M&E protocol for the adaptation outcome
Livelihood Improvement

Overview

Climate change is causing an increase in global temperatures and extreme weather events such as droughts, floods, and landslides. These phenomena have led to scarcity of natural resources, hampering vulnerable populations' access to basic needs and economic development. An approach that can help communities adapt to the impact of climate change is Ecosystem-based Adaptation (EbA). In the context of agriculture, EbA can include a variety of different practices based on the management of ecosystems, ecosystem services and biodiversity that can help farmers adapt to climate change. Some examples of EbA practices include the use of agroforestry systems to reduce the impacts of high temperatures, heavy rains or other climatic impacts on crops; the use of soil conservation practices to prevent erosion and maintain fertility under heavy rains; the establishment of living fences to prevent soil erosion; and diversification of crops to minimize the risk of production losses due to changing climatic conditions or outbreaks of pests and diseases.

This protocol provides a methodology to measure the contribution of EbA in improving the livelihoods of farmers under climate change. Livelihoods have been hereby classified as support bases of people that allow households to meet their needs, as well as face adverse situations and extreme weather events.

Table 1: M&E overview of the indicator that can be used to track livelihood security.

Indicator definition / unit	Data collection methods	Data sources / origin	National policies alignment
% Increased income of smallholders´ farmers due to nature-based and diversified activities	Household surveys (ENA – SIAP methods)	Agriculture, Livestock and Fishing information System survey (Sistema de Información Agroalimentaria y Pesquera)	Nationally Determined Contribution (NDC) Special Program on Climate Change (PECC) Mexico's Climate Change Mid Century Strategy (CCMCS)

1. Case study: Oaxaca and Chiapas, Mexico

Located in the southern and southeastern part of Mexico, the states of Chiapas and Oaxaca, totaling 16.7 million hectares (ha), stand out for hosting the greatest biological and cultural diversity of both the country and Mesoamerica. The states of Oaxaca and Chiapas host some of the highest biological richness of this megadiverse country: 5,053 animal and plant species in Chiapas and 9,235 species in Oaxaca have been registered (17% and 32%, respectively, of 29,429 species in Mexico). These states are vulnerable to the impact of climate change. Climate-related threats in Oaxaca and Chiapas include extreme rainfall events, drastic increases and decreases in temperature, droughts, tropical cyclones, floods, and landslides.

Climate change is causing irregularities in agricultural cycles, which have led producers to introduce coffee varieties from other regions. Pests and diseases, such as coffee leaf rust (*Hemileia vastatrix*), have become more frequent and virulent in recent years, possibly due to changing climatic conditions and poor management practices. This has led to reduced income from coffee production, which reduces access to basic food resources.

In these states, 4 communities were selected to participate in a project that aims to…. : Pluma Hidalgo and Santa María Guienagati in the State of Oaxaca and Tacaná and Jaltenango in the State of Chiapas. These communities were chosen due to their historical link to coffee production, which has been the main economic activity of most families in these areas. At the beginning of the last decade, large areas of coffee plantations were affected by pests and diseases, causing a significant decrease in production and problems within the economy of many coffee producers. A main reason why the outbreak was so severe was due to changing climate conditions (high temperature, irregular rainfall, increase of humidity in plots). This was exacerbated by a lack of diversification of crops as an alternative source of income. EbA measures can increase the resilience of these communities, specifically to improve economic income and adaptive capacities to extreme weather events, as well as pests and disease..

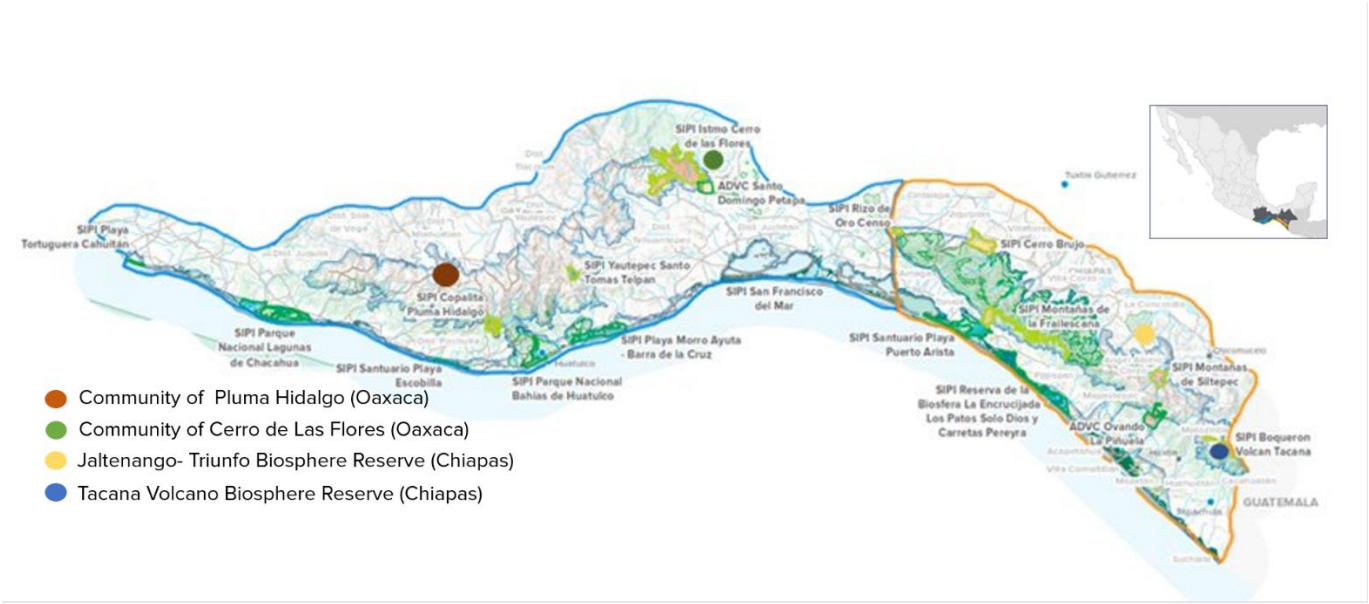

Figure 1 Map of Oaxaca and Chiapas with the communities where activities will be implemented.

2. Theory of Change

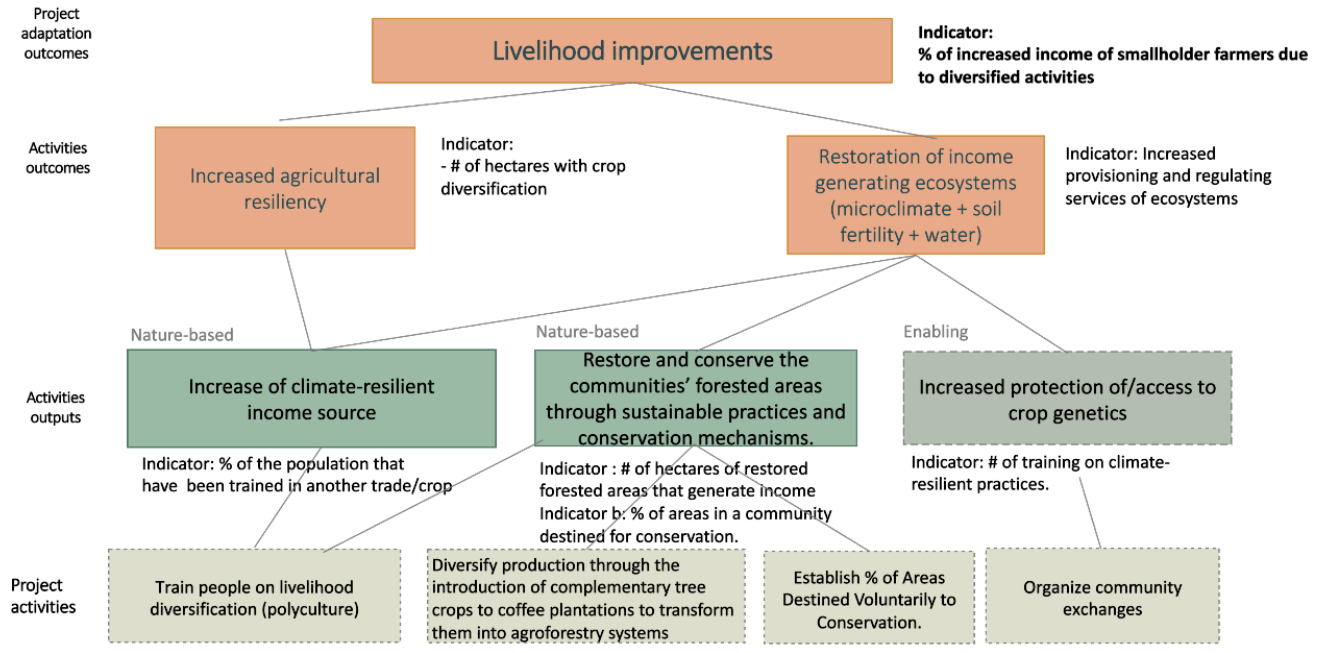

Figure 2: The Theory of Change reflects the implementation of various EbA activities that can lead to the improvement of livelihoods of farming communities in Oaxaca and Chiapas,, such as the training of people in the diversification of crops, the restoration and conservation of forested areas and the increase of agricultural resilience.

EbA can help reduce the vulnerability of communities to climate change. Activities include the diversification of crops, reforestation of native vegetation and other tree species, the implementation of agroforestry systems and the designation of voluntary areas for conservation. Through these activities, communities will be better prepared to address climate change impacts. The activities will also help maintain soil fertility, allowing farmers to improve productivity return from their investments. These activities will also improve farmers' income, access to basic services, and overall well-being. This will help producers be prepared for climate change-related threats.

3. Indicator's rationale and definitions

3.1. Linkages with national policies and priorities related to adaptation

The adaptation outcome indicator for livelihoods maintenance under climate change is directly aligned with Mexico's first Nationally Determined Contribution (NDC 2015). The NDC includes an adaptation component which aims to protect the population from effects of climate change and calls for the incorporation of climate change criteria in agricultural and livestock related programs. The NDC also guarantees the integral management of water for its different uses, such as agriculture. The Special Program on Climate Change (PECC 2014-2018) calls for the reduced vulnerability of productive sectors, as well as the implementation of sustainable agriculture and ecosystem-based adaptation activities. Mexico's Climate Change Mid Century Strategy (CCMCS 2016) encourages integrated land-use planning, forest restoration and protection, improved connectivity, and sustainable community management schemes for reducing ecosystem vulnerability to climate change. This strategy also encourages the adoption of a system for management, reporting, verification, and monitoring and evaluation. Similarly, the Climate Change Strategy from Protected areas promotes effective monitoring and assessment, the involvement of residents near protected areas in actions, and the development of their capacities to understand and respond to climate change and related hazards. This strategy also promotes multiple conservation schemes (e.g., PES, voluntary area for conservation, community forests) and the diversification of sustainable productive activities to increase the value of products and services delivered by protected areas in order to address climate change issues.

3.2. Definitions

Ecosystem-based adaptation: The use of biodiversity and ecosystem services, as part of a broader adaptation strategy, to help people adapt to the adverse effects of climate change (INECC, 2018)

Areas Destined Voluntarily for Conservation (ADVCs): Mexico's National Commission of Protected Areas defines Areas Destined Voluntarily for Conservation (ADVC) as protected natural areas under the competence of the Mexican Federation dedicated to a function of public interest and established by means of a certificate issued by the Ministry of Environment and Natural Resources (SEMARNAT) through the National Commission of Protected Natural Areas (CONANP); (CONANP, 2019). They respond to initiatives of indigenous peoples, social organizations, legal

entities, public or private, to allocate their properties to conservation actions and are administered by their legitimate owners, in accordance with their own Management Strategy.

Agroforestry systems: Agroforestry or agroforestry systems are terms used for joint agricultural, forestry, fruit and livestock production. Currently, CONAFOR considers Agroforestry Systems (AFS) as "the set of land management techniques that involve the simultaneous or staggered combination in time and space of trees with livestock and / or crops (CONAFOR 2020).

Smallholder farmers: Refers to producers who manage small plots of no more than 5 hectares, mainly carried out by family labor, with limited access to resources and production oriented predominantly to self-consumption (SADER, 2020)

Protected agriculture: Agricultural practices carried out under conditions in which the farmer can control certain environmental factors to minimize the impact of climate change on crops (SENASICA, 2016).

Livelihood diversification: Subsistence strategy to face the difficulties derived from the limited access to markets, physical infrastructure, and the climatic damages of hurricanes and droughts (Fierros & Ávila, 2017).

Agricultural disease: Any alteration caused by a pathogen that affects the synthesis and use of food, mineral nutrients, and water, in such a way that the affected plant changes its appearance and decreases its production level. These diseases are caused by viruses, bacteria, micro plasmas, and rust fungi (SIAP, 2019).

Agricultural pest: A population of phytophagous animals (plant-feeding) that decreases the production of the crop, reduces the value of the harvest or increases its production costs. Pests are constituted by insects, mites, nematodes, snails, birds, locusts, mosquitoes and blind hen (SIAP, 2019).

Agricultural frontier: Zone of division between lands occupied with crops and those that are not cultivated; that is, where non-agricultural activities are developed and only natural vegetation grows, which can be used for hunting, gathering fruits or other activity.

4. Methodology

4.1. Data sources and frequency

Information was obtained from the Government of Mexico's field surveys and datasets (National Agricultural and livestock Survey" of Mexico's National Institute of Statistics and Geography and the "Closure of agricultural production" from the Agri-Food and Fisheries Information SystemSIAP), which are dedicated to surveying agricultural information at the national, state and municipal level such as total production and income from specific crops. Livelihood information within communities was obtained through semi-structured interviews with key informants. These

were selected based on previously collected information sourced from other projects implemented by Conservation International Mexico. For the purpose of this work, the semi structured interviews with key informants were conducted during the months of April and May, when producers were more available due to the dry season's lower demand of labor.

It is recommended to conduct the interviews and access existing information at least twice: at the beginning of the project, when activities have not yet been implemented, as well as at the end of the project, when activities are fully implemented. By comparing the same metrics during these two time periods, information about improvements in the livelihood of farmers can be assessed.

4.2. Data measurements / collection

Information on hectares planted, hectares harvested and total production per year was based on the "National Agricultural and livestock Survey" of Mexico's National Institute of Statistics and Geography (INEGI, in Spanish) that provides combined information for each one of the variables at the municipality level and are available once a year. Additionally, the "Closure of agricultural production" (Cierre de producción agrícola) from the Agri-Food and Fisheries Information System (SIAP, in Spanish) was consulted to obtain information on the area planted, harvested and the total amount produced in tons, which are combined at the municipality level and available once a year.

4.3. Data analysis

4.3.1.Data Sources and frequency

The income of farmers, combined with the hectares planted, can be used to assess the improvements in the livelihoods of farmers. If the income of the farmers from agriculture has increased but the number of hectares planted is maintained or reduced after the implementation of the activities, compared with the baseline, it is indicated that the project activities are contributing to improve the livelihoods in the target area. However, information about income is sensitive and may be difficult to access for multiple reasons. Therefore, crop productivity, in combination with hectares planted, or agriculture discrepancy, could be used as proxies to assess the improvements in livelihoods from the EbA practices and measures implemented.

4.3.2. Hectares planted and hectares harvested

The harvested hectares will provide information regarding the agricultural area in use. If there is a significant difference between hectares planted and hectares harvested, it could imply that plots

are being suddenly abandoned, or even that certain producers are taking advantage of a governmental financial incentive to plant coffee without intention of harvesting it. Hectares planted each year is the sum of the fall and winter planted area and the spring and summer planted area. Hectares harvested each year is the sum of the harvested area in fall and winter and harvested area in spring and summer

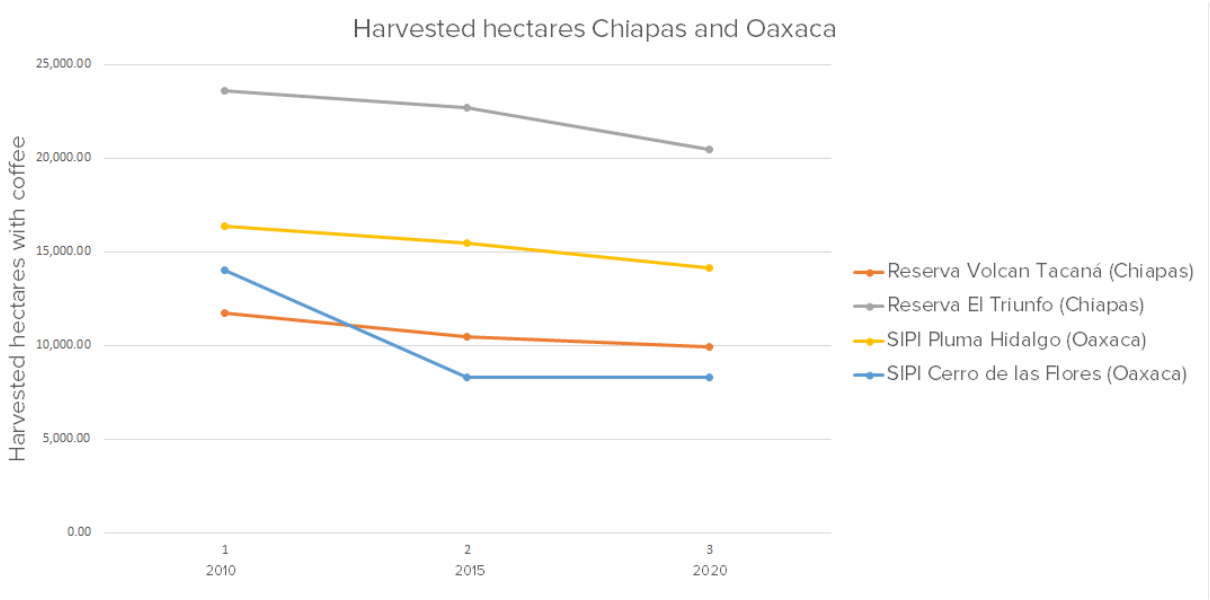

Figure 4. This graph represents the results obtained from the SIAP dataset on the number of harvested hectares with coffee plants in the four communities in Oaxaca and Chiapas.

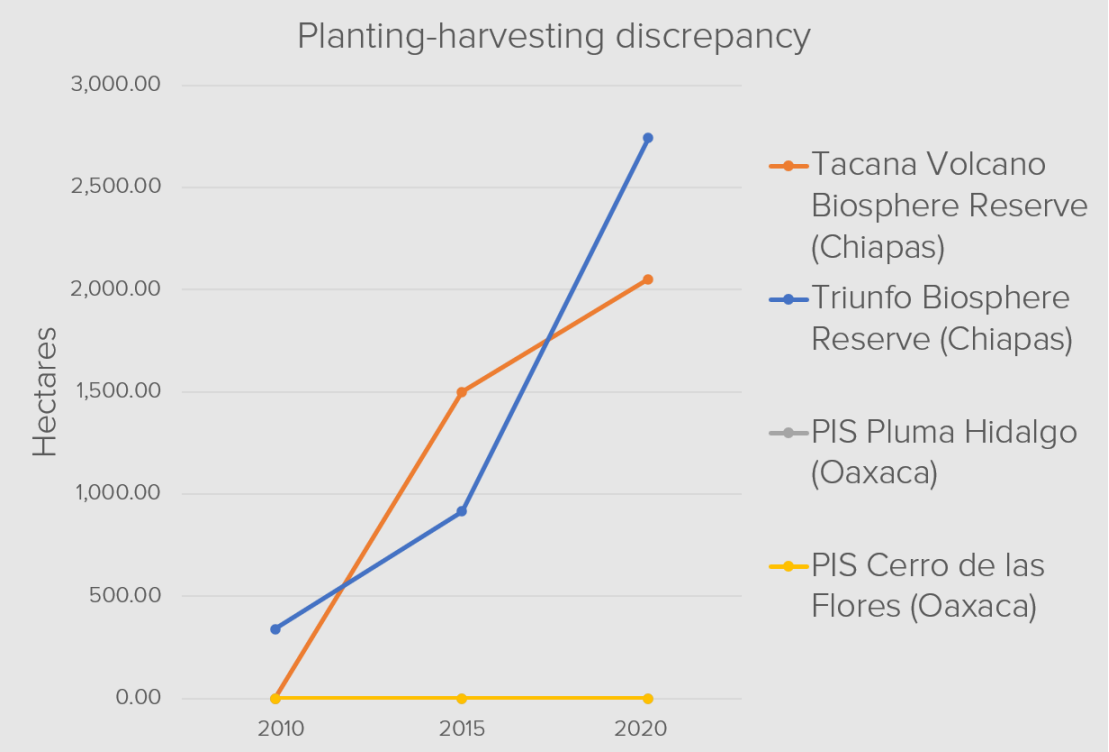

Figure 5: Agricultural discrepancy- the agricultural discrepancy is the difference between the total hectares planted and the total hectares harvested per year. This metric provides information on whether the crops are being impacted, which can be assessed when the planted area is higher than the harvested area.

4.3.2 Productivity

Production is a fundamental metric for producers, as it is interlinked with the projected income they will receive from their crops. Production should be measured in tons of the crop harvested per year.

PVoY = PVoFW + PVoSS (Figure 5)

Where:

- **PVoY:** Production volume yearly
- **PVoFW:** Production volume for fall and winter
- **PVoSS:** Production volume for spring and summer

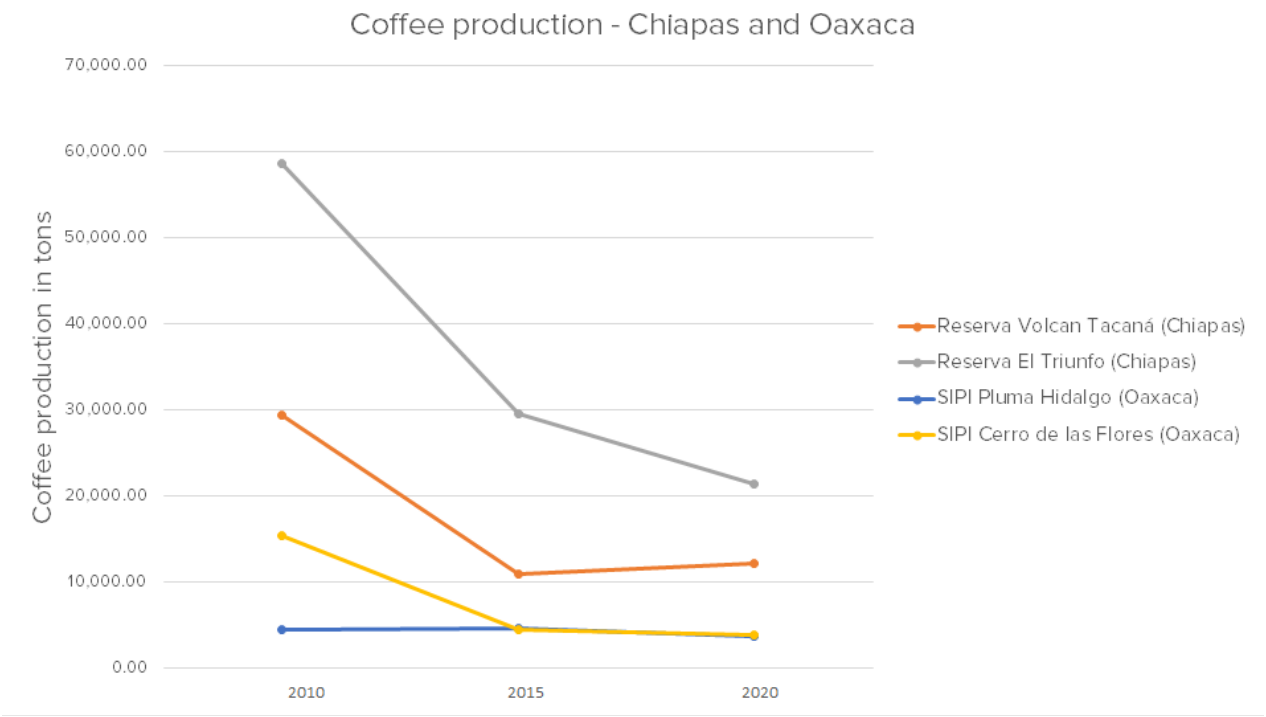

Figure 6: Trends in volume production of cherry coffee for the last decade. A steep drop in production is noticeable for Volcán Tacaná, El Triunfo and Cerro de las Flores.

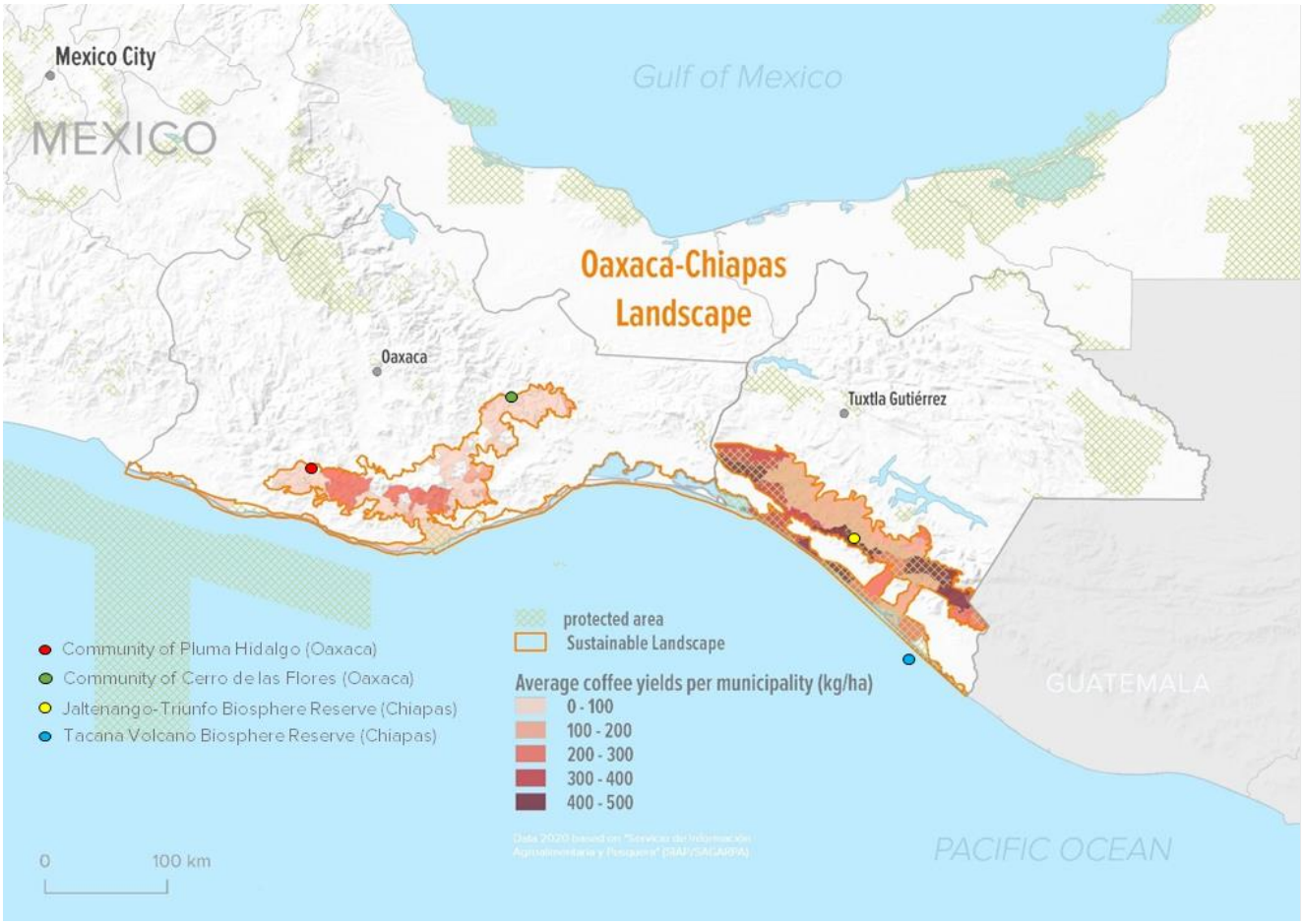

Figure 2: Average coffee yields per municipality (in kg/ha) in 2020. The coffee yields are based on "cafe oro" or green coffee (ready to be roasted).

4.3.3 Production value/hectares planted

This data refers to the total value of produce harvested per year. This information demonstrates how much a producer can earn per year from coffee cultivation, and is measurable over time, which provides data on whether production and market prices have improved or decreased.

4.4 Interpreting Your Results

The link between livelihood climate change adaptation and economic income assumes that households with higher incomes will be more resilient to the impacts brought forth by climate change. For example, producers would be more likely to possess savings in case extreme weather damaged their assets. In the same way, producers would be more likely to have the required funds to afford the inflow required for the next year's harvest and investing in the improvement

of their crops and the quality of their products to remain competitive. This would ensure a continuity in individuals' livelihoods, and it may mitigate field abandonment in areas where crop yield or product value has dropped untenably.

Agroforestry systems can provide multiple benefits to farmers, including protection from extreme winds, floods, landslides and soil erosion. Simultaneously, agroforestry systems regulate part of the ecosystem of their region and help to withstand the effects of climate change. The improvement of agricultural practices can lead to optimal production of crops. It may be difficult to reach the high levels of production compared to the pre-disease or pest years. However, it is expected that productivity will improve with the implementation of improved agricultural practices under climate change conditions.

It is worth noting that certain factors could significantly lead to unexpected results. For example, an area's agricultural transition from traditional to intensive crops could affect the expected results of this project, especially if such crops have negative repercussions on the ecosystem. This is for example true for oil palm, which needs large amounts of water, causing soil erosion and the displacement of the original vegetation. The unsustainable spreading of oil palm production in the target area would severely jeopardize the expected benefits of EbA through agroforestry systems.

In the same way, government changes have the possibility of altering results. Many producers benefit from agricultural support programs, and changes in government leadership may bring about the termination or changing of terms of many of these incentives. Given that transforming conventional production to EbA practices requires a relatively considerable investment, losing access to government financing mechanisms could lead to a significant drop in the producers' income, potentially making transformation untenable.

The hectares planted within the years 2010, 2015 and 2020 have been decreasing, and this could be because producers increasingly want to sow less due to the problems they have suffered within the crops as a result of climate change. The data of harvested hectares present the same characteristics. However, this could be because producers have lost interest in continuing to manage their land as a result of climatic effects. All of the above could be justified based on the production graph, since it shows that the total collected has suffered a significant decrease in productivity, decreasing the total tons obtained per year.

The semi-structured interviews provided vital information on the measures already taken by the communities' coffee producers to adapt to climate change. These ranged from diversifying production, allocating conservation areas, banning products that damage the fertility of plants and soil, and practicing good agricultural management practices.

Additionally, these interviews brought to light key factors affecting coffee production. These include the lack of investment for the adequate health of crops, the erosion of agricultural areas due to droughts and the migration of producers. These factors cause agricultural lands to be without proper management or the plots are simply lost in their entirety. For this reason, it is necessary to carry out training activities on the proper management of crops in the face of climate change effects and the control of diseases and pests.

Training on good crop management such as pruning, having control between shade and sunlight, as well as changing old plants for new ones, favors crops to present higher production, take better advantage of the nutrients in the soil, reduces some diseases such as fungus or pests such as insects, provides good quality to the harvested products, and greater income to the producers.

4.4. Data reporting, quality and limitations

The process of systematizing results must be divided into two specific steps, the first based on entering the information obtained through the questionnaires in an Excel database and designing visual material where the analyzed data is presented. Additionally, as a second step, there must be an individual in charge of the analysis of data so that there are no alterations in the results.

A limitation that could occur when looking for more information on public pages (government, NGO, private institutions) about livelihoods or specific topics is not finding them at the municipal or community level. Usually, the information obtained in these web platforms are at the national and state level.

4.5. Data repository and management

Agricultural information can be found publicly within the SIAP web portal, in its subsection titled Closure of Agricultural Production (https://nube.siap.gob.mx/cierreagricola/). The information that can be obtained through this platform includes the types of crops, the total of planted hectares, harvested hectares, the total production and the monetary value of the total production, annually. This information will be based on the national, state and municipal levels of the United Mexican States.

The information obtained in the field through interviews should be entered and saved in an Excel database for further analysis and easy feedback if more information is found. Therefore, it is recommended that an individual is charged with providing the analyzed information to anyone who requires it for subsequent studies, as well as continuing to work on the same database so that the data update is continuous and is not lost in external files.

Also, it is suggested to make graphs, tables or another visual analytical element so that the interpretation of the results is easy for anyone who needs to understand the study. Additionally, all information must be stored on external storage devices as well as on digital file protection platforms (Cloud).

Information collected in the field for the Oaxaca-Chiapas project is available by requesting it from akastanos@conservation.org.

5. Literature

CONAFOR. (2020). Sistemas agroforestales maderables en México. Gobierno de México

CONANP. (2019). Áreas Destinadas Voluntariamente a la Conservación participación social por el ambiente. Gobierno de México.

Fierros, Isael, & Ávila-Foucat, V. Sophie. (2017). Medios de vida sustentables y contexto de vulnerabilidad de los hogares rurales de México. *Problemas del desarrollo*, *48*(191), 107-131. Recuperado en 21 de junio de 2021, de http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0301-70320170004001 07&Ing=es&tlng=es

Gobierno de la República. (2014). Versión de Difusión del Programa Especial de Cambio Climático (2014-2018).

Gobierno de México. (2015). Intented nationally determined contribution

INECC. (2018). Adaptación al cambio climático. Gobierno de México.

SADER. (2020). Diario Oficial de la Federación.

SEMARNAT.INECC. (2016). México´s Climate Change Mid-Century Strategy. Ministry of Environment and Natural Resources (SEMARNAT) and National Institute of Ecology and Climate Change (INECC) Mexico City, Mexico.

SENASICA. (2016). La aplicación de sistemas de protección garantiza la disposición de frutas y verduras todo el año. Agricultura protegida. Gobierno de México.

SIAP. (2013). Diseño conceptual de la generación de información agropecuaria

SIAP. (2019). Normatividad Técnica para la Generación de Estadística Básica Agropecuaria.

SIAP. (2019). Normatividad Técnica para la Generación de Estadística Básica Agropecuaria. Citado de AgriFoodGateway: https://hortintl.cals.ncsu.edu.

LIVELIHOODS IMPROVEMENT

EXTRACT FROM NATIONAL AGRICULTURAL SURVEY

Location of the farm

State/province _____

District/miunicipality_____

GPS _____ Date: _____

Contact

Enumerator _____

Interviewer _____

Phone_____e-mail_____

Signature/oral consent _____

		area planted (ha)				
Crop code	Crop and/or variety	under irrigation	under rainwater	in greenhouse	organic production	perennial plants (total)

		area damaged (ha)					reason for damage
Crop code	Crop and/or variety	under irrigation	under rainwater	in greenhouse	organic production	perennial plants (total)	(1-12)

1: excess of humidity, 2: hail, 3: flood, 4: pests, 5: drought, 6: wind, 7: price, 8: frost, 9: low temperature, 10: diseases, 11: heat wave, 12: fires 13: other

		area harvested (ha)				
Crop code*	Crop and/or variety	under irrigation	under rainwater	in greenhouse	organic production	perennial plants (total)

		production or yield (specific unit ton/bunch/plants/…)					
Crop code*	Crop and/or variety	under irrigation	under rainwater	in greenhouse	organic production	perennial plants (total)	Unit (t,…)

average rural price			
Crop code*	Crop and/or variety	($/unit)	Unit

* identify the main crops of interest and list them with codes here

1.- since last year to today, what were the main products or agricultural crops, or trees for which you obtain most of the income?

(in order of importance)

1. _____
2. _____
3. _____

2.1- from the agricultural land, how many hectares were not planted?

- _____

2.2.- of these, how many hectares were not planted because of rest?

- _____

2.3 which one was the main cause because the land was not planted (other than resting) [yes/no]?

1. no interest in planting it _____ [ ]
2. lack of money _____ [ ]
3. lack of support/workers _____ [ ]
4. drought -_____ [ ]
5. too much humidity _____ [ ]
6. nobody that sowed it _____ [ ]
7. invasive species _____ [ ]
8. low soil fertility_____ [ ]
9. not profitable/low price _____ __ [ ]
10. Issue with water access _____ [ ]
11. lack of training or technical knowledge_____ [ ]
12. insufficient infrastructure for production _____ [ ]
13. lack of organization with procudtion _____ [ ]
14. cannot get credit_____ [ ]
15. Lack of documentation for land tenure/ownership _____ [ ]
16. Conflicts/security issue_____ [ ]
17. Litigation over land/occupation by others_____ [ ]
18. Other (specify) _____ [ ]

3.- from the total area, how many hectares are forested or with trees?

- _____

4- how much area under conservation plans and/or sustainable management ?

- _____ / _____

5.- would you like to have conservation plans for natural areas within your area? (if yes, how many hectares)

- _____

6.- From where does the (main) water come that was used for irrigation?

- Borehole, water hole ---------- [ ]
- Deep well ---------- [ ]
- Open air well ---------- [ ]
- river ---------- [ ]
- Spring ---------- [ ]
- dam ---------- [ ]
- other (specify)
  _____

17.- In the last 5 years, did you experience any environmental issue(s)?

- Change cultivation type _____
- Change the timing for planting or harvesting _____
- Changes in production _____