FINAL REPORT PROJECT 18396

CLOUD FORESTS OF PÁRAMO EL TAMBOR: WORKING WITH THE STAKEHOLDERS TO PROMOTE ECOSYSTEM CONSERVATION AND RESTORATION FOR CLIMATE CHANGE ADAPTATION

Exponsored by

The Van Tienhoven Foundation for International Nature Protection

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May, 2019

ACKNOWLEDGEMENTS

We are very grateful for the Van Tienhoven Foundation for their generous support to this important project for the conservation of the Andean cloud forests in Venezuela. Without their confidence and comprehension, we would have not been able to carry out such a project during these hard times for our country. We also thank Centro de Investigación en Gestión Integral de Riesgos (CIGIR) and especially to its president Dr. Alejandro Liñayo for logistic support and continuous encouragement during the project. Especial thanks to the people from Aldeas Consolidadas Communal Council from Andrés Bello municipality and La Cuchilla Communal Council from Campo Elías municipality (Mérida-Venezuela); to teachers, head staff, and students of the schools José Nolberto Moreno Palmi y La Carbonera for their participation. Our special thanks to the Arias family, owner of Finca Sinaí and the Varela family, owner of Finca El Rosario for facilitating their lands for establishing the restoration trials, and their support in carrying out the project. Also, we want to recognize Dugarte family, especially Ancelmo Dugarte for his invaluable knowledge of the flora and fauna of El Tambor and for his support in fieldwork. To the university students of Community Service of the Superior Technical Forestry School: Mariana Velázquez, Fabian Rojas, Cristian Gutiérrez, Yipsy Altuve and Angel Salas. Senior Forestry Technician Leidy Ortiz and intern Fabian Rojas; to Professor Miguel Ilija, wildlife specialist, for his support in educational workshops about the conservation of the cloud forest and its fauna, and finally to Erika Rodríguez and José Manuel Romero from the Ymago Biodiversity and culture Foundation, for the audiovisual documentation during the project.

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SUMMARY

Páramo El Tambor is an isolated mountain massif part of the Venezuelan Andes facing the Maracaibo Lake with unique environmental, wildlife and scenic characteristics. A notorious feature is the persistent cloudiness year around. Also, El Tambor is a complex socio-ecological system as farming and cattle ranching are traditional activities. Although partially under protection, the current Venezuelan crisis led to abandon institutional conservation actions. Therefore, deforestation and improper land managing practices are on the rise. These factors are driving degradation and habitat loss, altering the water cycle, which linked to climate change, pollutants, and pests, could drive many species to extinction. The project`s goal is working with stakeholders for implementing simple but impacting conservation and management actions (e.g. cattle exclusion, passive and active restoration with native species) and moving them to create conservation networks that will act as multipliers of successful practices. At the same time, through educational activities we look that communities recognize the crucial need of ensuring ecosystems function and species conservation, as well as the presence of an amazing biodiversity in the area.

We carried out the programmed activities, including the workshops, field-visits to the university forest, meetings with small groups, visit to families and interviews with community leaders. Informative and participatory activities included information on climate definitions, processes, and climatic features of the area. We introduced the concepts of climate change, and climate change adaptation having the opportunity of learning about the general knowledge and perceptions of participants about these issues. With respect to restoration, we focused in plant species identification (common names), and explanation of growing habits of native trees, seedling collection, and planting practices in the nursery (substrate mix preparation, planting seedlings in bags).

Stakeholders showed willingness to work in restoration activities at their farms, mainly from families who have children in the schools. According to factors such as community interest in recovering identified critical areas, accessibility, time availability, and capabilities to participate in collaborative works, we identified community people to develop work in critical areas for 2018-2020. We also discussed on threats and opportunities to implement a coordinated restoration plan. Major threads include deforestation and poorly planned and executed productive activities which cause unnecessary damage to the habitats. The final planned workshop suffered successive deferments due to increased difficulty to bringing people together on particular dates because of the deepening of the Venezuelan crisis. We opted to meet with small groups of people, but keep waiting for an opportunity to do a large meeting in the near future.

Deforesting for agriculture and cattle is the strongest threat in the area. In consolidated farms, the roaming of cattle within the remaining forest causes their degradation and eventual loss due to damage to plant regeneration and soil compaction. The last large deforestation was registered in 2016 (Maporal de La Osa and El Urumal), but surrounding communities and environmental organizations stopped this process at least for now. Eventual illegal logging is an always present threat. However, the felling of trees of a specific group of native species for fuelwood is an emerging threat given that the inhabitants lost access to natural gas which was the traditional way of cooking and making fuel needing activities.

Together with participants from schools, community and university students we worked in establishing demonstrative trials on passive and active restoration. Active restoration consisted in establishing a mixed plantation trial with 19 native tree species in a 1000 m^2 tract of degraded land (379 plants). The process included work from plant identification and selection according to species site requirements, building of temporal nurseries for plant production, caring of plantlets for ensuring their survival and

growth in the nursery, site preparation, planting, and initial care (survival over 85% despite the dry season lasted until April).

In relation with the passive restoration, in one of the selected areas we found a water spring. In this place, we agreed with the community and owner to spare approximately 1.5 hectares including areas with various levels of degradation and recovery. We completed an inventory of the woody component with the help of university students and field guides.

We elaborated a preliminary thematic map identified potential critical areas for disaster risk, deforestation hotspots, and areas for recovering using the map layers, and in-field checking with help of the communities. As for information dissemination and search for new funding sources: we have compiled an extensive amount of pictures and films on the various project activities. We will be including the material in web pages, reports, YouTube, and Instagram (@proyectotambor).

The inclusion of climate change and risk assessment approaches proved to be very effective to call more attention of stakeholders in environmental and habitat conservation matters. In addition to our current educative activities in habitat restoration, climate change, and risk assessment, we see the need of more educative work on promoting the knowledge and conservation of wildlife, especially those identified as endangered.

With this project, we have gained great insights on the next steps needed to coordinate and implement an effective restoration plan for the area. Although support of the communities is granted for continuing with the project; at this stage, financial support from international NGOs and other funding agencies will be needed to consolidate and expand it. We will continue looking actively for financial aid by applying to funding agencies. Unfortunately, no financial aid from the national/local government and universities is expected in the short-medium term due to the Venezuelan crisis. If the economic crisis is overcome, it is expected that in the midterm these environmental conservation activities will be seen as an integral part of the productive processes in the area and will be taken as an investment to maintain and increase productivity and ensure their quality of life.

CONTENTS

1 INTRODUCTION

1.1 Project area

El Tambor constitutes an isolated mountain massif part of the Venezuelan Andes facing the Maracaibo Lake covered by dense cloud forests, paramos, and wetlands creating a landscape of great scenic beauty with unique environmental characteristics (Figures 1 and 2). Politically is located on the Andrés Bello, Sucre, and Campo Elías in the Mérida state. The area occupies around 150 km^2 covered by cloud forests, "paramos", and wetlands, mostly under protection figures such as "La Culata National Park", and the San Eusebio University Forest (University of Los Andes). The climatic characteristics of the area are influenced by the altitude (max 3000 masl) and the trade winds coming from the NE that penetrate through the piedmont area facing the lacustrine plain of Lake Maracaibo. These winds come loaded with water vapor forming a persistent cloudiness that when it reaches its saturation point, triggers local precipitations in the slopes and valleys. The persistent thick cloudiness induces the existence of dense cloud forests and in flat sites, wetlands occur.

El Tambor is regarded a "Continental Island" because of its high biodiversity and endemisms. The cloud forest contains the largest Venezuelan population of the giant coniferous *Retrophyllum rospigliosii, an* endangered coniferous species according to the IUCN and other endemic trees such as *Vochysia meridensis* (tambor) reaching up to 45 m tall (Figure 3). The place is rich in mammal species (+30), birds (hummingbirds, quetzals, trogons, parrots, +200 - Figure 4-), amphibian/reptiles (+20), trees (+200), and epiphytes (+110 catalogued orchid species) (Figure 5). At least seven species are in the IUCN red list: the endemic toad *Atelopus carbonerensis* (Critically Endangered); the tree frog *Dendropsophus meridensis* (Endangered (E)); the helmeted curassow *Pauxi pauxi* (E); the spectacled bear *Tremarctos ornatus* (Vulnerable (V)); salamanders (e.g. *Bolitoglossa spongai* (E), *B. orestes* (V)); and. In addition to its ecological importance, Páramo El Tambor has anthropological and archeological connotation, existing at least two places "Piedra de El Tambor" and "Laguna de El Tambor" considered as sacred places by aborigines, and nowadays venerated by peasants who attribute them a role in the climatic equilibrium (dry-rain seasons), and "harvest benefactors".

El Tambor is a complex socio-ecological system as farming and cattle ranching are traditional activities that depend on the environmental goods and services provided by the ecosystems, especially water. The latitudinal location of the area, together with the atmospheric dynamics of the region and its relief configuration, define the climatic periodicity of the rainfall in the study region, which determines the dynamics and availability of water in the spatial-temporal plane. In recent years, due to meteorological phenomena such as "El Niño", which generates a deficit of rainfall and an increase in temperatures in the country, particularly in the Andes Region as well as the Oscillation in the Atlantic ocean, the raising of temperatures causes important alterations in the availability of water at a temporary level; therefore, the possible advance of global climate change could be affecting climate dynamics at different spatial scales, although such effects are still difficult to perceive and predict. Given the fragility of the ecosystems, and the relative isolation of the massif (very low maximum altitude (3000 m) as compared with other areas of the Venezuelan Andes (> 4000 m)), the effects of climate change can be accentuated if irrational anthropic activities continue; therefore, informative, raising awareness, and concrete conservation actions are imperative.

2 AIM AND OBJECTIVES

2.1 Aims

Our aim is to contribute to the conservation of the cloud forest ecosystem by raising local stakeholder awareness on the importance of maintaining the integrity and functionality of these forests as a climate

and water cycle regulator that will warrant their livelihoods in the short to long-term. We look at the involvement of local communities through collaborative climate adaptation actions such as informative-educative activities, identification of critical areas and risks, ecosystem restoration with native tree species, and foster care for the highly diverse wildlife and flora of this place.

2.2 Objectives

a. Sensitize the community on the importance of preserving the cloud forest as a regulator of the hydrological cycle and as a mitigating effect of climate change at the local level, through community and school education on conservation and restoration issues.

b. Contribute to the conservation and recovery of the Andean cloud forest of El Tambor, through ecological restoration methods including:

   b.1 establishing a demonstrative mixed planted forest with native species (selection of critical area for restoration, growing plants in nurseries, establishment in the field, initial care, and monitoring).

   b.2 selecting a critical degraded area for recovering and preservation through passive restoration (cattle exclusion).

c. Elaborate a thematic map with main environmental natural and anthropic features in order to identify the conservation status of the area and identifying critical areas as a preliminary step for the implementation of a restoration plan in the area.

d. Documenting the results and activities with short films, pictures, testimony, and other relevant documents.

Figure 1 Working area: a) Geographical location, b) Influence area (red line indicates the boundary above 2000 m.a.s.l. which is approximately the lower limit of cloud forests occurrence), c) a 3D view of El Chorotal and La Cuchilla showing the high degree of anthropic intervention (Images Google Earth [tm]).

Figure 2. El Tambor landscapes Above view of el Tambor peak from the North, below a rare view of the south of Maracaibo´s lake in a clear day.

Figure 3. Large trees such as tambor (*Vochysia meridensis*), pino laso (*Retrophyllum rospigliosii*), Mountain Cedar (*Cedrela montana*) and tree ferns (*Cyathea sp*.) grow to large sizes in El Tambor cloud forest.

Figure 4. El Tambor has a very high diversity of birds including a large variety of hummingbirds.

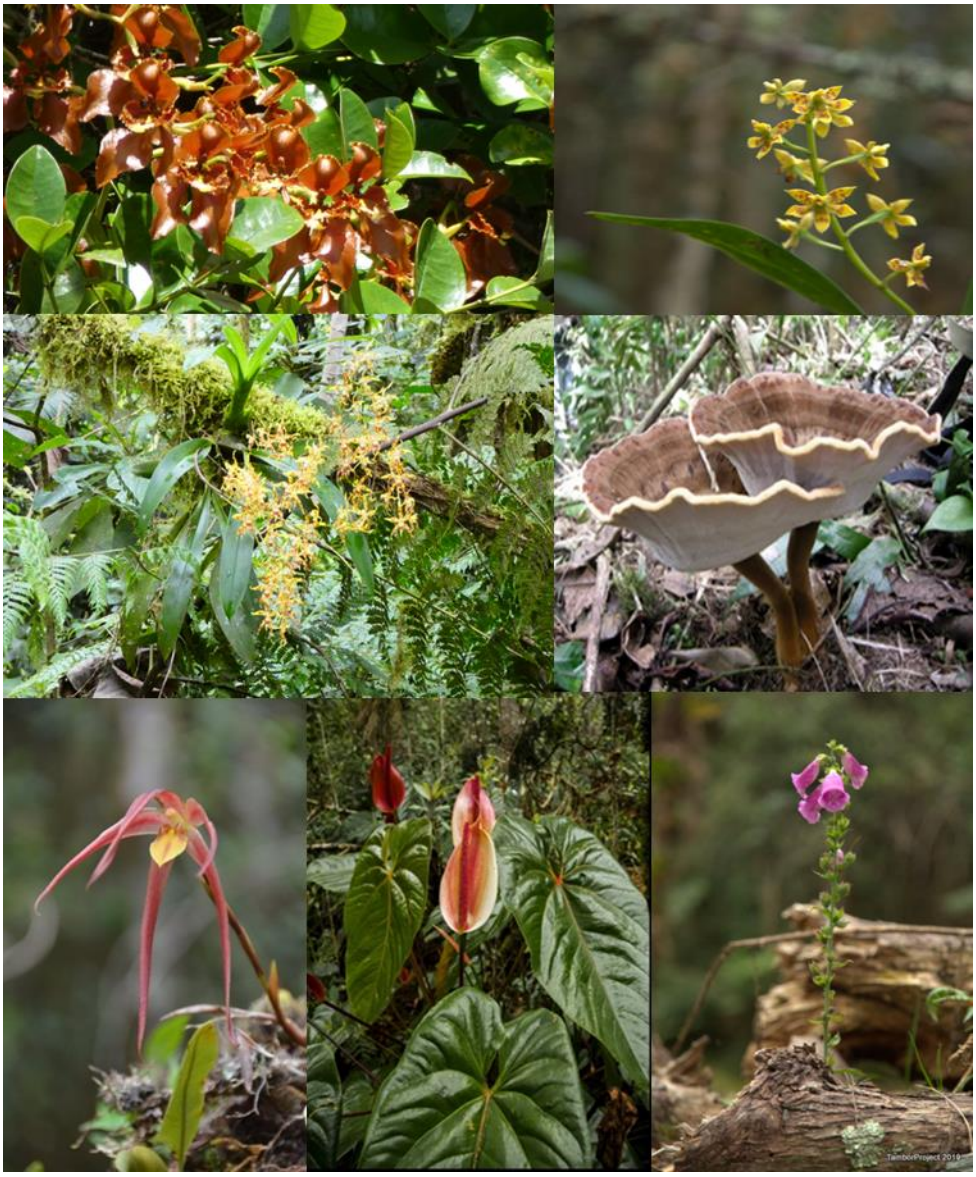

Figure 5. Trees and soils are covered with many epiphytic species including more than 110 orchid species.

3 RESULTS OF PROJECT ACTIVITIES

3.1 Sensitizing the communities:

- From June 2018 to April 2019, we carried out six meetings at the elementary schools of La Cuchilla and San Eusebio Sectors with introductory and participatory activities including our team and university students, elementary school teachers, children and their parents (mainly the mothers, which also play an important role in community council's decisions). Participants included 28 elementary school students and their parents, and eight teachers from both schools. Also, one forestry technician, five university students, one baqueano, and three university professors. Topics included climate and climate change basic concepts, water cycle, cloud forest vegetation, and wildlife, and man relationships (Figure 6). A field visit to the San Eusebio University Forest (University of Los Andes, Mérida) with the

children, teachers, parents and community people. Activities included climate and climate change perceptions of participants, plant species identification (common names), and explanation of growing habits of native trees, seedling collection, and planting practices in the nursery (substrate mix preparation, planting seedlings in bags).

- Exploratory trips to identify and talk with stakeholders, explore the accessibility to different localities, and identify features of landscape, vegetation, and degraded areas.

Figure 6. Sensitizing the communities through education and participative activities.

3.1.1 Results:

- From the meetings and exploratory trips we got knowledge of the perception, interests, and main concerns and limitations to carry out conservation activities by local people, in the light of the Venezuelan crisis which is also affecting strongly this rural area.
- Our work with the schools concentrated mainly on the elementary schools of San Eusebio and La Cuchilla sector. As activities proceeded teachers and parents from nearby sectors - Paramito (29 students) and Palo Negro (78 students) - within the influence area of the project participated actively in the meetings and offered their schools and lands to carry out the various activities in 2019-2020.

- We carried out the programmed activities, including the meetings, field-visits to the university forest and a meeting with the producers association. We were demonstrated willingness from several stakeholders to work in restoration activities at their farms, mainly from families who have children in the schools. According to factors such as community interest in recovering identified critical areas, accessibility, time availability, and capabilities to participate in collaborative works, we identified potential people to develop work for 2018-2020.

3.2 Nurseries and plant production:

- ***Nurseries:*** Due to the need of growing plants to be ready for planting before the beginning of the dry season and having an area to train people in nursery activities, we reconditioned our nursery at the University Forest. Following the suggestions of community people, portable nurseries were installed close to the planting areas (Figure 7).
- ***Plant production:*** We collected regeneration of at least 20 species of the various shade-tolerant functional groups. Among them we have collected a considerable amount of *Montanoa quadrangularis* which is shade-intolerant and the fastest growing native tree species in the area. We used this species to create shade conditions to introduce late succession shade-tolerant species.

Figure 7. Nurseries for plant production.

3.3 Restoration Areas

- One of the places identified by community´s people as critical, mainly because it affects their water sources, corresponds to a relatively large size farm (21,8 ha) with the name of "Sinaí" located at the top of "El Chorotal" limiting with legally protected areas. In this farm,

the former owner caused large damage to the ecosystems when trying to build a large tourism facility. Damages included total deforestation, opening of unauthorized roads, land movements to create artificial lagoons, removing of soils and rocks, and damage to wetlands by draining and excavation. This was a strong source of conflict, which was settled with the paralyzation of the project and selling of the property. Now, the new owners (The Arias family), who have been participating actively in the project, are willing to help in restoring the damages caused by the former owner. We visited the farm, and together identified the main damages and the most critical places. As the main activities for generating incomes in this farm are cattle and agriculture, we have advised about implementation of best practices for minimizing the impact of such activities. The farmer agreed to spare several areas for ecological restoration with mixed plantations, assisted natural regeneration, and passive restoration (Figure 8). We worked coordinately in a part of the assigned lands as pilot area. By November, we had the definitive working areas: The owner facilitated the barbed wire to exclude the areas from cattle which constitute the main threat for recovering the areas.

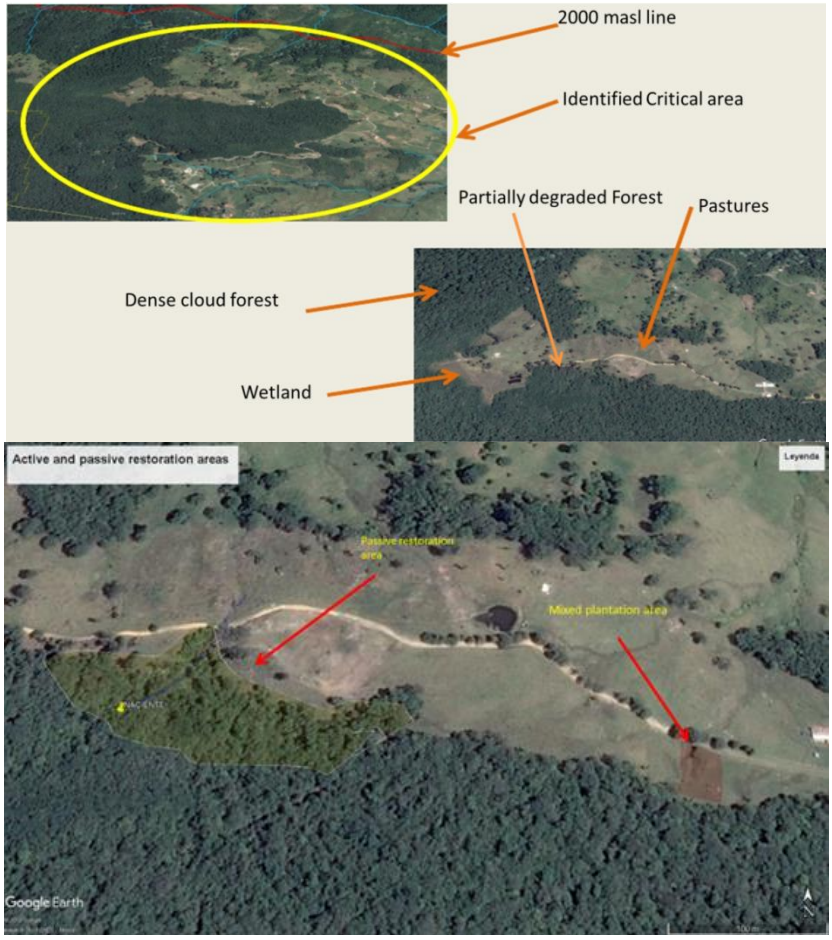

Figure 8. Critical areas at El Chorotal and selected areas at finca Sinaí for active and passive restoration.

3.3.1 Active Restoration (Mixed species planted forest)

This activity was carried from October to November 2018, well before the beginning of the dry season (December-January) in the chosen area, a small tract (~1000 m^2) surrounding one of the artificial lagoons. Planting in this area was challenging, as it is highly degraded due to strong

damage to soils when the lagoon was excavated (Figure 9). Most of the surface organic layer was depleted, and the only vegetation is composed of pastures, herbs and some small shrubs. In addition, there are not isolated trees that could help with shading to establishment of late-succession species. This area also limits with the native forest boundary. We did most of the plantation with help of the community service students, farm workers, teachers and school students. The mixed plantation comprised 379 plants of 19 native species (Table 1) in 1.5 m triangular spacing (Figure 10). The plantation faced a long dry season from December to March (Figure 11), so plants had to be irrigated regularly. Survival by April was about 89%.

Figure 9. Degraded area selected for active restoration with mixed plantations.

Table 1. Active restoration. Number of planted individual by species

Common name	Scientific name	Planted number
Algodón	*Alchornea grandiflora*	27
Anime	*Montanoa quadrangularis*	91
Canelo	*Hieronyma fendleri*	8
Cedrillo	*Guarea kunthiana*	8
Cedro	*Cedrela montana*	36
Cobalongo	*Bilia rosea*	8
Guamo	*Inga oerstediana*	14
Guayabón	*Myrcianthes karsteniana*	2
Huesito	*Casearia tachirensis*	1
Laurel baboso	*Ocotea macropoda*	34
Marfil	*Tetrorchidium rubrivenium*	38
Mortiño negro	*Miconia meridensis*	45
Mortiño rosado	*Miconia resimoides*	17
Pino aparrado	*Podocarpus oleifolius*	8
Pino laso	*Retrophyllum rospligiosii*	11
Quino blanco	*Ladenbergia undata*	4
Surure	*Myrcia acuminata*	14
Tambor	*Vochysia meridensis*	1
Tetajire	*Eschweilera tenax*	12
Total		**379**

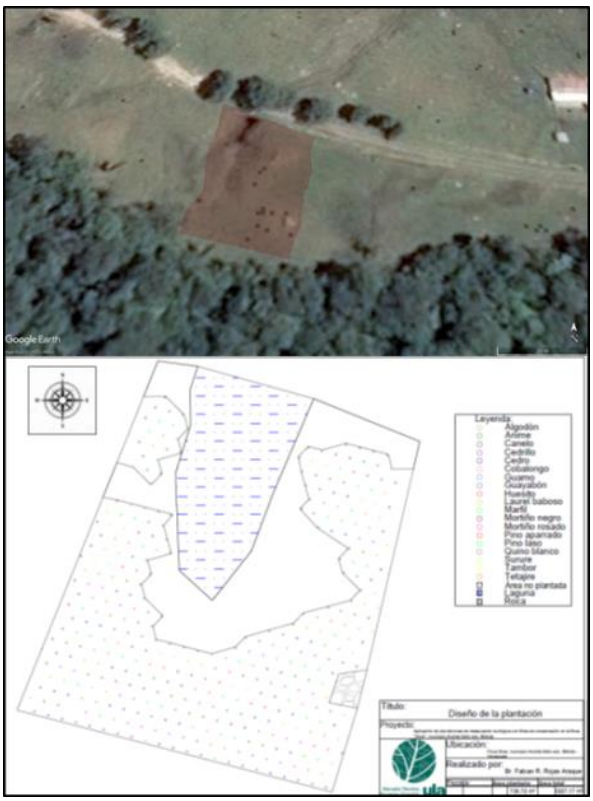

Figure 10. Google Earth Image and cartographic map showing plant distribution in the mixed plantation

Figure 11. Active restoration. Planting activities

3.3.2 Passive restoration

- ***Restoration with assisted regeneration*:** In the chosen area, we found a water spring surrounded by partially degraded forests. With consent of the owner we expanded the original area from 2000 m^2 to about a 1.5 ha to ensure the protection of the water spring

(Figure 12). The area was fenced to exclude cattle. We carried out a tree species inventory to assess the diversity of the area. We are planning to inventory the whole floristic component, which is very rich in palms, ferns and epiphytes. In the most degraded areas we plan cutting pastures, vines, and pioneer shrubs, but leaving all tree species natural regeneration. We pursue favoring growth of native trees by avoiding cattle damage, vine and pioneer shrubs competition. Initial inventory will dictate if addition of more species through planting will be needed. Most work will consist in monitoring the changes and growth of vegetation in the area. Initial results showed that in the most altered zones, pioneer trees such as canelo (*Hieronyma fendleri*, algodón (*Alcornea grandiflora*), and tuno are abundant; however, in the less degraded area, which is usually flooded, predominate trees such as granizo (*Hedyosmum brasilensis*) and tampaquito (*Clusia sp*.) which produce stilt roots.

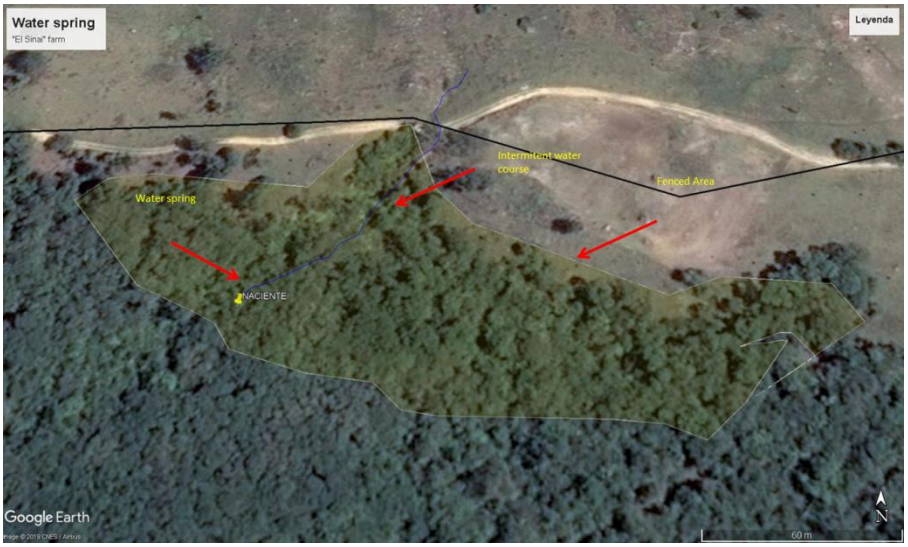

Figure 12. Excluded area (1.5 ha) for passive restoration.

3.4 Thematic map for preliminary restoration plan

Cartography of the area is rather poor and mostly old. Although we own high resolution images, identification of many features is only possible by visiting the sites. For example, it is extremely difficult to differentiate wetlands from deforested sites just from available satellite images. Therefore, only major ecosystem types were identified, as the differentiation at forest community level requires a more detailed work. Given the complex features of the area in this matter, we made a detailed work only on selected pilot areas or incorporated information of previous studies. This information was prepared for our cartography expert who is also knowledgeable of the working area. So far, results include:

- Setting of a preliminary boundary for the potential influence area of our project. To this end we have established a boundary line at a 2000 m.a.s.l. surrounding Páramo El Tambor. This is the approximate lower limit of cloud forest vegetation for the site. The study area falls within the municipalities of Andrés Bello, Sucre, and Campo Elías (Mérida state) with a calculated area of **11,837** ha. In addition, at lower scales there are several sectors known by

the inhabitants with local names (El Chorotal, La Osa, San Eusebio, Maporal, La Cuchilla, La Sabana). These places vary in the degree of isolation, land use activities, level of deforestation and degradation, and attitude of the people towards environmental issues.

- To characterize the study area, thematic layers were downloaded from the Simón Bolívar Geoportal (www.igvsb.gob.ve/): municipalities, states, cities, and towns. Available layers for rivers and roads were discarded, as they do not reach the level of detail required for this project. Instead, they were delineated following different approaches.
- The boundary of the study area, roads, and hydrological network (watershed boundaries, water courses, and lakes) were delineated using a Digital Surface Model (JAXA 2015). The DSM dataset is a 30 m mesh, with a width and height of 1º latitude/longitude and a precision of 5 m. This data set was combined with a panchromatic image (Copernicus 2015). **Sources:** JAXA, 2015. ALOS World 3d. Retrieved July 2018; Copernicus 2015, Sentinel data processed by ESA. Retrieved July 2018.
- For climate we used available information on precipitation and temperature, although today only three meteorological stations are working relatively close to the area.
- Given the complex topography of the area and difficult accessibility, we used the sectors as sub-units for critical areas identification and planning of restoration activities. We are making use of maps and satellite images to show them their properties, degree of deforestation, soil damage, damage to water courses and wetlands effects of their productive activities, risk areas (movement of land masses, landslides, and so on). Many stakeholders have been surprised by the magnitude of damage which is not observable from the ground.
- For easy work and distribution, the layers consist of a series of very small *kml* files that can be displayed on Google Earth, so no expensive software is needed (Figure 13).

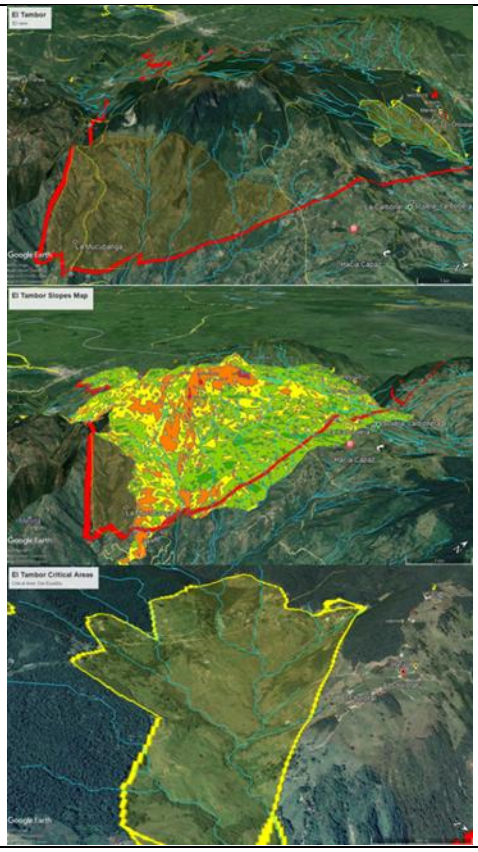

Figure 13. View of thematic layers: a) 2000 m boundary and rivers; b) Slopes c) San Eusebio critical area.

3.5 Promoting activities:

We worked, and continue doing so, in several activities that will serve to promote the project "El Tambor" at local, national, and international levels. Activities include:

- Making of short films showing the aims of our project in the frame of the environmental threats this natural area is facing. We included scenic and wildlife content, as well as the specific activities we are carrying out. To this end we worked with expert filmmakers (Fundación Ymago: https://www.facebook.com/ Ymagobiodiversidadycultura/).
- Taking high quality pictures for additional uses such as posters and presentations at events.
- Recording interviews with stakeholders and project participants.
- Compiling information and pictures (when possible) on plants/tree species and fauna to create a list including their identification and conservation status (IUCN), uses and perception by stakeholders.
- We opened a site in Instagram (@proyectotambor)
- We created a Logo for the project. The logo is simple and versatile so it can be used for related projects.

4 IDENTIFIED PROBLEMS AND THREATS

- Deforesting for agriculture and cattle is the strongest threat in the area. In consolidated farms, the roaming of cattle within the remaining forest causes their degradation and eventual loss due to damage to plant regeneration and soil compaction. The last large deforestation was registered in 2016 (Maporal de La Osa and El Urumal), but surrounding communities and environmental organizations stopped this process at least for now. Eventual illegal logging is an always present threat. However, the felling of trees of a specific group of native species for fuelwood is an emerging threat given that the inhabitants lost access to natural gas which was the traditional way of cooking and making fuel needing activities.
- Along the project execution, the major problem was the much accelerated deterioration of the economic and political situation in Venezuela. Deterioration of public services including water, gas, electricity, and transport; as well, as medicines and health services has produced a strong emigration to other countries. Given this situation, environmental issues are a lower priority, as people have to solve day to day urgent problems. However, particularly for farmers, the risk of losing their water sources keep them aware of the need for protection and conservation of the cloud forest.
- Although there is an increased environmental conscience by the inhabitants of the area, we observed, with exceptions, a lack of knowledge of many aspects of the habitats, biodiversity and the use of adequate practices in productive and conservation activities. For example, most people did not know how to grow native tree species, neither were they aware of their many potential uses. Exotic tree species are planted instead, because they are found in local nurseries, are fast growing and resistant. Several of these species have been planted by many years, and are seen as part of the landscape. Most of these species have not been a problem (e.g. eucalyptus, pine, and cypress) and have some economic importance; however other species such as acacias or ashes have the potential to be very invasive.
- These threats coupled together with social, economic, political and institutional vulnerability represent elements to be managed in a preventive manner before a socio-natural disaster occurs in the study area.
- Contrary to other locations in the Venezuelan Andes, fires were only a minor threat in this area.

- Social issues and conflicts can constitute a barrier for restoration activities. Political preferences, age of people, land inheritance (division of farms in smaller tracts for sons or relatives).

5 CONCLUSIONS AND FUTURE ACTIONS FOR CONTINUING THE PROJECT

The inclusion of climate change and risk assessment approaches proved to be very effective to call more attention of stakeholders in environmental and habitat conservation matters.

In addition to our current educative activities in habitat restoration, climate change, and risk assessment, we see the need of more educative work on promoting the knowledge and conservation of wildlife, especially those identified as endangered.

Because the cloud forest is a fundamental for the water management in the area, both in quantity and quality, and the area lacks of local meteorological information; we have proposed to the community implementing an Early Warning System, which can be operated through the use of a handcrafted rain gauge network, through which the community can get the estimated amount of water coming from the atmosphere, but also establish a network to prevent possible displacements of masses downstream with the consequences mentioned above.

Although the project has received logistic support from the community, the project will continue needing of financial aid from external sources such as international NGOs and other institutions such as the WWF and other agencies to consolidate and expand the project. No financial aid from the national or local government and universities is expected in the short-medium term due to the Venezuelan crisis. If the economic crisis is overcome, it is expected that in the medium term, these environmental conservation activities will be seen as an integral part of the productive processes in the area and will be taken as an investment to maintain and increase productivity and ensure quality of life.