Chapter 5
"To Take Care of the Land Means Taking Care of Ourselves": Local Perceptions on Human and Environmental Health in a High Agro-Biodiversity Landscape in the Yucatan Peninsula

María Elena Méndez-López, María Fernanda Cepeda-González, Karla Juliana Rodríguez-Robayo, Lilian Juárez-Téllez, Mariana Rivera-De Velasco, Rosa Martha Peralta-Blanco, Nicolás Chan-Chuc, Andrea A. Serrano-Ysunza, R. Antonio Riveros-Cañas, Oscar G. Sánchez-Siordia, and Sebastien Proust

Abstract The Forest and Milpa Landscape (FML) is a territory comprising 64 municipalities in the Yucatan Peninsula where the rainforest and the *milpa* system coexist. The ecosystems that predominate in the FML are sub-deciduous and subtropical evergreen forests, which represent an essential carbon reservoir worldwide. The use of natural resources for food security of FML families is associated with the *milpa*, which is a system that depends on the rainfall and the soil's ability to retain water. Within the framework of the 2020–2030 Country Strategy of the GEF

M. E. Méndez-López (✉) · L. Juárez-Téllez
CONACYT—Centro de Investigación en Ciencias de Información Geoespacial, Mérida, Yucatán, Mexico
e-mail: emendez@centrogeo.edu.mx

M. F. Cepeda-González
Capacitación y Asesorías Ambientales, Mérida, Yucatán, Mexico

K. J. Rodríguez-Robayo
CONACYT—Centro de Investigación en Ciencias de Información Geoespacial, Mérida, Yucatán, Mexico

Centro de Investigación Tibaitatá AGROSAVIA, Mosquera, Colombia

M. Rivera-De Velasco · R. M. Peralta-Blanco · N. Chan-Chuc · O. G. Sánchez-Siordia
Centro de Investigación en Ciencias de Información Geoespacial, Mérida, Yucatán, Mexico

A. A. Serrano-Ysunza · S. Proust
The GEF Small Grants Programme, United Nations Development Programme, Mérida, Yucatán, Mexico

R. A. Riveros-Cañas
Independent Consultant, Mérida, Yucatán, Mexico

M. Nishi et al. (eds.), *Biodiversity-Health-Sustainability Nexus in Socio-Ecological Production Landscapes and Seascapes (SEPLS)*, Satoyama Initiative Thematic Review, https://doi.org/10.1007/978-981-16-9893-4_5

Small Grants Programme (SGP), 20 indicators associated with the FML's resilience were evaluated through a participatory approach. The methodological route consisted of adapting the Toolkit for the Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes (SEPLS). A topic that generated much concern among participants was human health. The reflection generated around this indicator recognised problems associated with water contamination by agrochemicals and changes in diet, resulting in recurrent diseases, such as diabetes, hypertension, and obesity. The solutions proposed by the small producers are linked to the sustainable management of ecosystems and education on values towards traditional and agroecological food production.

Keywords Forest and *milpa* landscape · Resilience · SEPLS · *Milpa* · Yucatan Peninsula

1 Introduction

The Forest and Milpa Landscape (FML) is a territory comprising 64 municipalities distributed across the three states of the Yucatan Peninsula (YP) in Mexico: Campeche, Quintana Roo, and Yucatan. The FML is a region where the rainforest and the *milpa* system coexist (Fig. 5.1 and Table 5.1), and is one of the five landscapes where the GEF Small Grants Programme (SGP) operates in Mexico. The names given to each landscape aim to describe the ecosystems and traditional production activities of the region, creating an identity among communities. The FML is part of the participatory creation of the 2020–2030 Country Strategy of the SGP.

The SGP adopted a community-based landscape approach during its sixth operational phase (OP6), which recognises that community-based organisations are the driving force in rural development strategies and must take the lead in project planning, landscape governance, project execution, and monitoring. This approach is part of a strategic initiative to promote conservation and sustainable use of natural resources and ecosystems.

About one million people inhabit the FML, of which 48% is considered an economically active population (Instituto Nacional de Estadística y Geografía (INEGI), 2015a). More than three-quarters of the municipalities have upwards of 10% of residents engaged in subsistence agriculture. On average, 29% of the economically active and occupied population is engaged in natural resource-use activities (Instituto Nacional de Estadística y Geografía (INEGI), 2015a). In the FML, 45% of the population speaks an indigenous language, mainly Maya (Instituto Nacional de Pueblos Indígenas, 2015). The agro-biodiversity of *milpas* is an essential element for food security of indigenous families in the FML (Salazar Barrientos & Magaña Magaña, 2016).

The *milpa* is an agroecosystem based on rotational cultivation under the slash-and-burn technique, which depends on the seasonal rainfall and the soil's ability to retain water (Martínez et al., 2017; Salazar Barrientos et al., 2016). It makes up a matrix of polycultures, family gardens, and fragments of natural vegetation

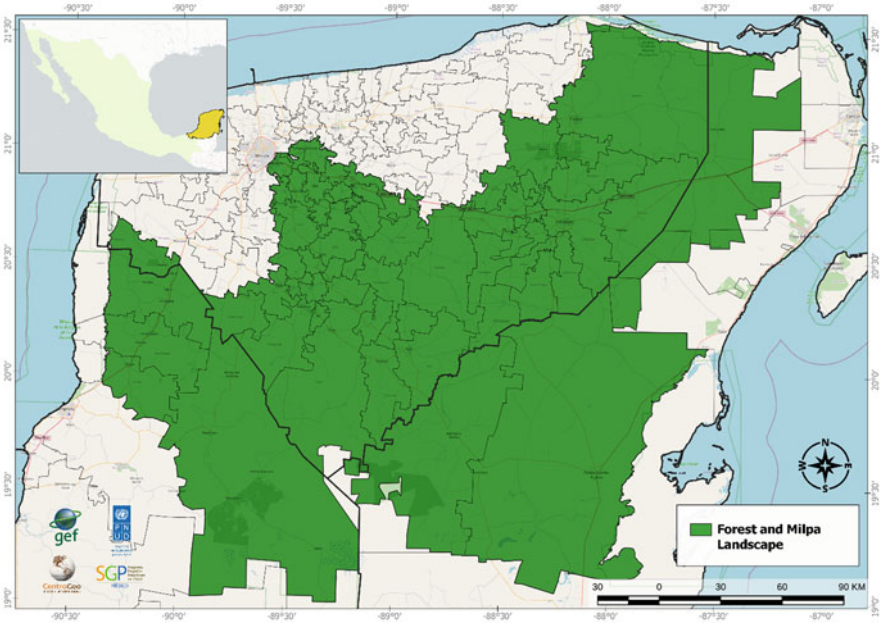

Fig. 5.1 Regionalisation of the forest and milpa landscape (source: prepared by Rosa Martha Peralta, Instituto Nacional de Estadística y Geografía (INEGI), 2015b; Instituto Nacional de Estadística y Geografía (INEGI), 2016; Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), 2015)

Table 5.1 Basic information of the study area

Country	Mexico
Province	Campeche, Quintana Roo, and Yucatan
District	n.a.
Size of geographical area (hectare)	5,268,000
Number of direct beneficiaries (persons)	n.a.
Number of indirect beneficiaries (persons)[2]	139,200
Dominant ethnicity(ies), if appropriate	Maya
Size of the case study/project area (hectare)	n.a.
Geographic coordinates (latitude, longitude)	20°12′18.0″N, 88°43′48.0″W

(Zizumbo-Villarreal & Colunga-García, 2017; Mariaca, 2015). The agro-biodiversity of the *milpa* is based on the so-called three sisters, corn, beans, and squash (Odum & Sarmiento, 1998), but comprises more than 30 species of other edible and medicinal plants (Toledo et al., 2003; Salazar Barrientos et al., 2016) along with other forbs and grasses known in Spanish as *arvenses*. The *milpa* in the FML has led to increased landscape diversity due to multistage and successional pathways of native secondary growth vegetation (Terán, 2010).

The ecosystems that predominate in the FML are sub-deciduous and subtropical evergreen forests, which represent an essential carbon sink worldwide. Yet, they are in a highly vulnerable status mainly due to the increase in mechanised agriculture and cattle ranching caused by the high demand for food (Aide et al., 2013; Comisión Nacional de Áreas Naturales Protegidas, 2020).

Regarding water, the FML has a peculiar characteristic: surface streams are almost inexistent. Water runs underground, and openings to the exterior are sinkholes or dolines called *cenotes*. The terrestrial surface consists of porous limestone rock with high permeability and transmissibility that allows rain to pass easily to the underground; in addition, rock fractures facilitate water flow, and other liquids poured onto their surfaces flow through the fissures. Thus, the FML aquifer is highly vulnerable to pollutants (Hernández & Ortega, 2017).

The FML is a region with shallow stony soils, rainfall patterns with 6 months of low rain, and a high incidence of hurricanes. Nevertheless, Mayan communities in the Yucatan Peninsula have adapted the *milpa* system to these adverse conditions (Toledo et al., 2008). This socio-environmental resilience is associated with the Yucatan's Mayan communities' multi-use strategies of nature that allow for the use of a variety of natural resources, at domestic units, both for subsistence purposes and for local and regional economic exchanges (Barrera-Bassols & Toledo, 2005; García-Frapolli et al., 2008; Toledo & Barrera-Bassols, 2011; Pinto & Barrios, 2015).

Today, the FML faces various threats that have diminished its resilience capacity. In the cultural sphere, a pattern of migration of young people to the Mayan Riviera has blocked the heritage of local knowledge associated with the *milpa* and their sustainable management (Rodríguez-Robayo et al., 2020). On the other hand, public policies have been implemented to make the *milpa* more profitable by promoting technology packages with genetically enhanced seeds and agrochemicals (Gutiérrez Núñez, 2020). Most of these chemicals are organochlorinated pesticides (OCPs) that mimic the functions of natural human hormones once they enter the body through water taken from contaminated wells and *cenotes*, and *milpa* foods consumed, by skin exposure or by inhalation (Polanco, Araujo, et al., 2018a). Pesticide-contaminated water in the FML is also linked to breast and uterine cancer and the presence of organochlorine substances in the breast milk of Mayan women (Polanco et al., 2017; Polanco, López, et al., 2018b).

The FML, as we have seen, is a landscape with multiple vulnerabilities. In this chapter, we want to share the vision of the FML inhabitants—their concerns over problems related to human health that they are facing today, and the strategies with which they aspire to overcome them.

We share reflections on the resilience of the FML from the perspective of the community members that inhabit it, namely, the peasants. A deliberation exercise was carried out by adapting the Toolkit for the Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes (SEPLS) (Bergamini et al., 2014). These indicators seek to enhance local communities' sense of proprietorship over landscape management processes and encourage them to think about how the

landscape's resilience can be improved. While indicators address different aspects of resilience, this study focuses on the issue of human and environmental health.

2 Methods

Within the framework of the 2020–2030 Country Strategy of the Small Grants Programme (SGP), two workshops were held in 2019, attended by a total of 40 peasants (18 women/22 men) living in the FML. The objective of the Country Strategy is to conduct a collective reflection on the status of production landscapes in Mexico, and propose plans based on local knowledge to improve those aspects where problems exist.

It was first necessary to identify stakeholders from the three states of the Yucatan Peninsula to invite to participate. We made a list of community leaders who have developed conservation and sustainability projects within the FML, and then we contacted these leaders and asked them to extend invitations to those interested in attending. Young people, women, and men were invited to these workshops to ensure that the exercise represented the various generations and genders in society.

The objective of the workshops was to evaluate 20 indicators that were adapted from the SEPLS Toolkit (Bergamini et al., 2014). This toolkit was used to generate resilience indicators from the perspective of the peasants who use and inhabit this socio-ecological production landscape.

Because participants came from different FML regions, sub-landscapes were defined using a participatory mapping technique, where producers themselves determined the extent of the territory on which they could make the assessment. Six sub-landscapes of the FML were evaluated utilising the indicators (Fig. 5.2).

Each sub-landscape was represented by a team of between five and six participants, who evaluated the set of indicators. The help of three Mayan-Spanish translators was engaged to ensure an inclusive process.

The Metaplan technique was used to evaluate the indicators. The process consisted of developing key questions to achieve a brainstorming process, followed by collective reflection and, finally, reaching a consensus on the score of each indicator using the Likert scale, with scores ranging from 1 to 5, where 1 is very low and 5 is very high. To ensure an accurate numerical value for each indicator, each participant was given a template with the five ranges (Fig. 5.3), and participants were asked to vote for the ranking category in which they considered each indicator to be, based on the discussion in the previous collective reflection. The values were averaged within the team and then between groups to get each indicator's overall value. Participants assessed five groups of indicators: (a) *heterogeneity and landscape protection*, (b) *agrodiversity and shared natural resources*, (c) *traditional knowledge and innovation*, (d) *governance and social equity*, and (e) *livelihoods*.

Each workshop lasted 2 days. During the first day, each team devoted an hour and a half to each group of indicators, with recess and recreation spaces to avoid fatigue.

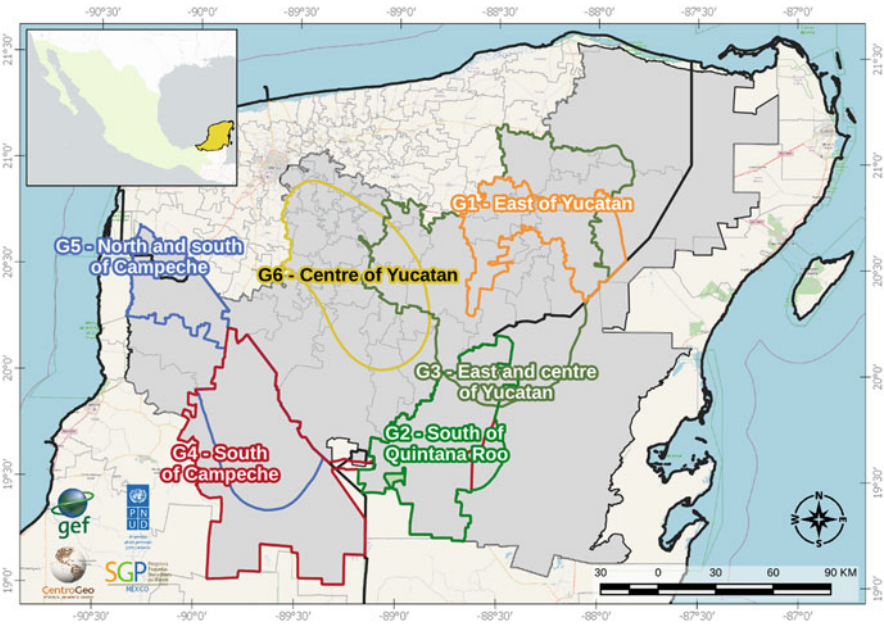

Fig. 5.2 Sub-landscapes of the FML as defined by six groups of participants from different regions (prepared by Rosa Martha Peralta)

Fig. 5.3 Ranges used to evaluate indicators of resilience (source: prepared by authors)

Very high	5
High	4
Regular	3
Low	2
Very low	1

On the second day, the results were discussed for each sub-landscape, and some strategies were developed to address indicators that obtained low ratings.

3 Results

3.1 Indicators of Resilience

The results are shown in Table 5.2. As noted, only 4 out of 20 indicators received a "high" rating, with most of them (13) evaluated as "regular," and only 3 put into the "low" category. In the first group, *landscape heterogeneity and ecosystem*

Table 5.2 Results of indicators of resilience (adapted from SEPLS Toolkit) for FML (source: prepared by authors)

Indicator	Evaluation
Heterogeneity and landscape protection	
1) Heterogeneity of the terrestrial/marine landscape	High
2) Ecosystem protection	Regular
3) Ecological interactions between different components of the marine/terrestrial landscape	Regular
4) Recovery and regeneration of the marine/terrestrial landscape	Regular
Agrodiversity and shared natural resources	
5) Diversity of local production systems	Regular
6) Maintenance and use of native varieties and species	Regular
7) Sustainable management of shared resources	Regular
Traditional knowledge and innovation	
8) Innovation in production practices and conservation	Low
9) Traditional biodiversity-related knowledge	Regular
10) Systematisation of biodiversity-associated knowledge	Regular
11) Women's knowledge	High
Governance and social equity	
12) Land/water rights and the management of other natural resources	Regular
13) Community governance of the marine/terrestrial landscape	Low
14) Synergy of social capital in the marine/terrestrial landscape	Regular
15) Social equity (includes gender equity)	Regular
Livelihoods	
16) Socioeconomic infrastructure	Regular
17) Human health and environmental conditions	Low
18) Productive diversification	High
19) Biodiversity-based livelihoods	High
20) Socio-ecological mobility	Regular

protection, one indicator was evaluated as high, and three were regular. In the second group, *agrodiversity and shared natural resources*, all three indicators were deemed to be regular. In the group of *traditional knowledge and innovation* indicators, one indicator was low, two regular, and one high. Three indicators were regular and one low in *governance and equity*. Finally, in the *livelihoods* group, two indicators were scored high, two regular, and one low (Table 5.2).

To address the issue of human and environmental health, we delved into the indicator that obtained the lowest value in both workshops: human health and environmental conditions (livelihoods group). Reasons for this focus include this indicator being an issue to which participants gave much weight in collective reflections, and also one that is associated with other indicators whose values were regular or low: socioeconomic infrastructure, traditional knowledge, community governance, and local production diversity.

The questions that were asked to participants in reflecting on human health and environmental conditions were the following: (a) Are our communities healthy? (b) Is there any link between the diseases we have in the community and the environmental conditions (soil, *cenotes*, forests)?

For the first question, answers were negative for all teams. The most mentioned diseases in the FML communities were stomach infections, diabetes, cancer, kidney problems, and hypertension. Other isolated mentions were infertility, anaemia, and headaches, among others (Table 5.3).

Answers to the second question were all positive regarding the relationship between disease and environmental health. Participants linked diseases such as stomach infections and cancer to water and air pollution caused by the lack of landfills and consequent burning of litter. Causes of diarrhoea mentioned included the increasing hot weather in recent years and water contamination due to the establishment of pig farms. Likewise, cancer was linked to water contamination by toxic residues from mechanised agriculture and excess of hormones in food.

Participants explained that diabetes is related to switching from a *milpa*-based diet (corn, bean, squash, bush meat, and honey, among other products) to an industrialised diet. Participants noted that the consumption of junk food and high-sugar carbonated beverages has increased in the last years in their communities. Participants associate this phenomenon with the indicator for traditional knowledge related to biodiversity, concerning which reflection focused on young people in communities losing interest in the *milpa* and its rituals: “They see traditional knowledge as backwardness”. This trend is strengthened by cultural uprooting due to migration, resulting in the *milpa* foodscape and other local production systems not being valued and a rising preference for industrialised products from the global market.

Other environmental health issues associated with the aetiology of diseases included water in communities containing a lot of chlorine; high deforestation rate of remnant forest patches; increment of disease vectors due to increased heat; and planting of GMOs.

Table 5.3 Responses to reflection questions for *human health and environmental conditions* indicator, shown for each of the groups formed in the workshops

Name of group and sub-landscape (see Fig. 5.2)	Reflection questions	
	(a) Are our communities healthy? (b) What are the main diseases that you have? (When the number of mentions is >1, it is indicated in parentheses)	(c) Is there any link between the diseases in the community and the environmental conditions (soil, *cenotes*, forests)? (When the number of mentions is >1, it is indicated in the parenthesis)
Group 1. Venados amarillos **Sub-landscape:** East of Yucatan state	(a) No (b) – Diarrhoea – Fever – Cough – Stomach infections – Influenza – Pneumonia – Diabetes – Kidney stones – Rheumatism (2)	– Kidney stones are caused by drinking dirty water (2) – Water and air pollution (no municipal dump, the trash is burned and smells bad) – Food with chemicals gets us sick – The chemicals get into the hens (2) – Climate change causes coughing and flu – Climate is hotter causing fevers and diarrhoea
Group 2. Loros verdes **Sub-landscape:** South of Quintana Roo state	(a) No (b) – Diabetes (4) – High cholesterol – High triglycerides – Diarrhoea – Anaemia – Fever – Cancer (3) – Depression	– Bad food [a long time ago meals came from the *milpa*] (4) – Diseases from the consumption of junk food – Sudden changes in temperature [flu] (2) – Chlorinated water – Pig farms produce water pollution – High temperatures – Food with toxic fumigation residues (2)
Group 3: Jabalíes verdes **Sub-landscape:** East and centre of Yucatan state	(a) No (b) – Fever (3) – Diabetes – Cough – Headache – Cancer	– Plastic burning – The sun is stronger (2) – Junk meals – Agrochemicals – Because we eat foods that have chemicals – A lot of Coca-Cola consumption
Group 4: Xunan Kab **Sub-landscape:** South of Campeche state	(a) No (b) – Gastrointestinal problems (7) – Hypertension (4) – Increased infertility (2) – Diabetes (5)	– Food (vegetables and animals contaminated with chemicals and hormones (7) – Exposure to pesticides (3) – Deforestation (5) – Environmental/water/air pollution (5)

(continued)

Table 5.3 (continued)

Name of group and sub-landscape (see Fig. 5.2)	Reflection questions	
	(a) Are our communities healthy? (b) What are the main diseases that you have? (When the number of mentions is >1, it is indicated in parentheses)	(c) Is there any link between the diseases in the community and the environmental conditions (soil, *cenotes*, forests)? (When the number of mentions is >1, it is indicated in the parenthesis)
	– Skin poisoning (3) – Different types of cancer (4) – Increased children with learning disabilities – Kidney problems (2) – Increased fever cases (5) – Headaches – Increased cases of obesity – Early onset of puberty	– Factories (2) – Climate change (5)
Group 5: **Che'el Azul Sub-landscape:** North and south of Campeche state (coinciding in the south with group 4)	(a) No (b) – Diabetes – Diarrhoea (2) – Hypertension – Respiratory infections (2) – Salmonellosis – Kidney problems (2) – Embolism – Paralysis	– The chemicals used for agriculture – The climate is very unstable (2) – Outdoor garbage burning (2) – Chlorinated water (excess chlorine) – Street food consumption – Formerly there was a season of mosquitoes, now there are mosquitoes all the time
Group 6: Chaak naal téel Sub-landscape: Centre of Yucatan state	(a) No (b) – Diabetes (2) – Rheumatism – Cancer (2) – Anaemia – Chronic cough – Cirrhosis – Hypertension – Obesity	– Temperature changes (3) – Bad food (2) – Use of agrochemicals (2) – Lots of chlorine in the water – Environmental pollution by mega projects/farms – Transgenic planting

In addition to the health problems faced by FML communities, the socio-economic infrastructure indicator showed a lack of medical services (hospitals, ambulances, and access to medicines).

3.2 Local Strategies for Resilience

On the second day of the workshops, a reflection was made on the FML's priority aspects, based on the work done on the first day. As mentioned earlier, the human health indicator was chosen as a priority. Although many of the factors that cause health problems are outside the communities, proposals were made for strategies with the potential to address issues at the local level to increase the resilience of the FML.

Regarding the problem of diabetes, education is a crucial element; as one participant mentioned:

> Children do not know the food from the *milpas*, we have to work with them, tell them that corn, sweet potato and beans are the best food, and share with them what we know about the value of *milpa*.

The same person mentioned a project that he develops in schools to build organic gardens:

> Students learn the whole process and thus they value food because they know what it costs to get it.

The participant concludes by saying that the best thing people can do to avoid getting sick is "to take care of the land, that means taking care of ourselves, but it is something we have not understood".

A proposed strategy to prevent pesticide contamination in water and food was to implement innovations in production activities, as one participant suggested:

> We can take advantage of the excrements of animals from our yards to make fertiliser, and we also can use microorganisms; we can mix these techniques with the old practices of *milpa* to make agroecology.

The problem of pesticides from extensive agriculture is more complex, as it is caused by public policies that have promoted agrochemicals since the 1940s, when the federal government supported national projects on "agricultural modernisation" that were derived from agreements with the Ford and Rockefeller foundations, the main campaigners of the Green Revolution. A strategy proposed by the workshop participants is associated with community governance:

> Here we realise the problems, we are talking about it, and they are problems that we have in common, even if we come from different places. We have to go now to talk to the people in our communities, we must understand that transgenic maize and pesticides are not the best options. We need a lot of organisation and communication to change those beliefs.

Regarding soil and water contamination, it was mentioned that the problem was not only the application of chemicals in *milpas*, but also the mismanagement of pesticide containers. One suggested strategy to address this problem is again related to community governance:

> In my community, we are making citizen complaints at all three levels of government (municipal, state and federal). We also have been able to make alliances with other organisations and universities ... we cannot continue to think that this is God's work—this is because there is bad ecosystem management.

Another proposal from participants involved innovation. They noted that it is essential for each community to find a way to get water filters, and also to get technologies for rain capture.

A proposal on addressing the shortcomings of health services in communities involved the creation of medicine hospitals:

> Young people could learn traditional medicine and train others so that we will no longer have to go looking for hospitals that are far away. We have to look for alternatives together.

Another of the strategies mentioned was to seek advice on how to know their rights with regard to human health in order to be able to demand them.

4 Discussion

The livelihoods and health of FML inhabitants are closely related to the proper functioning of ecosystems. The rainforest is essential to maintain the hydrological cycle in the FML, which means that rains preserve *milpas* and provide water for human consumption. Water is also used for irrigation of home gardens, to feed animals, and to maintain apiaries. In turn, all production activities conducted in the soil of the FML have a substantial impact on water quality due to the soil's high permeability. According to Batllori (2017), the main sources of water pollution include all those mentioned by the participants, including pig farms, agricultural activities, and garbage dumps, but also wastewater from tourist areas and urban areas that, although seem to be non-rural issues, have a significant impact on FML water quality.

The recognition of the close relationship between human health and ecosystem health has been lost over time. Older people continue to perform rituals of respect and appreciation for what nature provides to them (e.g. food, medicine, beauty), but younger generations have left these customs behind. The devalorisation of cultural ecosystem services in SEPLS has been identified as one of the main fronts of scholarly enquiry in the new geographies of conservation (Sarmiento & Cotacachi, 2019). Duarte (2017) reflected on the change in perceptions of resources, such as water or maize, noting that perceptions define how resources are valued and handled. She also recounts how on a visit to a *J'men* (a man specialising in the rituals of the Mayan *milpa*), she heard him say, "the holy water is a blessing to all human beings living on earth" (Duarte, 2017, p. 137). In this sense, the proposals made during the workshops on recovering and revaluing local knowledge by creating traditional medicine hospitals are very relevant, not only to redevelop and strengthen the meaning of the "human health-nature" relationship, but also to address a violation of a fundamental human right—access to public health systems.

Food production is another relevant issue for FML health. Some studies have analysed the relationship of pesticides with diseases, such as cancer, showing that they inhibit humans' hormonal functions (Polanco, López, et al., 2018b). Pesticides enter the FML's food chains from various sources, including honey, *milpa* products,

bush meat, and water. Participants' proposals to develop sustainable innovations for production practices and access to less contaminated water may fail to eliminate many pollution sources; however, these proposals are essential to ensure that production activities for self-consumption, like beekeeping and the *milpa* system, remain healthy systems for food security, and no longer function as another vehicle for pollutants to enter the human body.

Although our study is based on an analysis of the perceptions of FML inhabitants, it is interesting that their perceptions are closely associated with information from the scientific literature. For example, the concern they expressed in the workshops about water pollution associated with pig farms and pesticides has been documented in various studies previously mentioned in this chapter (Batllori, 2017; Hernández & Ortega, 2017; Metcalfe et al., 2011; Polanco et al., 2017; Polanco, Araujo, et al., 2018a). The problem of diabetes being associated with changes in diet has also been widely documented, and is relevant for these communities whose diet was previously based on the consumption of *milpa* products. For example, Narvaez and Segura (2020) analyse the recent increase of diabetes in indigenous Mayan regions; they also explain the antidiabetic potential of foodstuff from the *milpa*. Some studies have documented evidence showing that the introduction of industrialised foods into the diet of Mayan communities a decade ago, which meant a less nutritious diet, rich in sugars, saturated fats, salt, and colour and flavour additives, implied an increased risk of obesity and diabetes (Pérez Izquierdo et al., 2012; Leatherman & Goodman, 2005). In recent studies this problem prevails (Frank & Durden, 2017; Leatherman et al., 2020; Otero Prevost et al., 2017). Although the subject of dietary change related to gender did not arise in the workshops, it is relevant. For instance, obesity is a problem that affects women more in Mayan communities than elsewhere (Marín Cárdenas et al., 2014).

The generation of resilience indicators revealed the many vulnerabilities of the FML. However, it also allowed reflection on potential options to seek to enhance the landscape's resilience from the local point of view, accepting that the cause of vulnerabilities often comes from decisions made outside the FML communities. One of the most important lessons of this exercise is that assessing trends, reflecting collectively, and designing strategies from a bottom-up perspective have the potential to empower local people to begin to recognise themselves as managers of their territories.

5 Conclusion

One main lesson learned is that the landscape approach methodology is much more aligned with the peasants' view of their ecosystem than a sectoral approach. During the feedback sessions with participants, they mentioned that the integrated approach, for example including medicine produced within the ecosystem, allowed them to relate their experiences to the future SGP strategy. In rich biocultural diverse contexts, this approach is even more relevant.

The resilience indicators, co-created by the participants, focused on the perception of trends. In the development context, data is the main source of information to define a baseline. By asking participants how they visualise those trends, we recognise that they own the key knowledge. The methodology also allows for the detection of threats that are not monitored by governmental bodies, such as the use of pesticide in the rural sector in Mexico.

In 2019, during the workshops, the human health indicator was chosen as a priority by the participants. Because the strategies proposed are not GEF-eligible activities, adoption by the SGP of a specific strategy was considered as a challenge by the country's programme team. However, one year later, and after 14 months of the SARS-CoV-2 pandemic, the GEF is now holding discussions within its Scientific and Technical Advisory Panel on the link between ecosystem and human health (Scientific and Technical Advisory Panel (STAP), 2020). To add to these discussions, new theoretical proposals on the emergence of SARS-CoV-2 on the planet should be a priority. Alcántara-Ayala (2021) proposes the typification of this type of phenomenon as "syndemic pan-disaster". This approach recognises that society's vulnerability and exposure to COVID-19 have presented the great challenge of solving countless pre-existing problems, such as those detected in the exercise documented in this chapter. Thus, the communities detected local threats that are now fully part of the global environmental agenda, and action may be taken during the next 10 years in SGP Mexico to support those initiatives in the framework of the United Nations Decade on Ecosystem Restoration.

Finally, it is essential to mention that almost half of the participants in the workshops were women, highlighting the importance of the gender perspective during these workshops. This topic becomes highly relevant when scientific data show that environmental health affects men and women differently, for example, the relationship between uterine and breast cancer, and contaminated breast milk and pesticide contamination in water (Polanco et al., 2017; Polanco, López, et al., 2018b). The gender perspective makes it possible to generate strategies that better address the problems faced by SEPLS.

Acknowledgements This project was funded by SGP-GEF. We want to thank the Mayan men and women who shared with us their reflections and their knowledge.

References

Aide, T. M., Clark, M. L., Grau, H. R., López-Carr, D., Levy, M. A., Redo, D., Bonilla-Moheno, M., Riner, G., Andrade-Núñez, M. J., & Muñiz, M. (2013). Deforestation and reforestation of Latin America and the Caribbean (2001–2010). *Biotropica, 45*(2), 262–271.

Alcántara-Ayala, I. (2021). COVID-19, más allá del virus: una aproximación a la anatomía de un pandesastre sindémico. Investigaciones Geográficas, 104. https://doi.org/10.14350/rig.60218

Barrera-Bassols, N., & Toledo, V. M. (2005). Ethnoecology of the Yucatec Maya: Symbolism, knowledge and management of natural resources. *Journal of Latin American Geography, 4*, 9–40.

Batllori, E. (2017). Condiciones actuales del agua en la Península de Yucatán. In M. Chávez-Guzmán (Ed.), *El manejo del agua a través del tiempo en la Península de Yucatán* (pp. 201–225). UADY. isbn:978-607-8527-12-0.

Bergamini, N., Dunbar, W., Eyzaguirre, P., Ichikawa, K., Matsumoto, I., Mijatovic, D., Morimoto, Y., Remple, N., Salvemini, D., Suzuki, W., & Vernooy, R. (2014). *Toolkit for the indicators of resilience in socio-ecological production landscapes and seascapes*. UNU-IAS, Biodiversity International, IGES & UNDP.

Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). (2015). Límites y regionalización de los Corredores Biológicos del sureste de México, 2015, escala: 1:250000, México, D. F.

Comisión Nacional de Áreas Naturales Protegidas. (2020). viewed 14 December 2020. Retrieved from https://www.gob.mx/conanp/documentos/region-peninsula-de-yucatan-y-caribe-mexicano?state=published.

Duarte, A. (2017). La “santa agua” en la cutura maya en Yucatán. In M. Chávez-Guzmán (Ed.), *El manejo del agua a través del tiempo en la Península de Yucatán* (pp. 137–151). UADY. isbn:978-607-8527-12-0.

Frank, S. M., & Durden, T. E. (2017). Two approaches, one problem: Cultural constructions of type II diabetes in an indigenous community in Yucatán, Mexico. *Social Science & Medicine, 172*, 64–71.

García-Frapolli, E., Toledo, V. M., & Martínez-Alier, J. (2008). Apropiación de la naturaleza por una comunidad maya yucateca: un análisis económico-ecológico. *REVIBEC-Revista Iberoamericana de Economia Ecologica, 7*, 27–42.

Gutiérrez Núñez, N. L. (2020). Revolución verde en los suelos agrícolas de México. Ciencia, políticas públicas y agricultura del maíz, 1943-1961. *Mundo Agrario, 21*(47), e142. https://doi.org/10.24215/15155994e142

Hernández, L., & Ortega, D. (2017). El agua en la Península de Yucatán. In M. Chávez-Guzmán (Ed.), *El manejo del agua a través del tiempo en la Península de Yucatán* (pp. 37–45). UADY. isbn:978-607-8527-12-0.

Instituto Nacional de Pueblos Indígenas. (2015). *Atlas de los pueblos indígenas de México*, viewed 5 December 2021. Retrieved from http://atlas.inpi.gob.mx/?page_id=7256.

Instituto Nacional de Estadística y Geografía (INEGI). (2015a). *Población Económicamente Activa de México*.

Instituto Nacional de Estadística y Geografía (INEGI). (2015b). *Encuesta intercensal: Lengua Indígena.*

Instituto Nacional de Estadística y Geografía (INEGI). (2016). Conjunto de datos vectoriales de uso de suelo y vegetación, Escala 1:250,000, Serie VI.

Leatherman, T. L., & Goodman, A. (2005). Coca-colonization of diets in the Yucatan. *Social Science & Medicine, 61*(4), 833–846.

Leatherman, T., Goodman, A. H., & Stillman, J. T. (2020). A critical biocultural perspective on tourism and the nutrition transition in the Yucatan. In H. Azcorra & F. Dickinson (Eds.), *Culture, environment and health in the Yucatan Peninsula* (pp. 97–120). Springer.

Mariaca, R. (2015). La milpa maya yucateca en el siglo XVI: evidencias etnohistóricas y conjeturas. *Etnobiología, 13*(1), 1–25.

Marín Cárdenas, A. D., Sánchez Ramírez, G., & Maza Rodríguez, L. L. (2014). Prevalencia de obesidad y hábitos alimentarios desde el enfoque de género: el caso de Dzutóh, Yucatán, México. *Estudios Sociales, 22*(44), 64–90.

Martínez, F., Benítez, M., Ramos, X., García, G., Bracamontes, L., & Vázquez, B. (2017). *Derechos humanos y patrimonio biocultural. El sistema milpa como cimiento de una política de estado cultural y ambientalmente sustentable*. Centro Mexicano de Derecho Ambiental (CEMDA).

Metcalfe, C. D., Beddows, P. A., Bouchot, G. G., Metcalfe, T. L., Li, H., & Van Lavieren, H. (2011). Contaminants in the coastal karst aquifer system along the Caribbean coast of the Yucatan Peninsula, Mexico. *Environmental Pollution, 159*(4), 991–997.

Narvaez, J. J., & Segura, M. R. (2020). Foods from Mayan communities of Yucatan as nutritional alternative for diabetes prevention. *Journal of Medicinal Food, 23*(4), 349–357.

Odum, E. P., & Sarmiento, F. O. 1998, *Ecología: El Puente Entre Ciencia y Sociedad*, Editorial MacGraw Hill-Interamericana de Mexico.

Otero Prevost, D. E., Delfín Gurri, F., Mariaca Méndez, R., & Guízar Vázquez, F. (2017). La incorporación y el aumento de oferta de alimentos industrializados en las dietas de las unidades domésticas y su relación con el abandono del sistema de subsistencia propio en las comunidades rurales mayas de Yucatán, México. *Cuadernos de Desarrollo Rural, 14*(80), 1–16.

Pérez Izquierdo, O., Nazar Beutelspacher, A., Salvatierra Izaba, B., Pérez-Gil Romo, S. E., Rodríguez, L., Castillo Burguete, M. T., & Mariaca Méndez, R. (2012). Frecuencia del consumo de alimentos industrializados modernos en la dieta habitual de comunidades mayas de Yucatán, México. *Estudios Sociales (Hermosillo Son), 20*(39), 155–184.

Pinto, L. S., & Barrios, L. G. (2015). Conservación en espacios rurales humanizados, Ecofronteras.

Polanco, A. G., López, M. I. R., Casillas, T. A. D., León, J. A. A., Prusty, B. A. K., & Cervera, F. J. Á. (2017). Levels of persistent organic pollutants in breast milk of Maya women in Yucatan, Mexico. *Environmental Monitoring and Assessment, 189*(2), 59.

Polanco, A. G., Araujo, A., Tamayo, J. M., & Munguía, A. (2018a). The glyphosate herbicide in Yucatan, Mexico. *MOJ Bioequivalence & Bioavailability, 5*(6), 284–286. https://doi.org/10.15406/mojbb.2018.05.00115

Polanco, A. G., López, M. I. R., Casillas, Á. D., León, J. A. A., & Banik, S. D. (2018b). Impact of pesticides in karst groundwater. Review of recent trends in Yucatan, Mexico. *Groundwater for Sustainable Development, 7*, 20–29.

Rodríguez-Robayo, K. J., Méndez-López, M. E., Molina-Villegas, A., & Juárez, L. (2020). What do we talk about when we talk about milpa? A conceptual approach to the significance, topics of research and impact of the Mayan milpa system. *Journal of Rural Studies, 77*, 47–54.

Salazar Barrientos, L. L., & Magaña Magaña, M. Á. (2016). Aportación de la milpa y traspatio a la autosuficiencia alimentaria en comunidades mayas de Yucatán. *Estudios Sociales (Hermosillo Son.), 24–25*(47), 182–203.

Salazar Barrientos, L. L., Magaña Magaña, M. Á., Aguilar-Jiménez, A. N., & Ricalde-Pérez, M. F. (2016). Factores socioeconómicos asociados al aprovechamiento de la agrobiodiversidad de la milpa en Yucatán. *Ecosistemas y recursos agropecuarios, 3*(9), 391–400.

Sarmiento, F. O., & Cotacachi, C. (2019). Framing cultural ecosystem services in the Andes: Utawallu Runakuna as sentinels of values for biocultural heritage conservation. In UNU-IAS & IGES (Ed.), *Understanding the multiple values associated with sustainable use in socio-ecological production landscapes and seascapes (SEPLS)* (Satoyama initiative thematic review) (Vol. 5, pp. 31–46). United Nations University Institute for the Advanced Study of Sustainability.

Scientific and Technical Advisory Panel (STAP). (2020). STAP Chair's Report to the GEF Council (pp. 1–16).

Terán, S. (2010). Milpa, biodiversidad y diversidad cultural. Contexto social y económico. In R. Durán & M. Méndez (Eds.), *Biodiversidad y Desarrollo Humano en Yucatán*. CICY, PPD-FMAM, CONABIO, SEDUMA.

Toledo, V., Ortíz-Espejel, B. F., Cortés, L., Moguel, P., & Ordonez, M. D. J. (2003). The multiple use of tropical forest by indigenous people in México: A case of adaptive management. *Conservation Ecology, 7*(3), 9.

Toledo, V. M., Barrera-Bassols, N., García-Frapolli, E., & Alarcón-Chaires, P. (2008). Multiple use and biodiversity within the Mayan communities of Yucatan, Mexico. *Interciencia, 33*(5), 345–352.

Toledo, V. M., & Barrera-Bassols, N. (2011). Saberes tradicionales y adaptaciones ecológicas en siete regiones indígenas de México. In F. R. Escutia & S. B. Garcia (Eds.), *Saberes ambientales*

campesinos: Cultura y naturaleza en comunidades indígenas y mestizas de México (pp. 15–60). Universidad de Ciencias y Artes Chiapas.

Zizumbo-Villarreal, D., & Colunga-García, P. (2017). La milpa del occidente de Mesoamérica: profundidad histórica, dinámica evolutiva y rutas de dispersión a Suramérica. *Revista de Geografía Agrícola, 58*, 33–46.