groups, complex language and topics which participants did not understand, lack of time, and unforeseen distractions such as the PROCODES project coordinator arriving with the stipends for participants while the quiz was being applied. Despite all of these challenges, it was useful for us to observe participants' reactions to the tool and some of their answers. It should be noted that, for future projects, this tool should be modified as an oral quiz, a group quiz, or something that feels less formal and intimidating for participants.

3.7 Tool 6: Drought Survey

Drought surveys results are only available for two communities because the community of Valerio Trujano dropped out before we could apply this tool. The causes for this community's withdrawal will be discussed further in the section 4.4. Surveys were applied to 67 people in Concepcion Papalo and 78 people in San Pedro Jocotipac, which is 10% of each population. The surveys revealed that most community

members were familiar with the fact that water scarcity was affecting their communities, their parcels, and their economic security. What community members did not seem to have much knowledge about was the concept of adaptation or the opportunities to adapt to climate change and drought.

The questions and their answers are found in Figure 3.2.

1. For you, what is drought?
    A. It is the lack of water available to meet our different needs on the farm, at home and other economic activities.
    B. It is the lack of a good system of water supply.
    C. They are the impacts caused by the lack of water in the population.
    D. It is the dryness of the soil that we use for the crops.

2. Give an example of how drought is manifested in your community.
    A. Snow falls.
    B. It rains a lot more than before.
    C. It no longer rains in the season of the year that we expect it to rain.
    D. It's hotter.

3. Give an example of how drought can affect your community.
    A. The plants in our plots would not grow.
    B. The quality of the crops would not be as good as before.
    C. The plants in our plots would dry out.
    D. More than half of our crops would be lost.
    E. Disease may occur in the community.
    F. There may not be enough food in our community.

4. Why do you think it is important for your community to adapt to drought?
    A. To have fun.
    B. To continue farming in our fields.
    C. To have water forever.
    D. To preserve our customs.

5. Name a means of adaptation to the drought that families already use in your community.
    A. Rainwater harvesting through catchment systems.
    B. Water cisterns in homes.
    C. Reusing the water that was used to wash the dishes (gray water).
    D. Planting more trees.

Figure 3.2. List of questions and their answers that were used for the Drought Survey in Concepcion Papalo and San Pedro Jocotipac.

For Question 1, Answer A was the option that encompassed most completely what drought is. Answers B through D were considered to be components that fell below the overarching umbrella of Answer A so many community members decided it to be the best answer. This answer was also the most relevant for the most people. Answers B and C take a more community level look at drought and Answer D focuses on agriculture. Because we surveyed people from 18 to 90 years of age, and of all backgrounds from local leaders, to housewives, to *campesinos*, and taxi drivers, this answer was most relevant to their own daily struggles with water shortage.

We decided to list Answer C to Question 2 as an option because it was one of the first people would give us of climate change in all three communities. When deciding on their answer to Question 2, participants did not even have to reflect on the options before choosing Answer C. Some also included Answer D, that it is hotter now than before, but explained that the change of climate change was the change in seasonality of rain. This was the most chosen answer of the whole survey with nearly 70 positive responses from both communities (Figures 3.3 and 3.4).

Question 5 was the most difficult for community members to understand because of its technical language and the fact that it was asking for currently used adaptation techniques. Many answered that they were not sure what adaptation techniques were, or did not know which conservation works were being done with the goal of climate change adaptation, or did not know that conservation works could be considered adaptation actions, or did not know that they were being done at all. Most people had seen some sort of reforestation project at some point in their lives and suggested that it was something that they knew was good for the environment so it should also be good for climate change. Many people also suggested a reforestation was something that we should do if it was not already being done, saying things like 'we need more trees' and 'trees help to maintain soils humid and healthy.'

The results show that the communities had similar answers to from the Pre and Post-Tests show that community members in Concepcion Papalo and San Pedro Jocotipac had similar opinions on what drought meant, even though their ecosystems and access to water were very different.

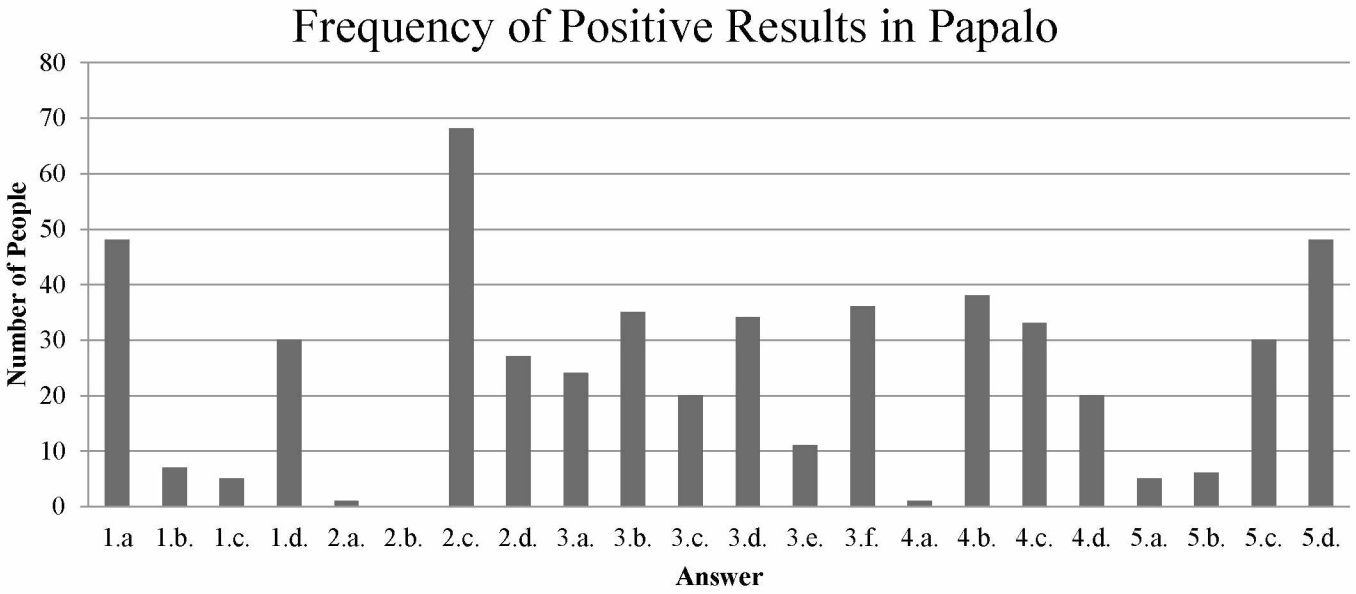


Figure 3.3 Bar graphs depicting the number of postivie responses from Concepcion Papalo to each answer of the Community Drought Survey questions received. Most correctly chosen answers were 1.a, 2.c, and 5.d.

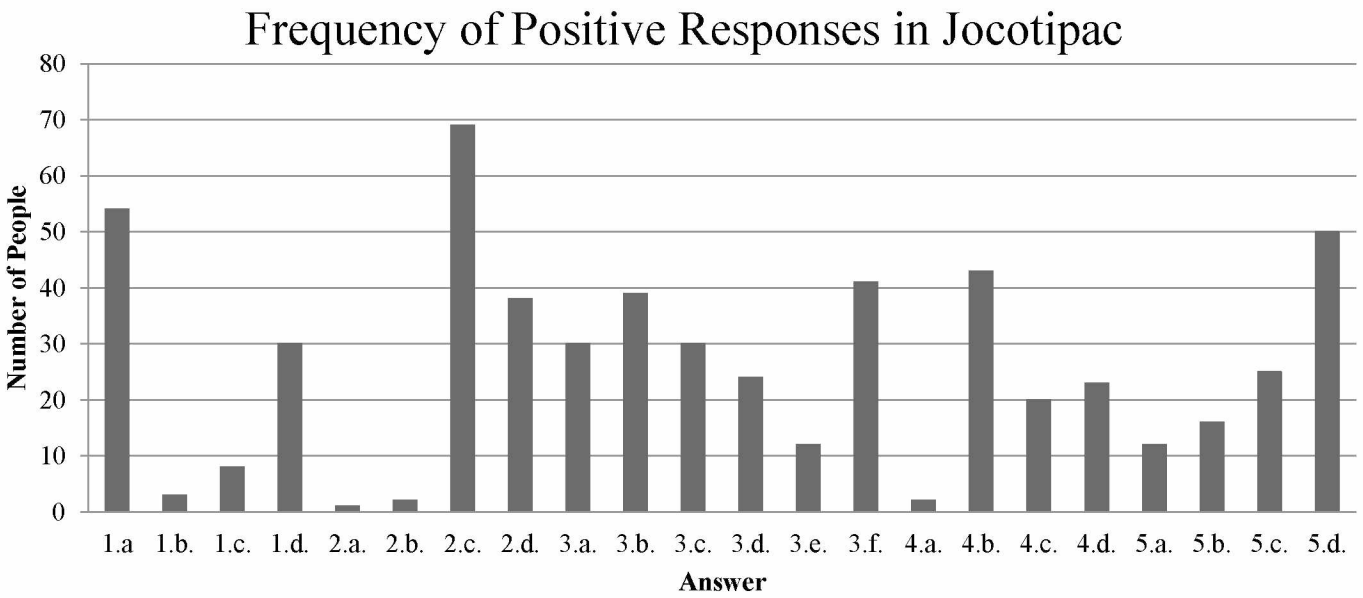


Figure 3.4. Bar graphs depicting the number of postivie responses from San Pedro Jocotipac to each answer of the Community Drought Survey questions received. Most correctly chosen answers were 1.a, 2.c, and 5.d.

3.8 Tool 7: Interview with Tehuacan-Cuicatlan Biosphere Reserve Staff

The results from Questions 3 through 6 will be shared below. The first two questions of our interviews sought to establish a baseline of how many years of experience each Staff member had in the region and which communities specifically he or she had worked in. This information can all be found in Appendices 7- 11.

When asked about the greatest socio-economic-environmental problems facing the communities (Question 3), Biosphere Reserve Staff commented that there were several problems affected the four regions of the canyon. For the valley, the most common response was that inadequate waste management. Also listed were deforestation, loss of soil fertility, infestations, water scarcity, illegal hunting, and employment. In the sierra, bark beetle infestation was the most common response. Staff also mentioned erosion, forest fires, low productivity of soil, deforestation, illegal hunting, lack of forest management plan, illegal extraction of firewood, inadequate waste management, change in soil use, and unemployment as other problems facing the region. For the Mixteca, water scarcity was the most common answer. Also mentioned were erosion, deforestation, degradation of soils, illegal hunting, infestations in palm groves, inadequate waste management, change in land use, and unemployment. For the Small Canyon region forest fires was the most commonly mentioned challenge with illegal hunting, erosion, land use change, degradation of soils, inadequate waste management and unemployment also mentioned.

Four of the five respondents admitted to having observed changes in these communities with respect to climate (Question 4). Some of these changes included increased extreme meteorological events and less precipitation than before. These changes affect corn crops, provoke more infestations that affect fruit trees and forests, and have led to increased migration of community members to find work. Three of the five respondents commented that they were working on climate change adaptation projects (Question 5) such as reforestations and soil conservation works.

All respondents agreed that the communities were vulnerable to climate change (Question 6). The reasons given for this vulnerability were the socioeconomic situation of the communities and the susceptibility of landslides in the region. Suggestions given for its improvement were more crop diversification, planning for climate change, building soil and water conservation works, restoration projects, studying changes in the forest, and reforestation. One respondent mentioned commented that these

projects were only feasible if there was money available to pay community members for participating in these types of projects because otherwise there was little community participation.

Chapter 4 Evaluation

4.1 Evaluation of Tools

From the seven different investigation tools we were able to gain a better understanding of the climate change situation in the region canyon of the Tehuacan-Cuicatlan Biosphere Reserve. We learned about the challenges that each community was facing, what already was being done to adapt to climate change, and how to best communicate important information with the population. That information will be discussed below, as well as our reflections on the effectiveness of the tools for obtaining the material that we sought.

4.1.1 Tool 1: Guiding Questions at Local Level

This list of questions addressed many important topics for building resilient communities. The questions themselves cannot be used as is with local leaders in the case of the Tehuacán-Cuicatlán Biosphere Reserve because they use complex language. When asked the questions as written, local leaders asked for the question to be rephrased or explained in another way. Many local leaders have only completed elementary school and struggle with language and concepts that are addressed in this list. On the other hand, most of the topics asked about were not issues that local leaders were currently addressing or were concerned with. At first the endless "No's" or "I don't know's" responses were frustrating to hear, but illustrated that many of the services and institutions in place at the national level do not trickle down to local leaders and community members where we are working. We heard of no outreach or training done by the federal government in order to prepare local leaders for their role as climate change adaptation facilitator. Another final observation is that it is helpful to find out the names of government programs such as *"Proteccion Civil"* so that they can be used during the interviews so that local leaders can better orient themselves to the questions.

4.1.2 Tool 2: Stratified Timeline

The stratified timelines proved to be useful for collecting large amounts of information in a single tool. Community members enjoyed sharing information about their communities and almost every participant contributed to the discussion afterward. The construction of these tools took over an hour and

can run even longer if there are many groups that need to present their timelines. Facilitators need to schedule enough time for everyone to design their stratified timelines and present their information. Often there were disagreements about when events actually occurred and it took extra time to work out the details.

It should be pointed out that this timeline is the only record that we were able to find of climatic events, natural disasters, and their impacts on the communities that participated in this project. Investigation into Civil Protection of Oaxaca (*Protección Civil*), the National Water Commission (CONAGUA), and the communities themselves revealed that this information either did not exist or was not organized in a way that could be shared with the Biosphere Reserve. Weather stations, (managed by CONAGUA) provide monthly averages of temperature and precipitation which dilutes extreme weather events such as heavy rainfall that occurs over short periods of time, or one day of extremely high temperatures. Extreme weather that affects these communities is not seen as a national emergency because there is no important infrastructure and low population, and records are only made of extreme weather events when large amounts of aid are sent there.

One weak point of the stratified timeline was that we were unable to take the information presented and turn it around into a talk on climate change. After participants shared their timelines the workshops were ended because participants were tired and the facilitators could not make a snap judgment on the climate change issues to be discussed. Time was needed to process the timelines and prepare for the pairwise ranking tool discussed in the next section. Additionally this tool helps participants share about extreme weather events such as floods or hurricanes, but does not provide a space for participants to talk about changes in weather patterns, rainy seasons, or other gradual shifts in climate, preventing us from capturing the full climate picture. This could be improved if facilitator collected information on other types of changes that have occurred with a follow-up discussion.

4.1.3 Tool 3: Pairwise Ranking

For all three communities, one of their main preoccupations was drought and/or water scarcity. Drought has many different scientific definitions and quantification methods, but what every community has in common is the inability to meet their water needs. It is interesting to mention that these workshops were carried out in the summer of 2015, which is typically the rainy season in this region of Mexico. At this

time, the rainy season was two months behind schedule, and community members were clearly suffering from water scarcity in their homes and farms, which may have contributed to them placing the highest priority on water scarcity. It would be interesting to conduct this workshop during or after the rainy season as well to see if opinions and priorities change.

4.1.4 Tool 4: Majority Vote

The majority vote was simple to implement and provided us with important information as to the preferences of community members, how comfortable participants felt sharing opinions with the rest of the group. Because the subject matter was more familiar than what was discussed in the Pairwise Ranking tool, more people participated in the discussion.

Participants' skepticism in the usefulness of workshops for communicating important information further explains the use of stipends or compensations for participation in government funded soil and water conservation works. Community members see time spent in a workshop as time and money lost. It is important to keep this in mind while designing an outreach campaign: communicating information may be important or useful to community members, but if it is not economically viable for them, they will not be able to participate.

4.1.5 Tool 5: Pre and Post- Test

This tool was discussed in the Results section 3.6 because we could not gather any meaningful results from its application. This tool was culturally inappropriate for understanding community members' perceptions of climate change due to its individual and test-like nature. This tool could be better used if community members could construct responses collectively.

4.1.6 Tool 6: Drought Survey

The drought survey was developed by the coordinators of communication and environmental education for the biosphere reserve, who believe that even surveys should be a teaching tool for community members.

For that reason, the questions are dense in information and nearly all answers are correct. The belief was that: even if the surveyor knew little about the topic, he or she could gain more information by listening to the answers. In practice, this theory did not seem to work mainly because the language was very advanced for the majority of community members who have only completed grammar school and Spanish as their second language. Many surveyed people chose only one answer for each question even though they were encouraged to choose more than one answer if they sounded correct. Additionally, we had to reword many questions on the spot because community members could not understand them. The design of the survey, in which almost all answers were correct, also confused community members who are more used to there being one correct answer per question. This should be modified in the future to make sure the survey is more user-friendly. Some incorrect options were originally added because Biosphere Staff decided that more than one or two possible options did not exist. This could be improved upon for next time by creating variations of the one correct answer

What we learned about community members' knowledge of climate change is that they are well aware that seasons are no longer occurring at the same time of year they always have. The overwhelming response from community members that climate change for them was manifesting as a shift in seasonal rains means that in the design of the outreach campaign, less focus would have to be put on this aspect of climate change. Community members are already living these effects and do not need any convincing that seasons are no longer predictable.

4.1.7 Tool 7: Interview with Tehuacan-Cuicatlan Biosphere Reserve Staff

The interviews were an effective tool for gathering Biosphere Reserve staff's opinions in a short amount of time. The fact that it was written up and sent via email allowed staff to answer when they had time, which was essential due to the fact that staff works in the field every day. Written interviews were returned by all but one staff member who had experience working in the canyon region, which probably because he was reassigned to a new protected area shortly before the interview was sent out.

We learned that some staff members were aware of what climate change adaptation meant and others were not. Training staff members on this information will be of utmost importance for effectively communicating it with communities. As seen in Appendix 10, Veterinarian Juan Manuel Salazar Torres mentions at the very end of his survey that there is no effective environmental education happening in the

Biosphere Reserve, which also contributes to communities' vulnerability. Due to budget, staff, and time limitations environmental education does not take place in all communities of the Reserve, and is usually restricted to one or two brief visits or activities a year. This is another reason why creating an outreach campaign that can stay in the community in the form of murals, pre-recorded loudspeaker announcements, or posters is so appealing to Biosphere Reserve staff: because they can allow the campaign to take place, without having to be present. An outreach campaign where community visits are not required educates community members and frees up staff members at the same time to carry out visits to other communities.

4.1.8 Summary of Evaluation of Tools

Our tools revealed that community members had observed higher temperatures, less precipitation, drought, and unseasonal rains in recent years. Community members also observed that these changes in weather had impacted the quality and quantity of their harvests leading to food scarcity and reduced incomes. Few individuals were able to identify the drivers of climate change, their own vulnerability, or the importance of adaptation to those changes. We interpreted these comments as indications that community members were in the early stages of the decision-making process regarding climate change adaptive action, as seen in Figure 4.1, which depicts the stages of the decision-making process according to Ekstrom and Moser (2014). It was our hope that by providing community members with more information about climate change and adaptation they could make more informed decisions when they were ready to take action. There is no timeline associated with the process depicted below and facilitators or change agents should be aware that it could be years before community members progressed from the understanding phase to the planning for adaptive action phase.

The Biosphere Reserve Staff Interviews revealed that staff was in the Managing stage of the climate change adaptation process in that they were planning and implementing adaptation projects in the local communities. Not all staff members were in the managing stage of climate change adaptation, but those who worked most closely with community members were also the ones who were in the managing stage. Other staff members were only aware of climate change issues, but were not at the level of planning nor managing adaptation projects.

4.2 Process Considerations

This section discusses some of the lessons learned while implementing this project. These considerations focus on the process and provide explanations for why some aspects of the project did not come out as originally planned.

4.2.1 What Happened in Valerio Trujano?

In November 2015, the community of Valerio Trujano withdrew from the project due to political unrest and local violence that directly affected the *comisariado*. It is important to point out that this community has had a long history of political strife and though certain community leaders were interested in the project, it was not possible to pursue further at that time. The *comisariado* warned me that if I was to continue working with the community it could jeopardize both his safety as well as my own. Around the same time local leaders also decided to sever communication with the Biosphere Reserve in order to focus on resolving local issues which included corruption, family conflicts, and impinging organized crime.

Climate change adaptation can be either facilitated or impeded by the social conditions of a community. In the case of Valerio Trujano, the lack of political organization and internal conflicts reduces their ability to adapt to climate change by drawing attention and resources away from climate change issues. In general, community members were aware that the climate was changing and that it was affecting their ability to farm as they had in the past. Most mentioned, though, that due to political problems within the community, climate change was not the first thing on their minds. It was also evident that lack of education made the conceptualization and processing of climate change information difficult for community members who only had a fourth grade education level.

According to Maslow's hierarchy of needs, safety ranks right above the most basic survival needs. In the community Valerio Trujano, community members were preoccupied with their own safety due to political conflicts, which often turned violent. Because community members' needs for safety were not met at the time when we were trying to organize the outreach campaign, they were unable to address higher needs. Self-actualization is the highest tier of the pyramid, which includes morality, problem solving, and acceptance of facts. Climate change adaptation and other actions that are seen as just caring for the environment all enter into this level of the pyramid if immediate results are not seen, by community

members, as applicable to their safety or survival. Community members saw the impending danger of political conflict more urgent than climate change adaptation. Until this threat is removed, or the threat of a changing climate becomes more immediate, such as a deadly hurricane or drought, community members will continue to focus on political unrest.

In other cases, it has been seen that conditions of social and economic stability within a community help to facilitate climate change adaptation (United Nations: Department of Economic and Social Affairs, 1995). When an individual's basic needs of survival, security, and love and belonging are met he or she is able to think critically about his or her impacts on the planet and acting in an environmentally sustainable manner.

4.2.2 Community Perception of the Facilitator

When working with rural communities, it is important to understand local perception of the investigator. Participation in environmental education activities that were not attached to a monetary benefit was regarded as a general waste of time, or a disregard on the part of the investigator for the time and needs of community members. It is important to keep in mind that local people have the same attitude towards Biosphere Reserve staff members, and expect a payment for participation in a project or workshop.

Additionally, community members do not trust Reserve staff, despite 18 years of continued community visits. Community members will always be wary of Reserve representatives, due to the fact that they are not from the community and are government employees. Among people from this region there is even a sense of suspicion of people from neighboring communities, as they are still considered outsiders. It is also fitting to mention that it is important to consider past experiences of these community members with investigators in which projects were not carried out with informed consent. Several participants had commented that other investigators had carried out their own research on local people or wildlife and left with samples and information, but never returned their findings.

As a project facilitator, community members must find participation in your project worth their time and money. Many community members see time spent in a workshop as a loss of time that they could be spending in their fields or on their trade, making it unrewarding to participate. If participants could be compensated for their participation in the project, higher attendance and more active participation might be

expected As a facilitator working with this status quo, it is important to consider that the community members will expect compensation when signing up for workshops.

Establishing trust in the project and belief in the existence of climate change are essential for carrying out research in communities (Weber, 2010, p. 10). Maintaining an active presence in the community and participation in local activities can help to familiarize community members with investigators. My workshops were not carried out in the same location in which I lived, which made it more difficult to develop a relationship with community members, thus reducing trust in the project. Culturally it is essential to establish a relationship with local authorities and those who will be participating in the event prior to starting any investigation. This allows both participants and the investigator to focus on climate change adaptation and collecting data, instead of trust building, which takes much longer to cultivate.

Despite the social and political issues, which inhibited our ability to carry out an outreach campaign, this work laid the foundation for future climate change adaptation initiatives among Reserve communities as well as for Staff. Through participation in the workshops and survey, community members gained more familiarity with climate change adaptation vocabulary and its presence in the community. Similarly, Biosphere Reserve staff gained experience in delivering tools and workshops to community members, as well as better understanding of climate change adaptation topics. Staff will be able to apply the skills and knowledge gained to a new initiative that has been started across the country called *Resilencia* (Resilience), which is a systematized adaptation plan for all protected areas of Mexico.

4.2.3 Mexico's Preparedness

Mexico, though highly active in international climate change policy such as the INFCC and COP summits, and at the national level in developing climate change policy, seems to lack the same level of support for local governments. The creation and maintenance of Civil Protection falls completely on local governments, which, in the case of Oaxaca, often lack the experience, knowledge, or resources to plan for disasters. The high number of municipalities in Oaxaca often means that leadership roles such as president or secretary of environment are occupied by people who may have only acquired an elementary level education, which does not cover issues such as climate change. Though it is true that rural Oaxaca generally has less infrastructure, population, and investments than other parts of the country; these populations are often the most vulnerable to slight changes in temperature and precipitation due to the

prevalence of subsistence farming. Though the government recognizes the vulnerability of subsistence farmers to climate change, there is a lag between the creation of policy, and the implementation of actions to reduce the vulnerability of these farmers on the ground. There is lack of focus on education for these vulnerable groups, which presents an opportunity for Biosphere Reserve staff to build their outreach campaign focusing on these populations specifically. According to the federal government, Tehuacan-Cuicatlan Biosphere Reserve communities are not even regarded as the most vulnerable in the country, and therefore not a priority, meaning that the support coming from the Biosphere Reserve may be the only support that these communities receive.

Chapter 5 Discussion and Conclusion

5.1 Discussion

Public perceptions of climate change can be investigated through a variety of methods such as observations, questionnaires, polls, focus groups, key informant interviews, and participatory workshops to name a few (KIMANI, OGENDI, & MUTUA, 2014, p. 62) (Swim et al., 2008, p. 23) (Keim, 2009) (Wolf & Moser, 2011). We decided to use seven tools in order to cross-reference our data and gain a more complete idea of how climate change was affecting participating communities, and the adaptations that were taking place (Table2.1). Tools were taken from a variety of sources such as other local researchers (Roge et al., 2014), international organizations (Daze et al., 2009) (The Peace Corps, 2005), and original tools created with Biosphere Reserve staff. We applied these tools to local leaders, participatory analysis groups, and individual community members in order to best capture local voices and perceptions. Each tool was targeted to a specific aspect of climate change to help participants focus on specific issues.

Obtaining local weather data and climate predictions proved to be more difficult than anticipated. The National Water Commission (CONAGUA) has weather stations located in communities across the region, but lacked updated data on temperature and precipitation, and local predictions of how climate change would affect communities. Additionally, the only climate data available for these communities was monthly maximum, minimum and average temperatures and average precipitation. Climate change manifests itself as an increase in global temperatures, but at the community level, these changes are manifested as more extreme temperatures, shifts in seasonal rains, and more intense storms. These types of events can be lost when data is averaged over a month. In order to better help prepare communities to adapt, we need a way to quantify and communicate extreme weather events that are more impactful to vulnerable communities.

Local leaders, who are responsible for communal land management at the community level, were aware that the climate was changing, but did not know that adaptation was possible and did not see it as a priority for their community because of the temporary nature of their political charge. Community leaders were in the Understanding stage of climate change adaptation and would not proceed to the Planning stage until they reached a threshold of concern about its impacts (MOSER & Ekstrom, 2010, p. 22028). Emergency support from the state and federal government was identified by local leaders as their only emergency action plan and no adaptation plans were being planned or implemented. Without the support and interest

of local leaders, community-wide adaptation can be greatly hindered. Adaptation options, in such cases, must come from community members themselves, or mandates from higher government that prioritize adaptation.

Tools applied to community members such as the Stratified Timeline, Pairwise Ranking, and Drought Survey were used to understand local perceptions of climate change, and if any adaptive actions were being taken at the household level. These tools revealed that community members were also aware of climate change and that it was manifesting as lack of seasonal rains, increased extreme weather events, and hotter temperatures. The greatest concern of the majority of participants was the lack of seasonal rains which also impacted community members in terms of their ability to plants crops on time, increase in infestations on their farms and forests, and decreased food and livelihood security. Community members drew links between the changing climate and their complications with harvesting enough food for their families. This was an expected result, as community members do not have a safety net for food or income. Community members normally do not have access to irrigation for their crops either, making seasonal rain the only source of moisture for their crops.

Living within these tight constraints, community members have had to resort to taking actions in order to maintain themselves and their families. As stated by participants in the Stratified Timeline workshop, support was requested of the state government in the form of food rations or money. Young men are faced with the difficult decision to emigrate to the United States or large cities in Mexico in order to find work to support their families. Other people were just waiting out the droughts, praying, and making due with less, as they have in other years of intense drought. We expected to find more adaptive actions being taken by community member on their farms, such as soil and water conservation works, but the only projects of this nature mentioned were suggestions by community members such as reforestations to increase infiltration.

We encountered problems implementing the tools that required one-on-one conversations with community members such as the Drought Survey and the Pre and Post-Test. One-on-one conversations are culturally appropriate within the community, but our position as government officials and the formal nature of these tools unnerved participants. Participants commented that they would rather not answer questions than answer incorrectly. As a result, community members' true knowledge of climate change adaptation in the community could not be captured. It is more culturally appropriate to work with community members in groups where dialogue can be created among participants and less pressure is felt to 'perform.' Tools

such as the Stratified Timeline, which were created collaboratively in groups, were much more culturally appropriate for working with these communities and generated productive conversations.

Tools that used excessively technical language, such as the Drought Survey, were also difficult to apply and capture community members' knowledge. Questions were rephrased on the spot to communicate their contents to community members, but each surveyor paraphrased in his or her own manner. This should be avoided to reduce incongruences among responses, by using questions that are easier for participants to understand. This problem could have been avoided by conducting a pretest beforehand with a small test population that could provide feedback on the appropriateness of questions (Vannette, 2014). Community members typically have a fourth grade education level and question design should take this into account. Even words like adaptation, which are central to climate change discussion, are not vernacular for community members and must be explained within the questions.

Another hurdle that we encountered was civil unrest that caused one community to withdraw completely from the project. Withdrawal of a participating community not only negatively impacts this opportunity to learn more about climate change and adapt to it, but also impacts the researcher and the project. In our case study, we proceeded with the two remaining communities, and did not search an alternative community to fill Valerio Trujano's space. Searching for a new community could have implied a loss of time or resources for the project, and in our case, there were no other potential communities located in the region receiving a soil and water conservation project with the Biosphere Reserve to invite to participate in this research. Civil unrest is not uncommon for communities in the state of Oaxaca, and investigators should be aware of the political situation of a community before starting work with community members.

Biosphere Reserve staff have, on average, ten years of experience of working with communities within the Reserve. Depending on staff members' specialty, their familiarity with local socio-economic and environmental issues varies greatly. Each staff member works with different communities within the reserve, which each has its own unique set of challenges and threats. Despite workshops that have been given on climate change there is still much need for adaptation related training for staff members. All projects that Reserve staff are currently working on such as soil and water conservation, wildlife monitoring, promotion of native corn cultivars, and ecotourism all support the goal of reducing their vulnerability to climate change. Encouraging staff to communicate the importance of these projects with

respect to climate change to participants in these projects could help to increase awareness of adaptation at the local level.

The extension of the work presented here would be the creation and implementation of an outreach campaign using information collected with the seven tools. We originally set out to carry out an outreach campaign following the initial investigation presented in this case study, but due to civil unrest across the whole state of Oaxaca, it was deemed unsafe. The first draft of the outreach campaign plan was created before civil unrest broke out, and can be found in Chapter 6.

This work could also be expanded by Biosphere Reserve Staff to include more communities within the region to gain a more complete perspective of how climate change is manifesting within the region and how local people are adapting. We chose three communities, which were representative of the three distinct sub-regions of the Oaxacan canyon: the Sierra, the Valley, and the Mixteca. Among these three sub-regions there are dozens more communities that will each have their own set of unique climate change adaptation challenges to overcome.

5.2 Conclusion

This investigation set out to understand community members' perceptions of climate change in three rural indigenous communities in the Tehuacan-Cuicatlan Biosphere Reserve, Mexico. Community members shared that they were aware of the changing climate, which manifested itself as a lack of seasonal rains, high temperatures, and more intense hurricanes and storms. The impacts of these changes were also identified by community members, such as loss of harvests, food insecurity, increased infestations in the forests and fields, increased forest fires, and migration of community members in search of more reliable livelihoods. Community members shared that they were not actively adapting to climate change due to lack of resources and information on how to adapt. Several adaptation projects were already taking place in each community in the form of soil and water conservation projects, but community members were not aware of them or their role in climate change adaptation. Governmental institutions such as the Tehuacan-Cuicatlan Biosphere Reserve are the main actors spearheading these adaptation projects in the participating communities, and are responsible for the construction of these works, but the environmental education aspect of them is often omitted. Communication and outreach efforts could be used to raise community

members' understanding of climate change and concern about adaptation which is important for moving people's stage of climate change adaptation from Understanding to the Planning level.

Climate change impacts are specific to the ecosystem, climate and activities of local people. Efforts such as the one shared in this case study focus on understanding these impacts and adaptations of people at the community level. It is important to document and share the experiences of communities with respect to climate change adaptation because they reflect the uniqueness of every situation being felt throughout the world, and the diverse options to help communities adapt. Armed with this information, environmental educators can enrich their own approach to communicating climate change adaptation to their audiences and tailor it to be culturally, environmentally, and socially appropriate.

Chapter 6 Future Work: Design of an Outreach Campaign

6.1 Introduction

The next phase of this project should be the design and implementation of the outreach campaign we had hoped to conduct, beginning with planning and development of the campaign's materials. Outreach campaigns are used to increase awareness and share information with a large population in a relatively short period of time, which in our case, could be six months. Outreach campaigns can span shorter or longer periods of time, but six months was determined appropriate by Biosphere Reserve staff for this pilot project, based on the length of previous outreach campaigns.

We compiled the data collected in the participatory workshops carried out in the summer of 2015, as well as community surveys and interviews with Biosphere Reserve staff to evaluate the biggest threats and opportunities for environmental communication in the region. All sources generally agreed that there was a lack of hydrological resource for the communities and that there was a great need for environmental outreach and education. This is an opportunity to plan an outreach campaign that addresses the vulnerability of the region to climate change and the potential for adaptation activities.

6.2 Pride Campaigns

One of the main activities of Tehuacán–Cuicatlán Biosphere Reserve is to provide relevant environmental education to local adults and children. Historically, environmental education has taken on the form of workshops, eco-fairs, classes, and campaigns, among others. Staff had designed and carried out two previous outreach campaigns before the start of this project: one that promoted water conservation in the northern region of the Reserve in 2005, and one that promoted conservation of the green macaw in the southern part of the reserve in 2008.

All of these outreach campaigns followed the Pride methodology created by Rare (Rare, 2007). Rare is an international conservation organization whose mission is to help communities adopt sustainable behaviors towards their natural resources. Their mission is achieved through community-level marketing campaigns called Pride. Rare identifies that "conservation's greatest challenge might be human behavior" and that encouraging pride in one's community and local resources can also encourage people to conserve them. Pride campaigns use a unique natural asset (usually a flagship species), demonstrates its importance

and the importance of the local community for its conservation. These campaigns also give local communities information and tools to enact local conservation.

The Pride methodology of social marketing was to be used for the climate change adaptation campaign because of its proven success in the region and its multi-pronged approach. Pride campaigns communicate climate change adaptation, address adaptation techniques for local people, promote the role of community within the ecosystem, and help people to appreciate their role in the conservation of their own natural resources.

6.2.1 Community Awareness

The Pride Handbook by Rare describes the importance of assessing the level of awareness of the community before designing outreach campaign materials. I have adapted The Stages of Behavior Change to climate change-relevant information.

1. Pre-contemplation Stage: The target audience is not considering a change and/or has very low levels of knowledge about climate change-related drought. Audience may not understand benefits or even be aware of alternatives to suffering drought.
2. Contemplation Stage: The target audience is aware of the proposition of adapting to climate change but ambivalent about changing. During this stage, they assess barriers (time, expense, hassle, fear, "I know I need to, but ...") as well as the benefits of taking adaptive action.
3. Preparation/Decision Stage: The target audience is prepared to take a specific climate change adaptive action. They may experiment with small changes as their determination to change increases.
4. Action Stage: Adoption of climate change adaptation has begun. The audience in this phase needs praise and constructive reinforcement to ensure adaptation is sustained.
5. Maintenance: Maintenance and relapse prevention involve incorporating the new behavior in the long-term and continually recognizing leaders of change. In other words, this phase ensures that the target audience continues to carry out their chosen adaptive action even "after the cameras leave." In this phase the sustainability of the climate change adaptation is tested. *(Prochaska and DiCelmente as referenced in Andreasen, Alan. 1995. Marketing Social Change:*

Changing Behavior to Promote Health, Social Development, and the Environment. San Francisco: Jossey-Bass.)

Workshop and community survey results revealed that many community members were in the pre-contemplative stage of change, as discussed previously, meaning that they were aware of drought, but did not know about the option of adaptation to drought (aside from a few individuals who were able to mention adaptation techniques). The list of Stages of Behavioral Change relates to the Decision Making Process graphic shown in Figure 3.1 in that the Pre-Contemplative and Contemplative stages of Behavior Change can be thought of as the Understanding phase of the Decision Making Process.

6.2.2 Theory of Change

Additionally Rare suggests creating a "theory of change" which is a holistic look at how the campaign will create sustainable change for biodiversity conservation. The theory of change requires you to think about the objectives of the outreach campaign holistically before the start of the campaign, as part of the planning phase. They encourage you to plan the objectives of the campaign with respect to the people affected, the actions you would like to carry out, setting, and expected outcomes.

The people affected by our outreach campaign are the population of the communities of San Pedro Jocotipac and Concepcion Papalo. The campaign will focus especially on the beneficiaries of the governmentally funded soil and water conservation projects. This campaign will produce increased awareness in climate change/drought adaptation options, an increase in individuals who can mention adaptation technologies, and a higher enrollment/participation in governmentally funded soil and water conservation projects.

This program will include sharing recorded radio spots that can also be used as loudspeaker announcements, at least 1 mural in each community, and participatory workshops with the community members who are participating in the governmentally funded soil and water conservation projects for 2016. The design and development of these materials will take place in the main office of the Tehuacán Cuicatlán Biosphere Reserve office in Tehuacán, Puebla. The implementation of these materials and activities will take place within the communities of San Pedro Jocotipac and Concepcion Pápalo.

6.3 Our Outreach Campaign

The plan for our outreach campaign can be seen in Appendix 12. This plan was created in June 2016, right before I was evacuated from the state of Oaxaca. It is not a finalized plan, but due to my removal from the project, lack of human resources, and other priorities, Biosphere Reserve staff has not improved upon this version. Nevertheless, the plan contains essential information such as the message and media types that would be used. The plan includes many approaches to communicating climate change adaptation and adaptation options for community members. Because climate change vulnerability involves many factors, the adaptation techniques should address many of these factors.

This outreach campaign follows a three-phase strategy. This campaign includes workshops and radio spots in all three phases, with the mural being painted in the final phase. The first phase of this campaign is designed to inspire pride in the audience's identity and community as a unique and important place to protect. This phase will also introduce the topic of climate change and some climate change predictions for the region. The second phase is designed to inspire rational and moral reactions to climate change. This phase will introduce the ideas of mitigation and adaptation to climate change and some options for the types of climate change impacts experienced in the region. The third phase is designed to inspire hope and action among community members. In this phase information about previous adaptation works are shared and community members learn how to create new ones. The outreach campaign should span six months, with each of the three phases lasting two months.

The media used in the outreach campaign would be a combination of radio spots, participatory workshops, and community murals. Radio spots were chosen as one of the most viable media channels to communicate information to community members in all three communities. These spots can be recorded and used over the loudspeaker system that each community has in their town hall as well as on public radio stations in Tehuacán. Workshops were not voted as the most popular mode of communication in previous workshops, but due to the complexity of the information regarding climate change and the requirement of holding workshops for those community members participating in the government subsidized soil and water conservation projects, Biosphere Reserve staff decided to include workshops in the outreach campaign plan. Finally, murals can take the place of the posters that were elected by community members in previous workshops due to their permanence and lower cost.

The workshops planned for this outreach campaign involve both visiting local soil and water conservation works and creating new works. In both communities there are already existing retaining rock walls and trenches on hillsides to encourage water retention and infiltration. These previous works can be seen in the outreach campaign plan under the lists of previous government assistance projects. Expanding upon these constructions by building more and including reforestation as part of soil and water retention were planned to increase local soil humidity. There is no one solution to water scarcity for rural communities because there are often many factors that reduce availability of water and increase vulnerability of local people. Employing a collection of techniques to reduce local vulnerability and increase availability of groundwater is the most effective way to help rural communities adapt to climate change.

6.4 What Happens after an Outreach Campaign?

An outreach campaign alone does not reduce a community's vulnerability to climate change. Follow up actions such as a community supported soil and water conservation project, alternative income project trainings, or some other option are essential to build upon the knowledge gained from the outreach campaign. These activities would be identified by community members once they have progressed towards the Planning phase of the Decision Making Process. The goal of the outreach campaign is to inform various community members in a relatively short amount of time on climate change issues, the importance of adapting, and how to adapt. This information, coupled with community members' previous experiences with a changing climate in their daily lives helps empower them to make informed decisions on when and how to adapt.

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Appendix 1: Lesson Plan for Workshop 1

Lesson Plan 1: Community participatory groups of the climate change outreach campaign project

Topic: stratified timelines

Purpose: To construct a stratified timeline with the group of participants.

Skills that are applied:

• Reflect on the climatic history of the community. Link climatic events with human activities / adaptations.

Time: 150 minutes.

Didactic resources:

• Tables

• Pre-evaluation

• Flip-chart paper

•Markers

•Pencils

Workshop Agenda

05 min: Welcome

Presentation of staff Group of 20 -30 community participants

10 min: Project Presentation

Present the schedule and anticipated products of the project

10 min: Pre-assessment

Present pre-evaluation. Invite participants to fill pre-assessment

1 hr 30 min: Construction of stratified timeline

Separate people into groups of 10 people. Present the idea of stratified timeline. Provide paper and markers to each group and explain that each level requires year and brief explanation of the event. Start with first level: Historical events (10 minutes). Second level: Climatic events (10 minutes). Third level: Impacts to the community (10 minutes). Fourth level: community/individual adaptations (10 minutes).

Give each group 5 minutes to present their work to the other group.

20 min: Reflection Guided questions

• Did we observe differences between the two chronologies that were made? What were they?

• Do we observe any relationships between events? The impacts? The adaptations?

Observing the chronologies: if something happens to us again how can we prepare and / or react?

05 min: Close

Thank participants and schedule the next workshop

Appendix 2: Lesson Plan for Workshop 2

Lesson Plan 2: Community participatory groups of the climate change outreach campaign project

Topic: Designing an Outreach Campaign
Public: Adult men and women in the community (Community Participatory Groups).

Objectives:
• Prioritize an environmental/climatic problem that will be communicated in the outreach campaign.
• Jointly select the communication medium/a of the outreach campaign to promote adaptation to climate change.

Skills that are applied:
• Development of critical thinking in the detection of adaptation needs to climate change.
• Knowledge of the implementation of a dissemination campaign.

Time: 180 minutes (3 hours)
Didactic resources:
• Tables
• Chairs
•Flip-chart paper
•Markers
• Stratified Timelines created in the last workshop
• Broadcast materials (video, radio recording, brochure, poster)
•Speakers
• Laptop
• Projector

10 min: Welcome Presentation
Presentation of goals for workshop 2 (revisit project goals)

20 min: Workshop 1 Review
Share results of Workshop 1.

30 min: Pairwise ranking
Create a pairwise ranking table with environmental/climatic problems in the community, using the Stratified Timelines created in the last workshop if participants need a reminder. Explain how a pairwise ranking works and carry out the activity with participants.

20 min: What is Communication/ Outreach?

What is outreach? What is the goal of communication or outreach? How do we communicate in the community?

30 min: Group Activity

Form three groups. Give each group a communication media (writing, poster, audio, video etc). Give each group time to observe their media and answer the questions:

- What kind of media did they receive?
- How was the message shared?
- Have you seen a campaign like this in the community?

Give each group 5 minutes to present their media and the answers to the questions.

15 min: Reflection/Discussion of Media Assessment

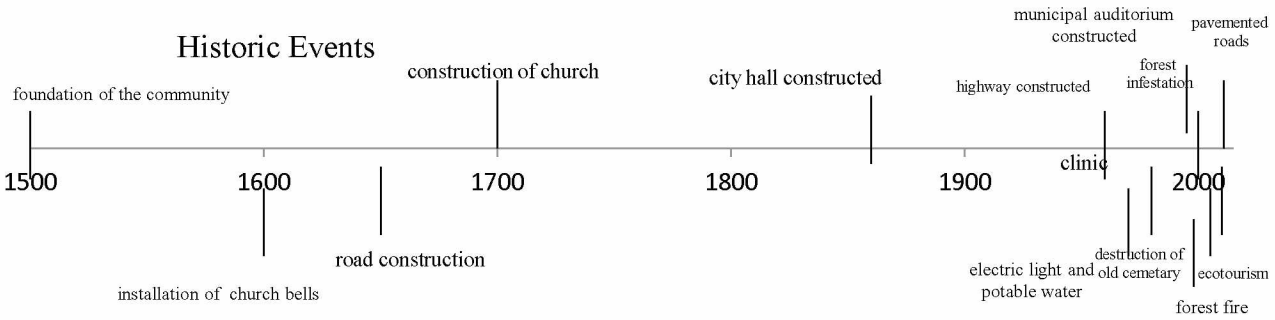
- Which media shared your message better?
- How do people in the community prefer to receive important information?
- Would one of the media be inaccessible to members of the community? Which one and why?

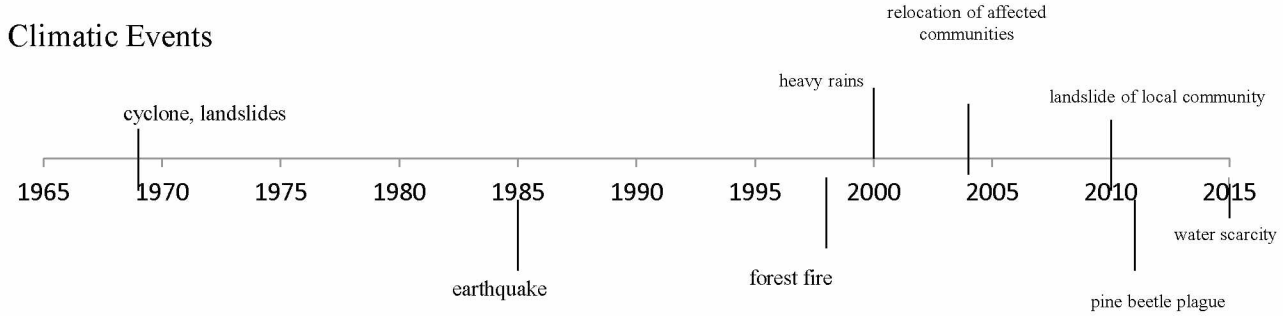
20 min: Closing

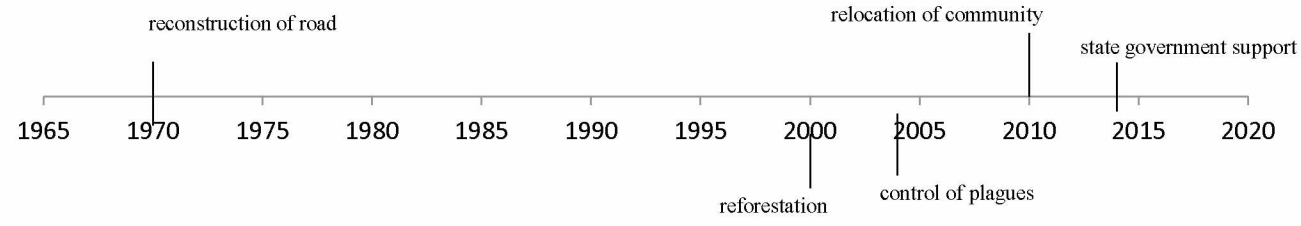
Share plan for next steps. Ask participants:

- What was the most useful / interesting of the workshops?
- What information on climate change and adaptations did we want to share in the outreach campaign?

Appendix 3: Stratified Timeline 2 for Concepcion Papalo

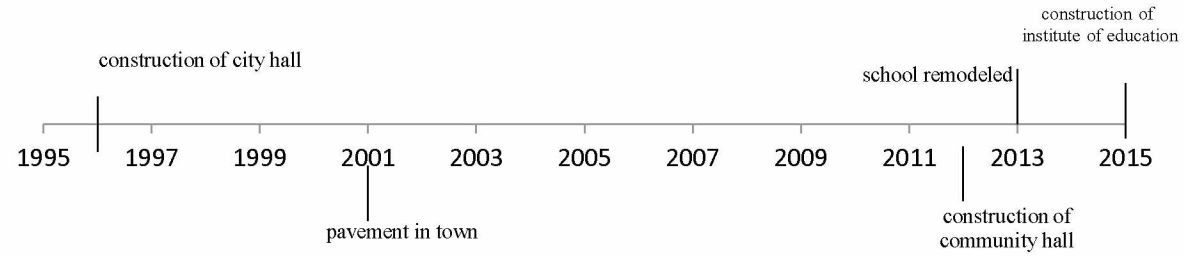




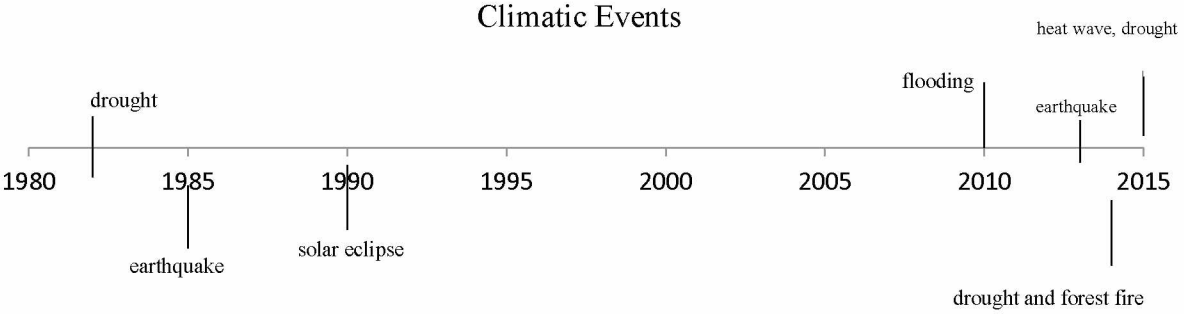


Appendix 4: Stratified Timelines from San Pedro Jocotipac

Historic Events



Climatic Events



Impacts

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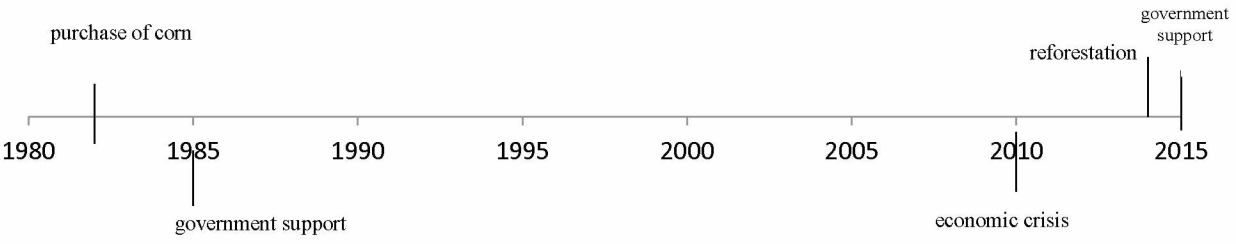
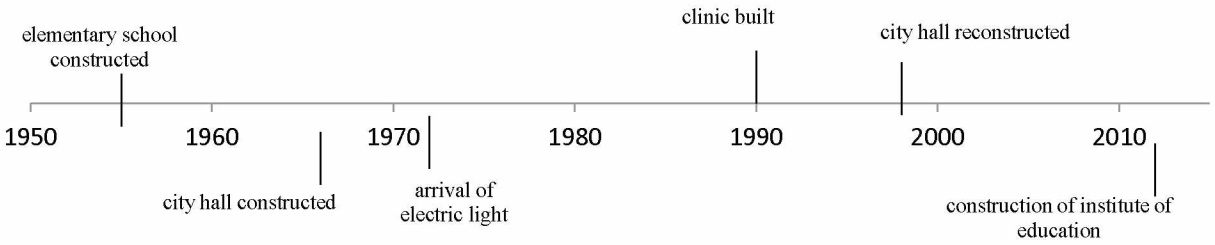
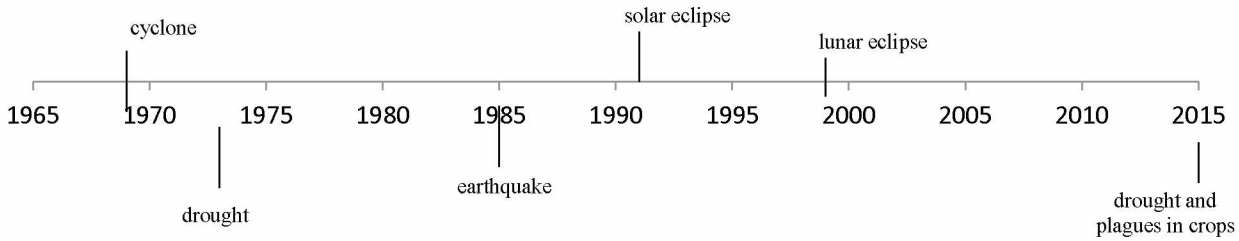


Historic Events



Climatic Events



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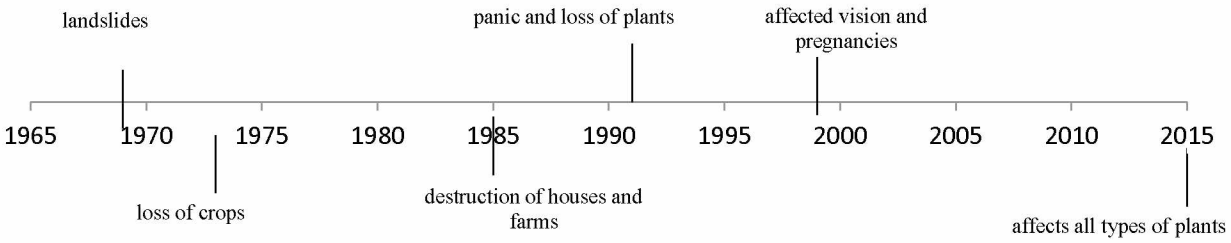

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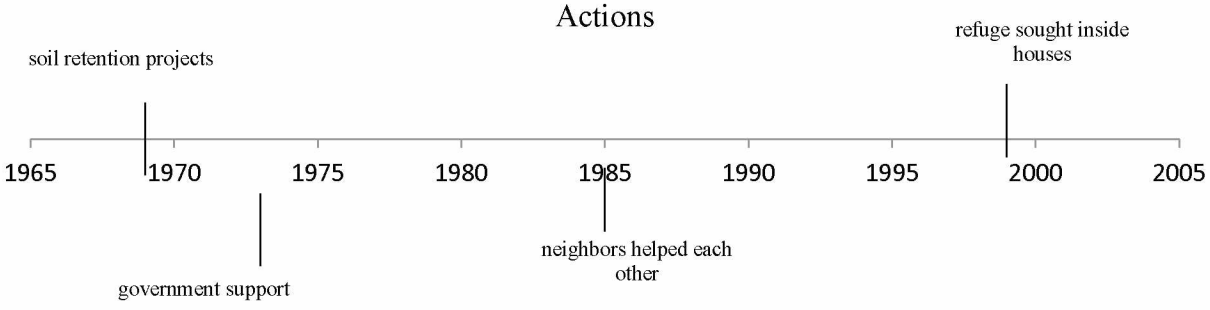
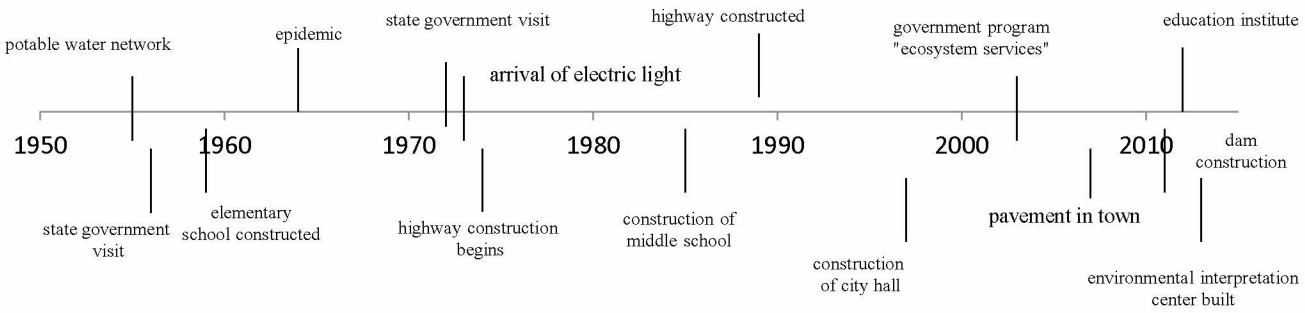
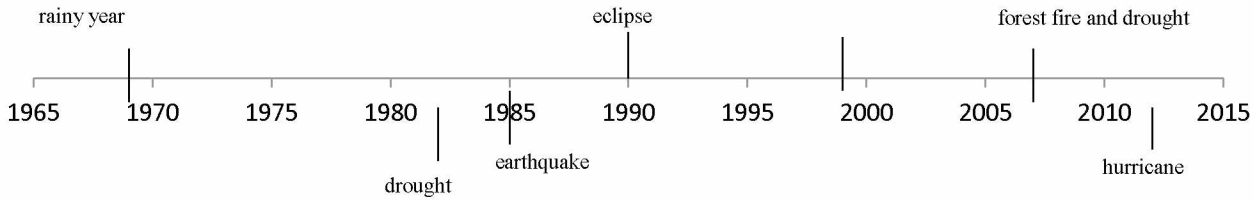


Historic Events



Climatic Events



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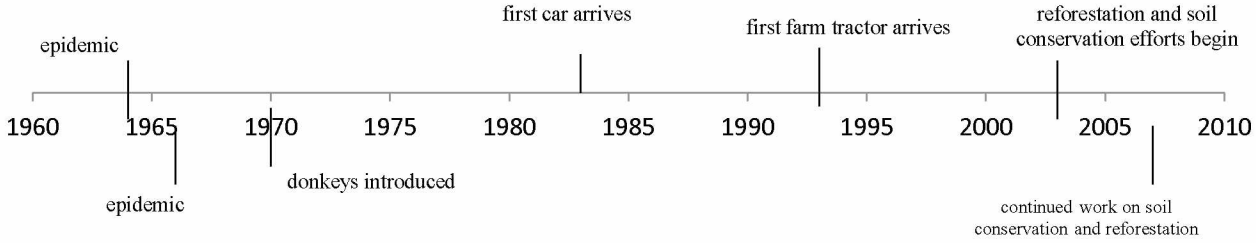

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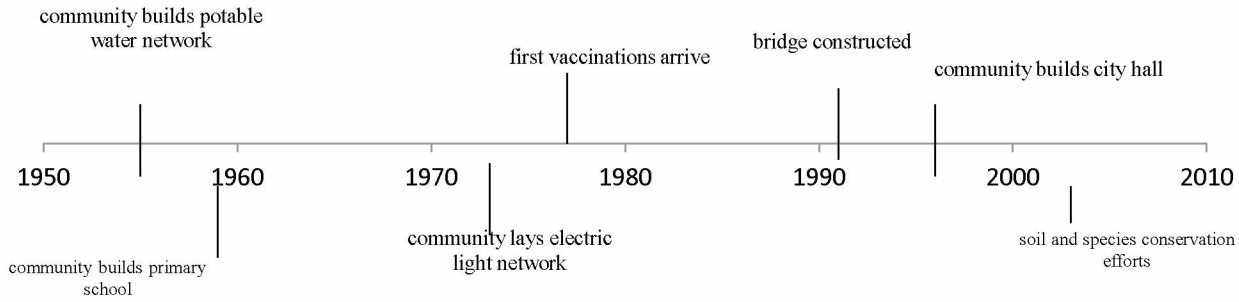
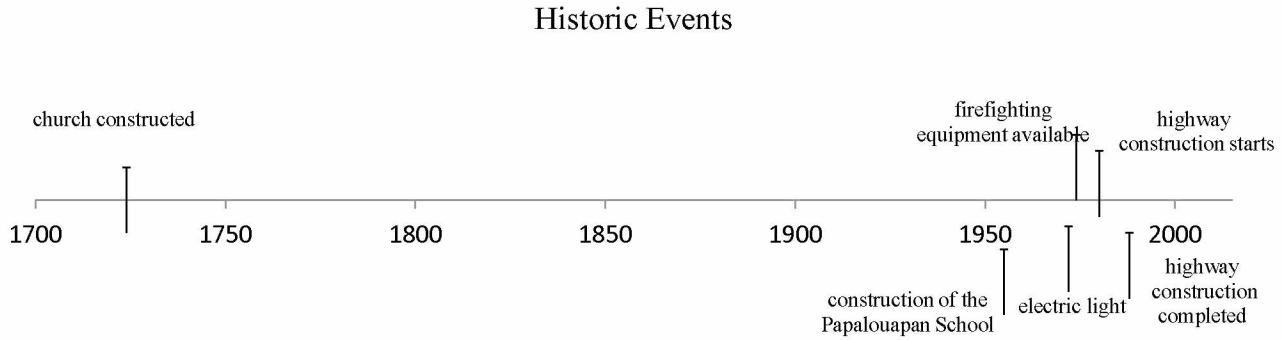
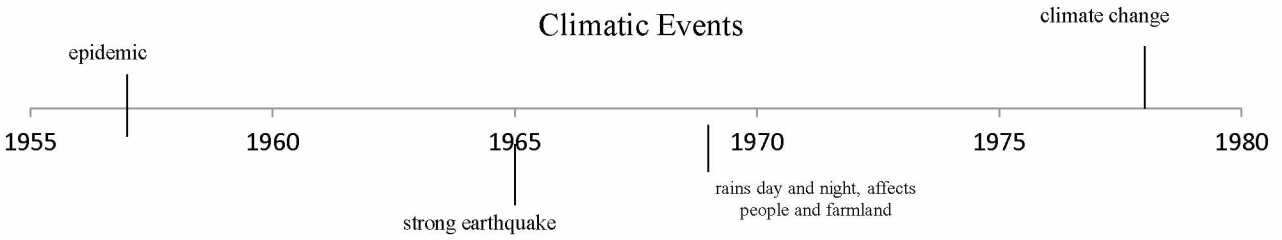
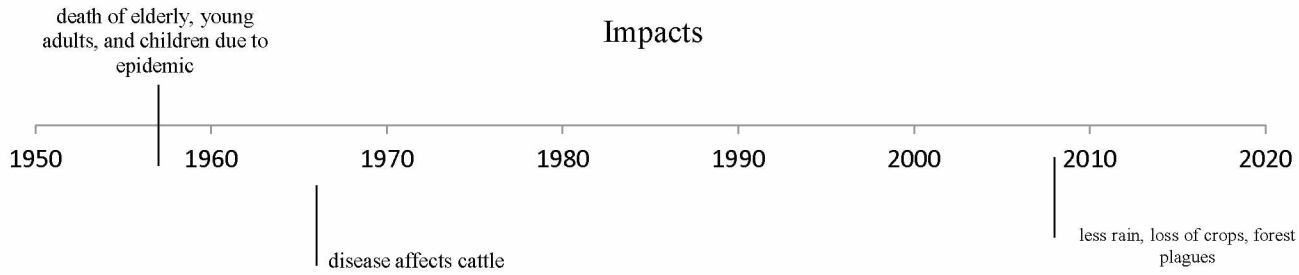


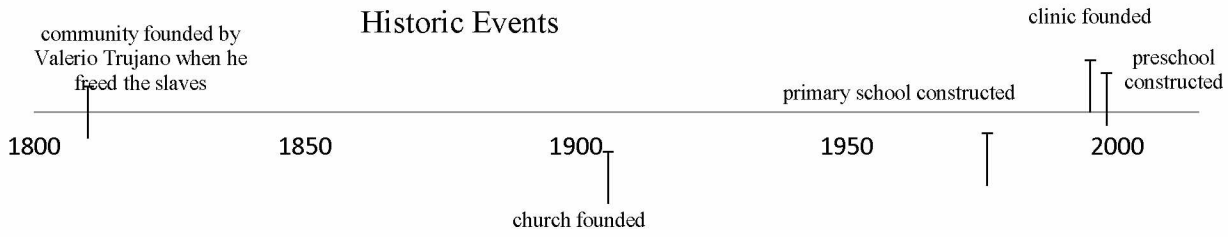


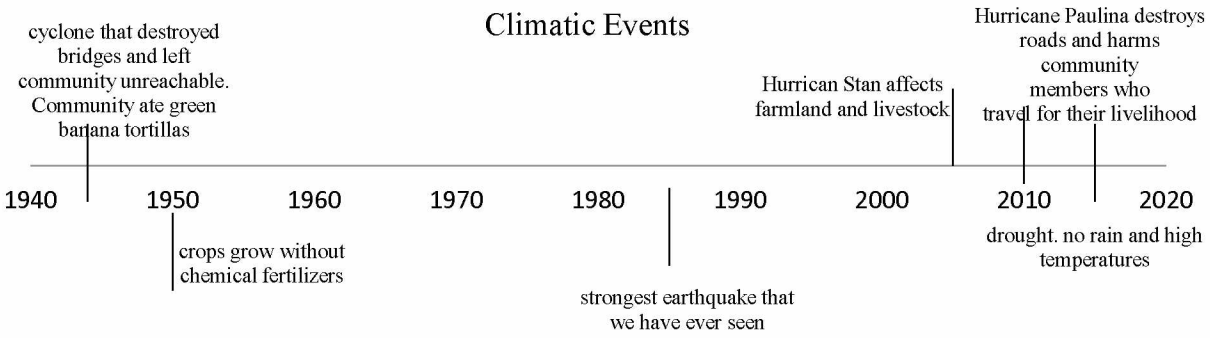


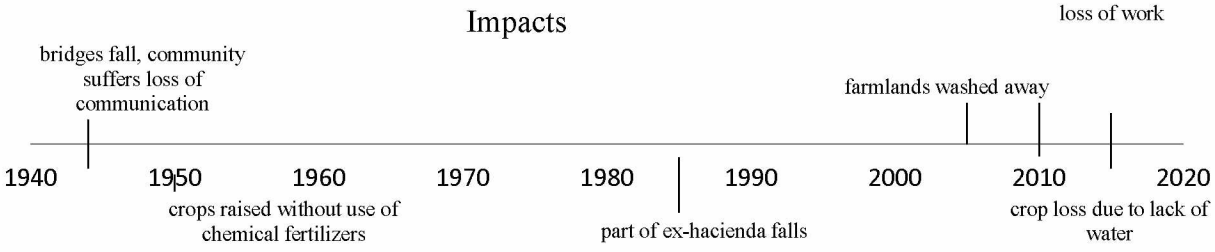


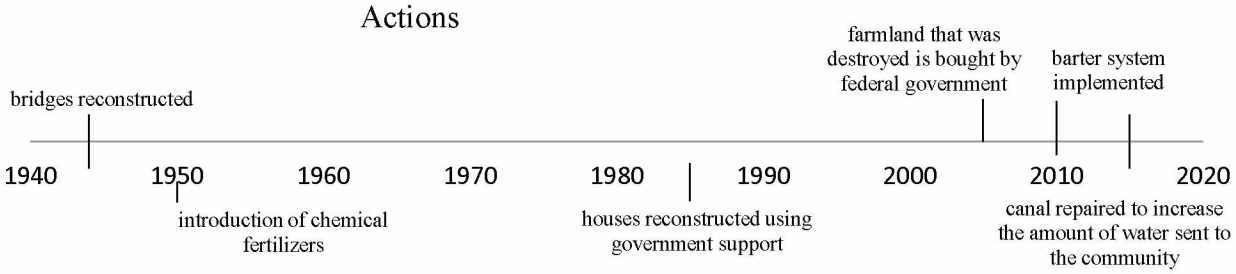
* Note: this group did not complete an Actions timeline.

Appendix 5: Stratified Timelines from Valerio Trujano

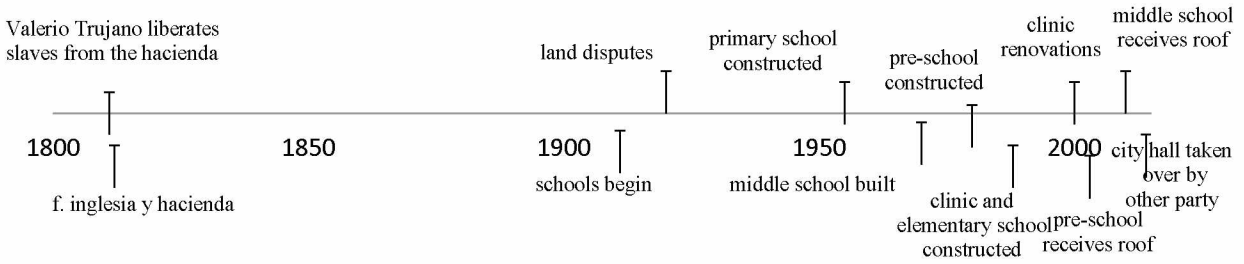




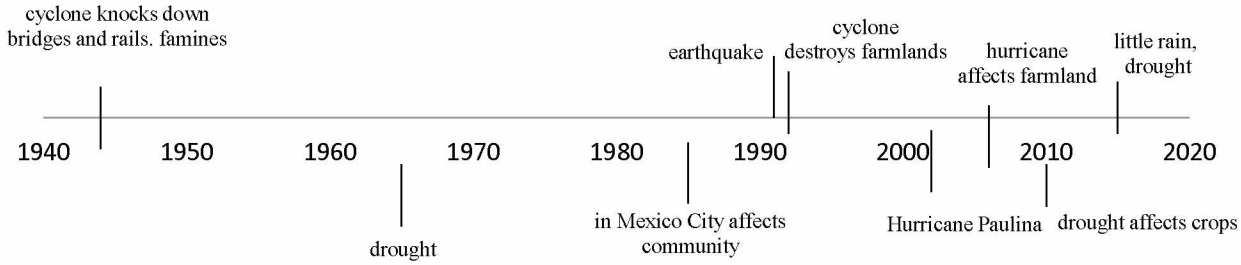




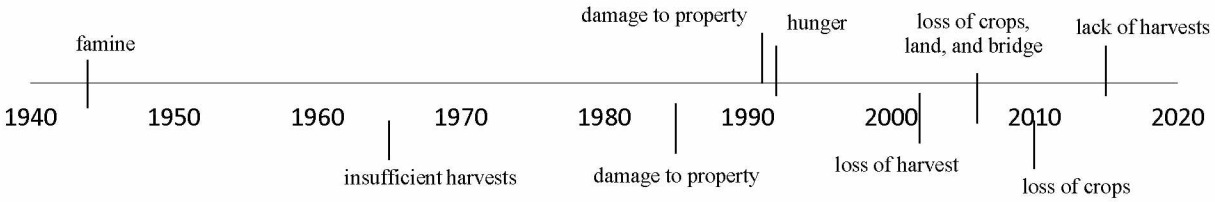
Hisotric Events



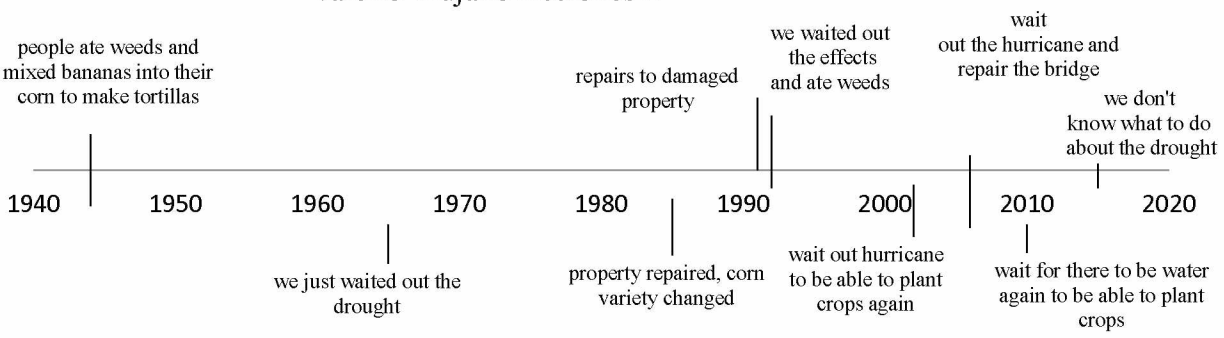
Climatic Events



Impacts



Valerio Trujano Acciones 2



Appendix 6: Pre- and Post-Evaluation Form

Number	Question
1	What is climate change?
2	Mention one example of how climate change manifests itself.
3	Mention one example of how climate change could affect the community.
4	Why is climate change adaptation important?
5	Mention one activity that is an adaptation to climate change.

Appendix 7: Interview with Geographer Rafael Arzate Aguirre

INTERVIEW WITH TECHNICAL PERSONNEL FROM THE TEHUACÁN – CUICATLÁN BIOSPHERE RESERVE THAT HAS WORKED IN THE CANYON REGION OF OAXACA

Name: ___Rafael Arzate Aguirre__
Gender (x) Male ( ) Female
Age: ___44_____ Academic Background: _Geography__
Position in the Biosphere Reserve _Coordinator_____
3 Which communities have you worked in during the past 10 years.

Municipality	Valley region	Sierra region	Mixteca region	Small canyon region
	Locality	Locality	Locality	Locality
San Antonio Nanahuatipam	Casa Blanca			
Teotitlán de Flores Magón				
San Martín Toxpalan	San Martin Toxpalan			
San Juan de Los Cues		San Antonio Nopalera		
Santa María Tecomavaca	Sta. María Tecomavaca	Buenavista		
San Juan Bautista Cuicatlán	-San Juan Bautista Cuicatlán -San José del Chilar -Santiago Dominguillo -Santiago Quiotepec	-San Francisco Tutepetongo -El Cacique		
Valerio Trujano	Valerio Trujano			
Santa María Papalo		Sta. María Pápalo		
Concepción Papalo		Concepción Pápalo		
Santos Reyes Papalo				

San Pedro Jocotipac		San Pedro Jocotipac		
San Pedro Jaltepetongo		San Pedro Jaltepetongo		
Santiago Nacaltepec		San Juan Tonaltepec		
San Juan Bautista Atatlahuca	San Juan Bautista Atatlahuca			
San Juan Tepeuxila				
Mazatlán Villa de Flores				
Santa María Ixcatlán	Santa Ma. Ixcatlán			
Santa María Texcatitlán				

4 How many years have you worked in the above mentioned communities?
from 2006 to 2015

5 In your opinion, what are the greatest three socio-economic-environmental problems these communities face?

Region	Problem 1	Problem 2	Problem 3
Valley	Improper waste management	Loss of soil fertility	Illegal hunting
Sierra	Erosion	plagues and illnesses	Hunting and firewood extraction
Mixteca	Erosion	Wáter scarcity	garbage and pollution
Small canyon	Illegal hunting	Erosion	Forest fires

6 Have you observed changes in these communities? If so please mention some examples of what you have seen, including its impacts on the communities.

Yes. Corn crops each year are affected by extreme meteorological events. Some communities have had to change the crops that they grow because some just don't grow anymore. Plagues and infestations have affected fruit trees and forests with more frequency than they have before.

7 Have you developed any climate change adaptation projects in the above mentioned communities? If so, please mention what they are.

This is a new phenomenon but anyway we are reforesting in a lot of the communities I mentioned on the first page.

8 Do you consider these communities vulnerable? Why? How could this situation be bettered?

The majority are vulnerable because of their socioeconomic conditions in which they live. One suggestion for helping this would be diversification of crops, recuing small productive spaces like home gardens to make families more food secure.

Appendix 8: Interview with Technician Maribel Ramirez Garcia

SURVEY WITH TECHNICAL PERSONNEL OF THE RESERVE OF THE TEHUACÁN - CUICATLÁN BIOSPHERE WHO HAS WORKED IN THE REGION OF THE OAXACAN CANYON

Name: Maribel Ramírez García

Gender () Male (X) Female

Age: _____39_____ Academic Background: _____

Position in the Biosphere Reserve: Technician

1. State the communities in which you have worked the last ten years in the area of the Oaxacan canyon of the RBTC.

Municipality	Valley region	Sierra region	Mixteca region	Small canyon region
	Locality	Locality	Locality	Locality
San Antonio Nanahuatipam				
Teotitlán de Flores Magón	x			
San Martín Toxpalan	x			
San Juan de Los Cues	x			
Santa María Tecomavaca	x			
San Juan Bautista Cuicatlán	x			
Valerio Trujano	x			
Santa María Papalo		x		
Concepción Papalo		x		
Santos Reyes Papalo		x		
San Pedro Jocotipac			x	

San Pedro Jaltepetongo			x	
Santiago Nacaltepec			x	
San Juan Bautista Atatlahuca				x
San Juan Tepeuxila				x
Mazatlán Villa de Flores				x
Santa María Ixcatlán			x	
Santa María Texcatitlán				

2. How many years did you work in the communities mentioned above? (Refer to years, for example from 2005 to 2008)

We have worked in almost all the communities, I do not remember the years but if they have had subsidy for at least a year and another three to four consecutive years, this information of the years and types of support can be found with Engineer Martin.

3. In your opinion, what are the 3 main socio-economic and environmental problems that communities face most?

Region	Problem 1	Problem 2	Problem 3
Valley	Deforestation	Hunting, infestations	Waste management
Sierra	infestations, wildfires	Hunting	Waste management
Mixteca	Deforestation	Hunting	Land use changes
Small canyon	Forest fires	Land use change	Waste management

4. Have you noticed changes in the climate of the communities where you worked? If yes, mention at least three evidences of these climatic changes, as well as their impact on the people of the community.

It no longer rains as before, sowing corn in communities such as San Pedro Jaltepetongo, San Pedro Jocotipac and San Pedro Nodon is no longer profitable since their planting is seasonal, and many people of the communities migrate to other countries. There are more infestations and more deforestation as a result of these infestations.

5. Have you prepared projects that promote adaptation to the impacts of climate change in the community(s) where you worked? If the answer is yes, please mention them and in which community(s) you did them in.

I believe that all soil conservation projects help with the impacts of climate change as they seek to improve their lands with the restoration and conservation of soils in communities

6. Do you consider the community(s) vulnerable? Why? If it is vulnerable, how could the situation be improved?

Yes because due to their economic situation and waning resources they deforest more plots for cultivation which continues the cycle of reduced resources and increased vulnerability.

Appendix 9: Interview with Biologist Leticia Soriano Flores

SURVEY WITH TECHNICAL STAFF OF THE RESERVE OF THE TEHUACÁN - CUICATLÁN BIOSPHERE WHO HAS WORKED IN THE REGION OF THE OAXACAN CANYON

Name: LETICIA SORIANO FLORES_____

Gender () Male (X) Female

Age: 39_____ Academic background: Bachelors of Biology

Position in the Biosphere Reserve: Head of research project on protected areas at the RBTC.

1. State the communities in which you have worked the last ten years in the area of the Oaxacan glen of the RBTC.

Municipality	Valley region	Sierra region	Mixteca region	Small canyon region
	Locality	Locality	Locality	Locality
San Antonio Nanahuatipam				
Teotitlán de Flores Magón				
San Martín Toxpalan				
San Juan de Los Cues	Contlalco, La Nopalera			
Santa María Tecomavaca				
San Juan Bautista Cuicatlán				
Valerio Trujano				
Santa María Papalo		Santa Maria Papalo		
Concepción Papalo		Concepcion Papalo		

Santos Reyes Papalo		Santos Reyes Papalo		
San Pedro Jocotipac				
San Pedro Jaltepetongo				
Santiago Nacaltepec				
San Juan Bautista Atatlahuca				Zoquiapan Boca del Rio, Atatlahuca
San Juan Tepeuxila				San Juan Tepeuxila
Mazatlán Villa de Flores				
Santa María Ixcatlán			Ixcatlan	
Santa María Texcatitlán				

2. How many years did you work in the communities mentioned above? (Refer to years, for example from 2005 to 2008)

___2014 - 2015_____

3. In your opinion, what are the 3 main socio-economic and environmental problems that communities face most?

Region	Problem 1	Problem 2	Problem 3
Valley	-	-	-
Sierra	Low productivity of cropland	Increase in forest infestations and diseases	Change of land use
Mixteca	Water scarcity	Infestations in palm groves	
Small canyon	-	-	-

4. Have you noticed changes in the climate of the communities where you worked? If yes, mention at least three evidences of these climatic changes, as well as their impact on the people of the community.

Yes, infestation increase mainly in forest areas of timber species such as pine and oak forest.

5. Have you prepared adaptation projects to the impacts of climate change in the community (s) where you worked? If the answer is yes, please mention them and in which community (s) you did them.

No

6. Do you consider the community (s) vulnerable? Why? If it is vulnerable, how could the situation be improved?

Yes, preparing for the changes, making conservation works and restoration projects, pay attention to the changes that happen in the forest.

Appendix 10: Interview with Veterinarian Juan Manuel Salazar Torres

SURVEY WITH TECHNICAL STAFF OF THE DIRECTION OF THE RESERVE OF THE TEHUACÁN - CUICATLÁN BIOSPHERE WHO HAS WORKED IN THE REGION OF THE OAXACAN CANYON

Name: _JUAN MANUEL SALAZAR TORRES_____

Gender (X) Male () Female

Age:__49__ Academic Background: ___BACHELORS IN VETERINARY MEDICINE_

Position in Biosphere Reserve _____Regional Coordinator_____

1. State the communities in which you have worked the last ten years in the area of the Oaxacan canyon of the RBTC.

Municipality	Valley region	Sierra region	Mixteca region	Small canyon region
	Locality	Locality	Locality	Locality
San Antonio Nanahuatipam	x			
Teotitlán de Flores Magón	x			
San Martín Toxpalan	x			
San Juan de Los Cues	x			
Santa María Tecomavaca	x			
San Juan Bautista Cuicatlán	x			
Valerio Trujano				
Santa María Papalo		x		
Concepción Papalo		x		

Santos Reyes Papalo		x		
San Pedro Jocotipac			x	
San Pedro Jaltepetongo			x	
Santiago Nacaltepec				x
San Juan Bautista Atatlahuca				x
San Juan Tepeuxila				x
Mazatlán Villa de Flores				
Santa María Ixcatlán			x	
Santa María Texcatitlán				

2. How many years did you work in the communities mentioned above? (Refer to years, for example from 2005 to 2008)

_____ 2005 TO 2014_____

3. In your opinion, what are the 3 main socio-economic and environmental problems that communities face most?

Region	Problem 1	Problem 2	Problem 3
Valley	Municipal garbage of Cuicatlan and Teotitlan	Water	unemployment
Sierra	Bark beetles infestation	Lack of forest management program	unemployment
Mixteca	Degradation of soils	Water shortage	unemployment
Small canyon	Forest fires	Degredation of soils	unemployment

4. Have you noticed changes in the climate of the communities where you worked? If yes, mention at least three evidences of these climatic changes, as well as their impact on the people of the community.

less water in aquifers, increase in infestations, torrential rain

5. Have you prepared adaptation projects to the impacts of climate change in the community (s) where you worked? If the answer is yes, please mention them and in which community (s) you did them.

---

6. Do you consider the community (s) vulnerable? Why? If it is vulnerable, how could the situation be improved?

both upper and lower communities are vulnerable because of landslides in the upper part and lowlands in the bottom

Comment: there is no effective environmental education in the area

Appendix 11: Interview with Engineer Martin Antonio Perez Trinidad

SURVEY WITH TECHNICAL STAFF OF THE RESERVE OF THE TEHUACÁN - CUICATLÁN BIOSPHERE WHO HAS WORKED IN THE REGION OF THE OAXACAN CANYON

Name: _____Martin Antonio Pérez Trinidad_____

Gender (x) Male () Female

Age: ____48____ Academic training: ___Bachelors in Agricultural Engineering__

Position held at the RBTC Management: ___ UNDP Consultant_____

1. State the communities in which you have worked the last ten years in the area of the Oaxacan glen of the RBTC.

Municipality	Valley region	Sierra region	Mixteca region	Small canyon region
	Locality	Locality	Locality	Locality
San Antonio Nanahuatipam	x			
Teotitlán de Flores Magón				
San Martín Toxpalan	x			
San Juan de Los Cues	x			
Santa María Tecomavaca	x			
San Juan Bautista Cuicatlán				
Valerio Trujano				
Santa María Papalo		x		
Concepción Papalo		x		
Santos Reyes Papalo		x		

San Pedro Jocotipac			x	
San Pedro Jaltepetongo			x	
Santiago Nacaltepec				x
San Juan Bautista Atatlahuca				x
San Juan Tepeuxila				x
Mazatlán Villa de Flores				
Santa María Ixcatlán				
Santa María Texcatitlán				

2. How many years did you work in the communities mentioned above? (Refer to years, for example from 2005 to 2008)

From 2006- 2015

3. In your opinion, what are the 3 main socio-economic and environmental problems that communities face most?

Region	Problem 1	Problem 2	Problem 3
Valley	Garbage in Tecomavaca and Los Cues		
Sierra	Deforestation due to change of land use		
Mixteca			
Small canyon			

4. Have you noticed changes in the climate of the communities where you worked? If yes, mention at least three evidences of these climatic changes, as well as their impact on the people of the community.

I think locally it is difficult to detect the climatic changes this as it manifests itself nationally

5. Have you prepared climate change adaptation projects in the community (s) where you worked? If yes, please mention them and in which community (s) you did them.

It is a very long list, but I will mention some, in San Juan Tonaltopec soil conservation works (trenches), Santiago Dominguillo reforestation, San Pedro Jocotipac retaining walls, San Pedro Nodón tree pruning etc .

6. Do you consider the community(s) vulnerable? Why? If it is vulnerable, how could their situation be improved?

All communities are vulnerable to any disaster. I could tell you that it is important to promote reforestation to cope with climate change but unfortunately the communities in the canyon region do not care about climate change, they do not work unless you give them at least $ 150.00 per day, there is no project appropriation by the beneficiaries.

Appendix 12: Outreach Campaign Outline

Climate Change Adaptation in the Canyon Region Outreach Campaign Outline

Message for Outreach Campaign in Concepción Pápalo

Concepción Pápalo faces climate change; all hands on deck!
The work done by farmers is important for the planet, for Mexico and the region, who not only provide basic food like maize and beans but also are the first defenses against climate change. Each time they carry out soil conservation and water catchment projects in their community, they are helping the rest of the population mitigate the effects of climate change and reduce vulnerability. For each forest they preserve they help reduce harmful gases in the environment and lessen the impact of climate change on the community.

For 5 years our community has been working on adaptation measures for climate change with the management of the RBTC, who has been working to establish fruit trees, reforestation with *pinus patula*, 96 hectares of retaining rock walls, 15 km of fire-breaks, and the construction of wood burning stoves in the community of Concepcón Pápalo.
We have the power; the wealth of our people are the campesinos.

The strategy and its implementation

Deployment time: 6 months
Objective: Generate the necessary knowledge about climate change, its impact on rural life and as a resident of the Tehuacán - Cuicatlán Biosphere Reserve, mitigation and adaptation measures that are locally appropriate.
Specific objectives:

- Achieve understanding of climate change and its effects in the world, Mexico and the canyon region of Oaxaca.
- Develop capacities in the inhabitants of the locality of Concepción Pápalo to carry out actions of adaptation and mitigation before the climatic changes more.
- Strengthen the active and responsible social participation of the people of Concepción Pápalo for their vulnerability to possible scenarios of climate change in their community.

We would like the outreach campaign to focus on three main points:

1. My community is located in the most biodiverse state of Mexico, but it is vulnerable to climate change, and has already been suffering some of its effects.
2. Some of the daily practices I do in my community are helping to accelerate climate change.
3. Climate change should be discussed, understood, and reacted to either with adaptive or mitigative actions.

In order to address these three points, the outreach campaign will

1. Promote the importance of the community and the individual's work as a campesino for the Biosphere Reserve and the world.
2. Explain climate change, how their community could be affected by it, and some potential adaptation and mitigation measures, such as the soil and water conservation works that are already being used in the community.
3. Encourage community members to take an increased active and social role especially with respect to adaptive actions to climate change, and through taking this role, build a more climate change resilient future for the community.

Target audiences:
The target audience for this campaign is divided into two groups:
1. Primary Audience: These are people to whom all communication efforts are addressed. This audience will be those community members who attend workshops and receive radio spot messages, and see the murals.
2. Secondary Audience: These are the people to whom only the mass communication will reach. These community members will only hear radio spots, see mural, and/or hear second-hand information learned in the workshops.

Slogan
A slogan is considered as the most effective advertising medium to attract the attention of a particular product or company.
Thinking about our target audience, we suggest the following campaign slogans:
1. "Climate change does not wait, you shouldn't either. Let's get to work!"
2. I work on my present to improve my future. We go hard against climate change!
3. I work on my present to improve my future. Peasants are the first defense against climate change.

Environmental messenger

'Arita', the green macaw will be used as the messenger throughout the campaign; this character is already well known in the region, due to previous outreach campaigns. Arita will be used in mural design and radio spots.

Communication channels

The goal of communication is to disseminate information through the appropriate means and to be able to achieve the greatest influence and penetration in the mind of the captive public.

The set of criteria that allowed us to properly select the communication channels was as follows:

1. The profile of the target audience (inhabitants)
2. The use of the media in the life of the communities, and workshop participants' feedback on media types that are appropriate for their community (radio spots, mural, workshops)
3. The usability of the message (The ability of receiver to decipher the written or spoken message).
4. The three main questions of a campaign. These three questions ask what the expected results are in terms of community members' actions and thoughts. These questions are used to backwards design the material that is shared during the outreach campaign, by first stating the desired outcomes. In every phase of the campaign these three questions are asked, and they may vary between phases. The "we" in the questions refers to Biosphere Reserve Staff.

- What do we want the receiver to think?
- What do we want the receiver to say?
- What do we want the receiver to do?

This campaign will contain three different voices that correspond with the information being shared. The target audience should be able to logically follow the flow of information:

First phase (2 months): Positive and emotional voice, with the intention of the receiver to find stimulus factors such as: pride, identity and value of the place where he lives.

Second phase (2 months): Rational and moral voice, to awaken the rationality of the audience, arousing interest.

Third phase (2 months): Hopeful voice, with a view to the future, with the aim of stimulating action to improve the future of their families and their community.

Phase 1 "Informational" (2 months)

Key Message

My community is located in the most important state of Mexico because of its biodiversity and culture, is part of an ANP and is vulnerable to the effects of climate change (positive emotional voice).

Positioning
1) I reassess the importance of the place where I live (state, community and ANP).
2) I recognize that my farming is of great value.
3) My community is vulnerable to climate change.

Over the course of two months, the following information will be broken down according to the three basic questions of any campaign: what do we want them to know; what do we want them to think; what do we want them to do.

What do we want them to know?
1) I live in the most biodiverse state of Mexico.
2) I live in a community (show the physiographic characteristics) that is part of a Natural Protected Area of great value for its biodiversity
3) My agricultural activity historically and socially has a lot of value
4) My community and climate change: predictions for Mexico, Oaxaca and the vulnerability of its community.

What do we want them to think?
I live in a state of great importance to Mexico for its biodiversity, where my community is part of an ANP and is vulnerable to the effects of climate change.

What do we want them to do?
Share information received in workshops so that more people know the importance of their state and community where farming is of great value and very vulnerable to the effects of climate change.

Communication channels:
• First version of radio spots
• Workshops for adults using the Climate Change Pedagogical Packets developed with CECADESU
• School talks

Phase 2 "Retentive" (2 months)

Key Message

My community and my livelihood are affected by the effects of climate change so adaptive and mitigating measures can be taken, and these are important for more neighbors in my community to know and to do (rational and moral voice).

Positioning
1. I know about adaptation and mitigation.
2. I know that my farming can be even more affected if I do not learn to adapt. (Types of adaptations: soil and water conservation, reforestation, etc.)

This is the phase when the person acquires a new knowledge, fixes it in his mind and incorporates it into his previous experiences and knowledge. Over the course of two months, the following information will be broken down:

What do we want them to know?
1. To address climate change can be done in two ways: adapting or through mitigation.
2. Climate change affects the rural life of my community.
3. Adapting ourselves in my community can deal with climate change (types of works: soil and water conservation, reforestation, etc.)

What do we want them to think?
My community and my farming are affected by the effects of climate change, so adaptive measures can be undertaken. (Types of works: soil and water conservation, reforestation, etc.)

What do we want them to do?
Identify climate change effects and understand how to cope with it to reduce its negative impacts. (Types of works: soil and water conservation, reforestation, etc.)

Communication channels:
• Second version of radio spots
• Workshops for adults using the Climate Change Pedagogical Packets developed with CECADESU
• School talks using the Climate Change Pedagogical Packets developed with CECADESU
• Mural painting

Phase 3 "Remembrance" (2 months)

Key Message

I live in a very important place that deserves to be conserved and protected against the effects of climate change (hopeful voice)

Positioning
I recognize that for 5 years my community has been doing adaptation and mitigation activities in the face of climate change and that there is much to be done individually and in community.

In the remembrance phase the community members recall what has been learned, integrating this information in their previous knowledge and experiences.

What do we want them to know?
1. Climate change is affecting my farming; therefore we should make adaptation actions in my community to help protect future generations.
2. I remember and reevaluate the actions of adaptation to the climate change in the last 5 years through different subsidy programs of the Direction of the RBTC.
3. I learn to perform soil and water conservation works.

What do we want them to think?
I live in a community that is vulnerable to the effects of climate change, but we in our community can take different actions to reduce our vulnerability. We have been doing adaptation projects for at least 5 years with the support of the Biosphere Reserve Tehuacan-Cuicatlan. The following list covers previously funded projects in each community which will be used to identify old projects to show participants.

Historical projects: Concepción Pápalo
2010 Procodes __ Establishment Of Fruit Orchards
2011 Procodes ($120000) Reforestation With Pinus Patula
2011 Promac ($167040) Construction of 96 Hectares of Borders
2013 Pet ($116500) 15 km of Fire Breaks
2014 Procodes ($44200) Construction And Management Of Wood Saving Stoves
2015 Procodes ($160000) Soil Conservation And Restoration
2016 Pet __ Fire Breaks

Historical projects: San Pedro Jocotipac
2013 Promac ($58400) Payment for Forest Maintenance
2013 Pet ($116500) 15 Km of Fire Breaks
2014 Promac ($123500) Payment for Forest Maintenance
2014 Procodes ($120000) Construction of Center for Promotion and Environmental Culture

2015 Procodes ($86850) Construction Of Terraces

What do we want them to do?
I carry out climatic change adaptation and mitigation activities on my own farm, forests and in my home.

Communication channel:
• Third version of radio spots
• Workshops for adults of how to build a rainwater catchment system
• School talks of how to build a rainwater catchment system
• Mural painting