Co-managers of Pico Pijol National Park, Honduras
Co-manejadores del Parque Nacional Pico Pijol

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Summary of Ecosystem Integrity Index Analysis for the Region Connecting Pico Pijol National Park and Mico Quemado Wildlife Refuge[1] April 2025

Abstract

The Mesoamerican Development Institute (MDI) was invited to participate in an analysis of ecosystem integrity for the region of Honduras that includes the Mico Quemado Wildlife Refuge, Pico Pijol National Park, and lands that connect the two protected areas. The MDI team, including coffee farmers with deep knowledge of these regions, joined fellow Park Co-Managers, NGO's, municipalities, and the Honduran Forest, Park, and Wildlife Services in the analysis facilitated by the US Agency for International Development (USAID) as part of their recently cancelled Climate Adaptation program for the country.

The Ecosystem Integrity Index analysis, an assessment of the ecosystem capacity to sustain wildlife and ecosystems services, was produced by consensus of participants. The Mico Quemado—Pico Pijol region as a whole was rated in **"critical condition."** The individual ecosystems or landscapes analyzed, and their ecosystem indices are provided in the table below. The buffer zone of Pico Pijol National Park was determined to be **in "poor condition."**

Ecosystem/Landscape Analysis of the Mico Quemado—Pico Pijol Region Total Area: 222,968 hectares (2,229 km^2)		
Ecosystem/landscape	Area	Ecosystem Integrity
Humid and broadleaf forest	52,299 ha/523 km^2	**Fair (1.8)**
Dry forest	20,471 ha/205 km^2	**Critical (0.2)**
Pine forest	22,084 ha/221 km^2	**Critical (0.4)**
Mixed forest	9,856 ha/99 km^2	**Critical (0.6)**
Cloud forest	3,299 ha/33 km^2	**Fair (2.0)**

- [1] R, Raudales, R. Trubey, Summary of Ecosystem Integrity Index Analysis for the Region Connecting Pico Pijol National Park and Mico Quemado Wildlife Refuge, MDI, ICF, and fellow park Co-Managers in studies facilitated by USAID over the course of 2024 and 2025. Published April 2025 (www.mesoamerican.org).

In addition to the Ecosystem Integrity Analysis, participants were asked to assess the threats to these ecosystems/landscapes by scope, severity, and irreversibility. The Mesoamerican Development Institute was asked to focus primarily on threats to forest habitat and water resources for the Mico Quemado—Pico Pijol region.

This assessment found the main drivers of deforestation differ by elevation:

- Expanding coffee production is the primary driver of deforestation at coffee elevations (900 Meters and above), as well as a primary threat to degradation of watersheds, rated equal to water contamination in overall threat to water resources.
- In the lower elevations, humid forest, and especially dry forest, are most threatened by expanding urban development through agricultural and livestock production given the favorable topographic conditions and fertile soils.

Additional threats were assessed including forest fires, illegal road openings, illegal urban development, advancing agricultural frontier, cattle ranching, solid waste pollution, illegal logging, and illegal mining.

Introduction

Given our experience in ecosystem and biodiversity management in Pico Pijol National Park and the coffee regions that connect National Parks and protected areas, our organization, the Mesoamerican Development Institute (MDI), was asked to participate in an evaluation of ecological integrity indicators for Pico Pijol National Park, Mico Quemado-Guanchillas Wildlife Refuge, and region connecting these two protected areas.

The seven days of analysis was sponsored and facilitated by USAID as part of its Climate Adaptation program in Honduras, a program that has since been canceled. The workshops brought together participants with a unique knowledge of the region in question including fellow park Co-Managers, Fundacion En Accion Comunitaria De Honduras (FUNACH); the environmental units of the municipalities of Yoro and Morazán; representatives of the Honduran Instituto de Conservación Forestal (ICF)—the equivalent of the Forest, Park and Wildlife Services, as well as ICF's program, Programa Padre Andrés Tamayo (ICF-PPAT); local NGOs, including the Rain Forest Alliance, Movimiento Ambientalista Morazán Yoro (MOAMY); and experts from El Zamorano agricultural school, and the National Autonomous University of Honduras (UNAH).

While organizations were limited to two participants, MDI petitioned USAID to allow additional participants, including coffee farmers with deep knowledge of coffee production

in the target region. MDI was granted seats for seven participants provided we sponsored the additional participants.

Workshop Objectives:

- To train key landscape participants and organizations in the methodological aspects and basic concepts of the ecological integrity index (EII) tool, to improve their understanding and enhance their participation in the analyses.
- To analyze the current ecological functioning of the ecosystems that make up the Mico Quemado-Pico Pijol landscape. This region includes the Mico Quemado-Guanchillas Wildlife Refuge and Pico Pijol National Park, as well as the landscape that connects these two protected areas in order to determine their health using the Ecological Integrity Index (EII).

The following is a summary of the analysis process and its conclusions.

The evaluation process methodology was adapted from a class of environmental evaluation tool referred to as an Ecosystem Integrity Index. Proponents of the Ecosystem Integrity Index seek to "combine metrics of ecological integrity that can be evaluated qualitatively and quantitatively with basic training, can be implemented quickly and each valued component is directly associated with key aspects for the assessment of the ecosystem capacity to sustain wildlife and ecosystems services.[2] The Ecosystem Integrity Index applied to these workshops results in an average score that is used to classify the functional health of ecosystems as:

Critical	Poor	Fair	Good	Very Good
<0.8	=>0.8	=>1.6	=>2.4	=>3.2

Ecosystem Integrity Indicators

The following five indicators (A—E) were evaluated to provide a measure of the health of specific ecosystems, or landscape cover types, to support wildlife and provide ecosystems services. Values from 0 to 5, with five representing good health.

[2] Ecosystem Integrity Index, an innovative environmental evaluation tool for agricultural production systems, Blumetto et al, Journal of Ecological Indicators, 101 (2019) 725—733.

Table 1. Ecosystem Indicators

Indicator	Critical = 0	Poor = 1	Fair = 2	Good = 3	Very good = 4
A. Food chain[1]	Almost never observed	Found in ≤ 30% of the area	Some present all the time, others rare	Several present infrequently	Several taxa abundant in 50% of the area
Relative Abundance of Top Predators					
B. Sensitive species[2.]	Almost never observed	Found in ≤ 30% of the area	Some present all the time, others rare	Several present infrequently	Several taxa abundant in 50% of the area
Relative Abundance of Disturbance-Sensitive Species					
C. Invasive species[3.]	present in 80% of the area, common				Common in < 20% of the area or present but scarce in 50% of the area
Relative Abundance of Species that Represent a Disturbance					
D. Disturb-ances[4]	Indicators occur multiple times, at multiple sites, over large areas				No indicators are present
Systemic Effects of Disturbances During the Last 5-Years					
E. Space/urban expansion[5]	>2% of the area of natural ecosystem has been lost				Natural ecosystems cover a larger area than observed five years ago
Anthropogenic Effects Over the Last 5-Years					

Table Notes:

1. Some examples of top predators in the workshops include jaguar in seen Pico Píjol National Park, puma sighting (2016); for mixed forest the coyote and boa, at lower elevation forest, the great eagle, and barba amarilla (large and venomous pit viper)
2. Some examples of disturbance-sensitive species in the workshops include: the great curassow bird, or *pajuil* (crax rubra), which only eats pine seeds; deer, ocelot, wild boar, toucan, and tapir; in cloud forests many species, such as the Quetzal, are becoming rarer and more difficult to spot. Note: MDI is partnering with the ICF installing critter cams in Pico Pijol National Park in an attempt to determine what species are still present.
3. Some examples of species that represent a disturbance in the workshops includes: Guarumo, blunt-leaved trumpet tree [*Cecropia obtusifolia]* (often used as a shade tree on coffee farms, a native but invasive species that indicates disturbance; cattle egret [*Bubulcus ibis*] (tick-eating, indicating presence of cattle); invasive grasses; house gecko [Hemidactylus frenatus] invasive lizard, cane toad [Rhinella marina], introduced orchids [e.g., Oeceoclades maculata], African Orchid, which indicates damaged forests; Tilapia [Oreochromis niloticus]; domestic cats, dogs, and coffee.

   In cloud forests many species are becoming rarer and more difficult to spot. Note: MDI is partnering with the ICF in stalling critter cams in Pico Pijol National Park to determine what species are still present.
4. Some examples of systemic effects of disturbances discussed during the workshops include pests, chemical or solid pollution, forest fires; many systemic effects were determined to be large and widespread.
5. Some examples of anthropogenic effects discussed at the workshops include reduction of natural space, construction of streets, highways, conversion to agriculture or livestock, urban or agricultural expansion, and dams.

To aid in the analysis, maps and photographs, including examples of perturbations of ecosystems were provided by the facilitators. Participants rate each ecosystem and discuss their rationale with the group until concensus is reached by all workshop participants for each ecosystem. The wide range of maps available to assist in analysis include soil type, watersheds, sub watersheds, and micro watersheds, land use and cover, department boundaries, ecosystems, and forest fire history (see Appendix A). Additional resources for data gaps were provided through the National Science Foundation's Research Data Archive (Home | NSF NCAR Research Data Archive). Historical forest fire data was provided through Global Forest Watch.

The USAID consultants who adapted the Ecosystem Integrity Index tool for the Mico Quemado-Pico Pijol landscape selected five ecosystems or landscapes for which to apply the indicators for analysis:

Table 2. Ecosystems/Landscapes for Analysis

Ecosystem/landscape	Area
Humid and broadleaf forest	52,299 ha/523 km^2
Dry forest	20,471 ha/205 km^2
Pine forest	22,084 ha/221 km^2
Mixed forest	9,856 ha/99 km^2
Cloud forest	3,299 ha/33 km^2

The total area applied to the landscape analysis is 222,968 hectares (2,229 km^2) that includes the Mico Quemado Wildlife Refuge, Pico Pijol National Park, and lands that connect the two protected areas. Within this area 48.49% of the landscape is forested; and 51.51% is non forest.

This region maintains connectivity as evidenced by the range of movement of the jaguar through the Sierra Nombre de Dios mountain range. This region includes the municipalities of Negrito, Progresso, Morazán, Santa Rita, Victoria, Yoro, and Tela. There are 54 declared micro watersheds.

Additional areas of significant wildlife include San Nicolas and the Oloman private reserve.

The Mico Quemado Wildlife Refuge includes 331 plant species, broadleaf forest, 247 species of fauna. Pico Pijol National Park includes 128 plant species, 502 species of fauna, 112 species of amphibians and reptiles, 294 bird species, 47 mammal species, and 41 insect species.

Landscape Analysis

The landscape indictors were applied to five ecosystems or landscapes to determine the ecological health of the ecosystems that make up the Mico Quemado-Pico Pijol landscape. These results were reached by consensus with all workshop participants (approximately 30 participants).

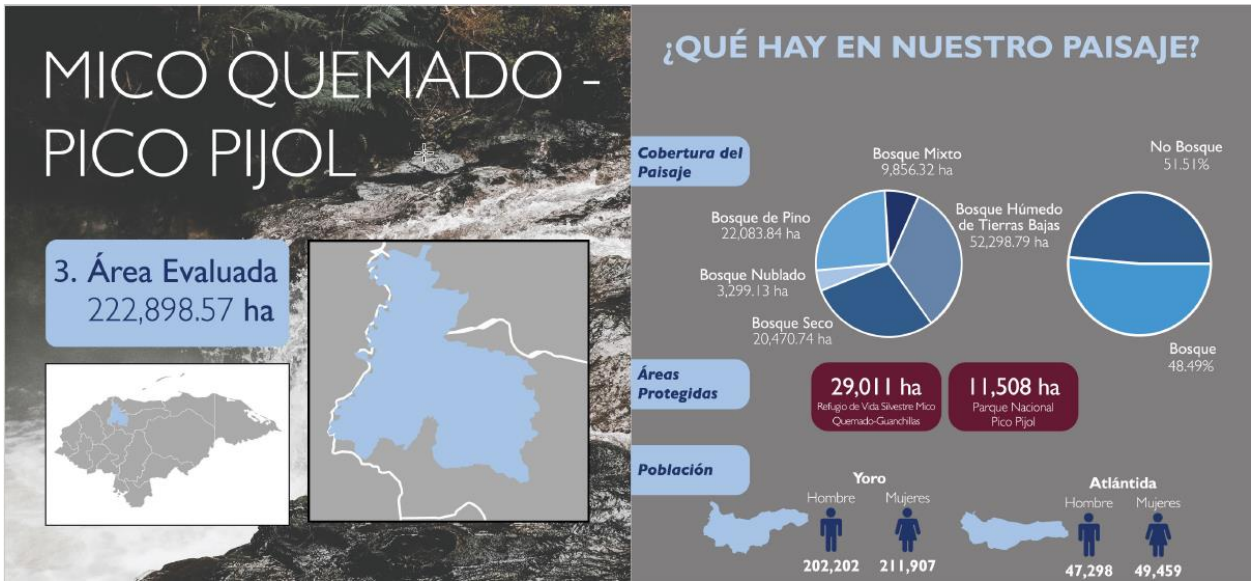
Table 3. Landscape Analysis

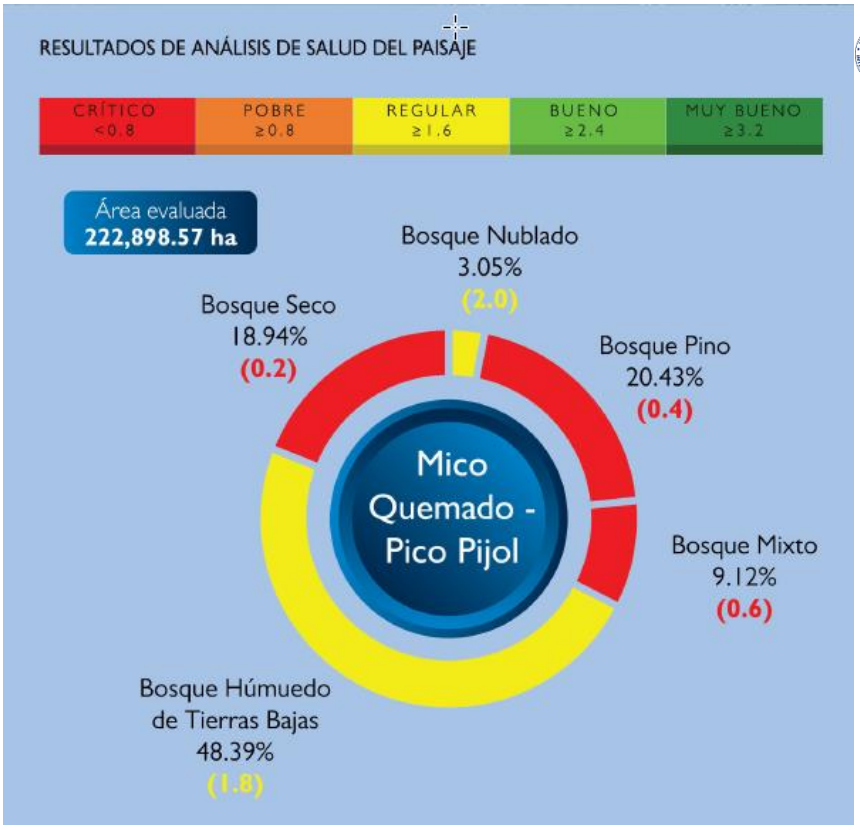
Ecosystem	Indicator					Average
	A. Food chain[1]	B. Sensitive species[2]	C. Invasive species[3]	D. Disturb-ances[4]	E. Urban expansion[5]	
Broadleaf & humid forest	2[a]	3[b]	2[c]	1	0	**1.8 Fair**
Cloud forest	3	---	---	0	3	**2.0 Fair**
Mixed forest	1	1	1	0	0	**0.6 Critical**
Pine forest	0	1	0	0	1	**0.4 Critical**
Dry forest	0	1	0	0	0	**0.2 Critical**
Pico Pijol buffer zone	1	2	1	0	0	**0.8 Poor**
Landscape as a whole	1	1	0	0	0	**0.4 Critical**

Table 4. Ecosystem Integrity by Landscape Cover and Area

Ecosystem/landscape	Area	Ecosystem Integrity
Humid and broadleaf forest	52,299 ha/523 km^2	**Fair (1.8)**
Dry forest	20,471 ha/205 km^2	**Critical (0.2)**
Pine forest	22,084 ha/221 km^2	**Critical (0.4)**
Mixed forest	9,856 ha/99 km^2	**Critical (0.6)**
Cloud forest	3,299 ha/33 km^2	**Fair (2.0)**

The following graphic summarizes the workshop results.





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ADAPTACIÓN CLIMÁTICA

Threat Analysis

In the final portion of the workshops, the MDI team of researchers, Pico Pijol National Park Co-Managers, and coffee producers were asked to evaluate:

1. Threats to the ecosystems or landscapes using a template to assess scope, severity, and irreversibility characteristics of the threats.
2. Threats to the hydrologic systems and watersheds in these ecosystems or landscapes.

Expanding coffee production is the primary driver of deforestation at coffee elevations (900 Meters and above), as well as a primary threat to degradation of watersheds, rated equal to water contamination in overall threat to water resources. Coffee production shares the same elevation as the headwaters that generate the streams and rivers that provide water resources for towns, cities, and municipalities downstream. Headwaters rely on forest cover for the health of watersheds and in maintaining water quality. In addition, coffee de-pulping and washing is a source of water contamination.

Cloud forest for the region is rated in fair condition and is being most impacted by the expanding coffee frontier. In the higher elevations, pine, and mixed forest, are in critical condition and most impacted by expanding coffee production. Coffee is also extending into cloud forest within protected national parks and their buffer zones. Illegal logging threatens broadleaf forest in protected areas at the same or similar rate as expanding coffee cultivation in protected areas.

Forest fires are widespread, impacting all forest types without regard to elevation, including dry forest where coffee is not present. This places forest fires at the same threat rating as coffee, even though the area forest loss due to forest fires represents just 12% compared to other drivers.

In the lower elevations of humid forest, and especially dry forest, are most threatened by expanding urban development through agricultural and livestock production given the favorable topographic conditions and fertile soils.

The following tables summarize and prioritize a variety of threats to the ecosystem integrity that these landscapes are experiencing, as well as the threats to watersheds and water resources. The templates for this analysis were provided by the USAID consultants facilitating the workshop.

Table 5. Threat analysis to ecosystem integrity

Threat	Conservation Object	Scope	Severity	Irreversibility
Forest Fires	Cloud Forest	1	3	4
	Broadleaf Forest	1	3	4
	Pine Forest	1	3	4
	Dry Forest	1	3	4
Advancing Agricultural Frontier	Broadleaf Forest	4	3	3
	Dry Forest	1	1	1
	Pine Forest	3	3	3
	Hydrologic system	3	3	3
Advancing Coffee Frontier	Cloud forest	3	4	4
	Broadlead forest	4	4	4
	Pine forest	3	3	3
	Hydrologic system	4	4	4
Contamination of Water Resources	Pine forest	3	3	3
	Hydrologic system	4	4	4
Contamination from Solid Waste	Broadlead forest	2	2	2
	Dry forest	2	2	2
Advancing Illegal Urban Development	Pine forest	2	2	2
	Broadleaf forest	3	3	3
	Dry forest	3	3	3
	Hydrologic system	3	2	2
Illegal Timber Cutting	Pine forest	3	3	3
	Broadleaf forest	4	4	4
Opening of Illegal Roads	Pine forest	1	1	1
	Broadleaf forest	3	3	3
	Dry forest	3	3	3
Advance of Cattle Ranching	Pine forest	3	3	3
	Broadleaf forest	4	3	3
	Dry forest	1	1	1
	Hydrologic system	3	3	3
Illegal Mining	Hydrologic system	3	3	3
	Pine forest	3	3	3

Scope - commonly defined in spatial terms such as the proportion of the conservation object that can be reasonably expected to be affected by the threat in the next ten years given the continuation of current circumstances and trends. For ecosystems and ecological communities, it is measured as the proportion of the occurrence of the

conservation object. For species, it is measured as the proportion of the population of the conservation object.

4 = Very high: The threat is likely to be generalized, affecting the object of conservation in all or most (71-100%) of its occurrence/population.

3 = High: The threat is likely to be wide, affecting the object of conservation largely (31-70%) of its occurrence/population.

2 = Medium: The threat is likely to be limited, affecting the object of conservation in part (11-30%) of its occurrence/population.

1 = Low: The threat is likely to be close range, affecting the object of conservation in a small proportion (1-10%) of its occurrence/population.

Severity - Within the scope, severity is the level of damage to the conservation object from the threat that can be reasonably expected, given the continuation of current circumstances and trends. For ecological ecosystems and communities, normally measured as the degree of destruction or degradation of the conservation object within the scope. For species, usually measured as the degree of reduction of the population of the object of conservation within the scope.

4 = Very high: Within the scope, the threat is likely to destroy or eliminate the conservation object or reduce its population by 71-100% in ten years or three generations.

3 = High: Within the scope, the threat is likely to degrade or seriously reduce the conservation object, reducing its population by 31-70% in ten years or three generations.

2 = Average: Within the scope, the threat is likely to degrade or moderately reduce the conservation object, reducing its population by 11-30% in ten years or three generations.

1 = Low: Within the scope, the threat is likely to degrade or slightly reduce the conservation object, reducing its population by 1-10% in ten years or three generations.

Irreversibility - Within the scope, irreversibility signifies a change in an ecosystems structure, function, or composition so drastic that conservation object is unlikely or impossible to return to its previous condition. For ecological ecosystems and communities, normally measured as the degree of destruction or degradation, such that the recovery of ecosystem is impaired or restricted. For species, usually measured as the degree of reduction of the population can longer be sustained.

4 = Very high: Within the scope, the threat is extreme and most likely to induce changes so drastic that the ecosystem cannot recover to its previous condition or population levels in ten years or three generations.

3 = High: Within the scope, the threat is significant enough to risk inducing changes that will limit the recovery of the ecosystem to its previous condition on population levels in ten years or three generations.

2 = Average: Within the scope, there is moderate threat of inducing changes that will limit the recovery of the ecosystem to its previous condition on population levels in ten years or three generations.

1 = Low: Within the scope, there is a low threat of inducing changes that will limit the recovery of the ecosystem to its previous condition on population levels in ten years or three generations.

Table 6. Threats to Forest Habitat

Threats to forest habitat rated by scope, severity, and irreversibility			
Forest Type	Threat	Scope Severity & Irreversibility Score	Comment
Cloud Forest	Expanding Coffee Cultivation	11	Coffee cultivation is concentrated at elevations of 800 meters and above. It is the primary driver of deforestation at these elevations. Note that coffee is not grown in dry forest.
Broadleaf Forest	Expanding Coffee Cultivation	12	
Pine Forest	Expanding Coffee Cultivation	9	
	Total	**32**	
Cloud Forest	Forest fires	8	Forest fires are widespread though they represent 12% of forest loss from 2001 to 2023.
Broadleaf Forest	Forest fires	8	
Pine Forest	Forest fires	8	
Dry Forest	Forest fires	8	
	Total	**32**	
Broadleaf Forest	Illegal Road Opening	9	Illegal roads are found to lead to significant loss of forest habitat due to illegal logging or conversion to agricultural uses
Pine Forest	Illegal Road Opening	9	
Dry Forest	Illegal Road Opening	9	
	Total	**27**	
Broadleaf Forest	Illegal Urban Development	9	
Pine Forest	Illegal Urban Development	9	
Dry Forest	Illegal Urban Development	9	
	Total	**27**	
Broadleaf Forest	Advancing Agricultural Frontier	13	Primarily below elevation of 1,000 meters
Pine Forst	Advancing Agricultural Frontier	10	
Dry Forst	Advancing Agricultural Frontier	3	Dry forests are limited to the lowlands (valleys).
	Total	**26**	

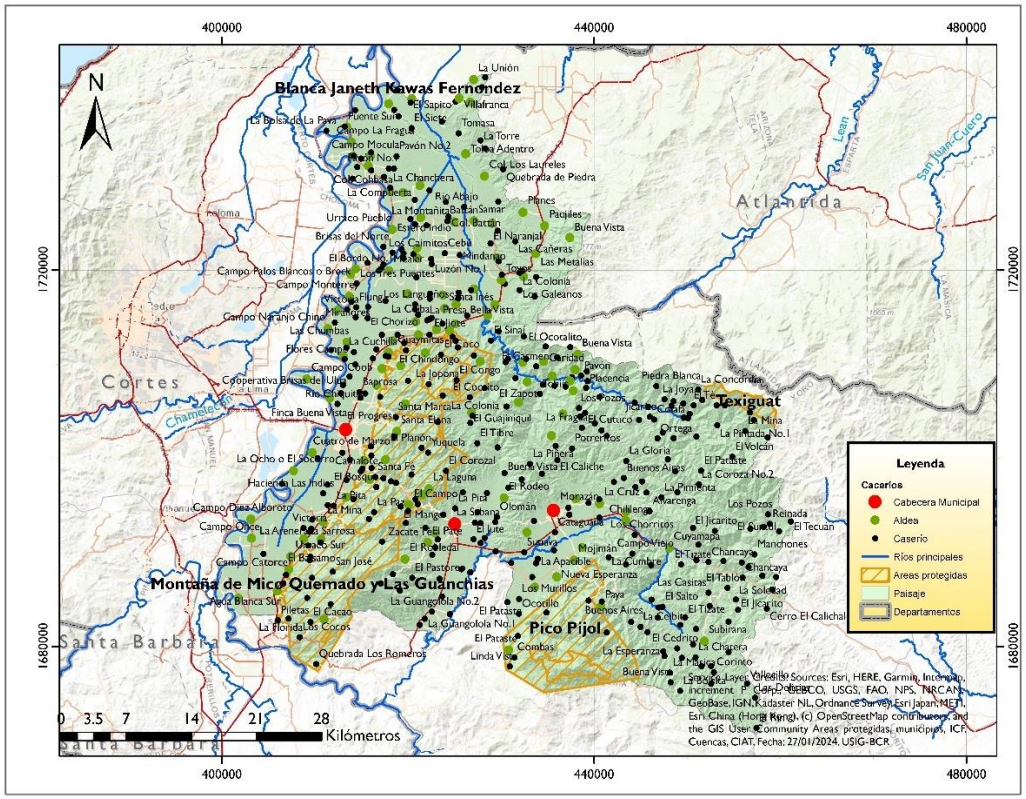
Broadleaf Forest	Cattle Ranching	10	Primarily lower elevations
Pine Forest	Cattle Ranching	9	
Dry Forest	Cattle Ranching	1	
	Total	**20**	
Broadleaf Forest	Solid Waste Pollution	6	
Pine Forest	Solid Waste Pollution	6	
Dry Forest	Solid Waste Pollution	6	
	Total	**18**	
Broadleaf Forest	Illegal Logging of high-value broad leaf trees (mahogany, teak, ceder)	12	Illegal logging threatens broadleaf forest in protected areas at the same or similar rate as expanding coffee cultivation in protected areas.
Pine Forest	Illegal Logging of high-value trees (mahogany, teak, ceder)	3	
	Total	**15**	
Pine Forest	Illegal Mining	9	
	Total	**9**	

Table 7. Threats to Water Resources

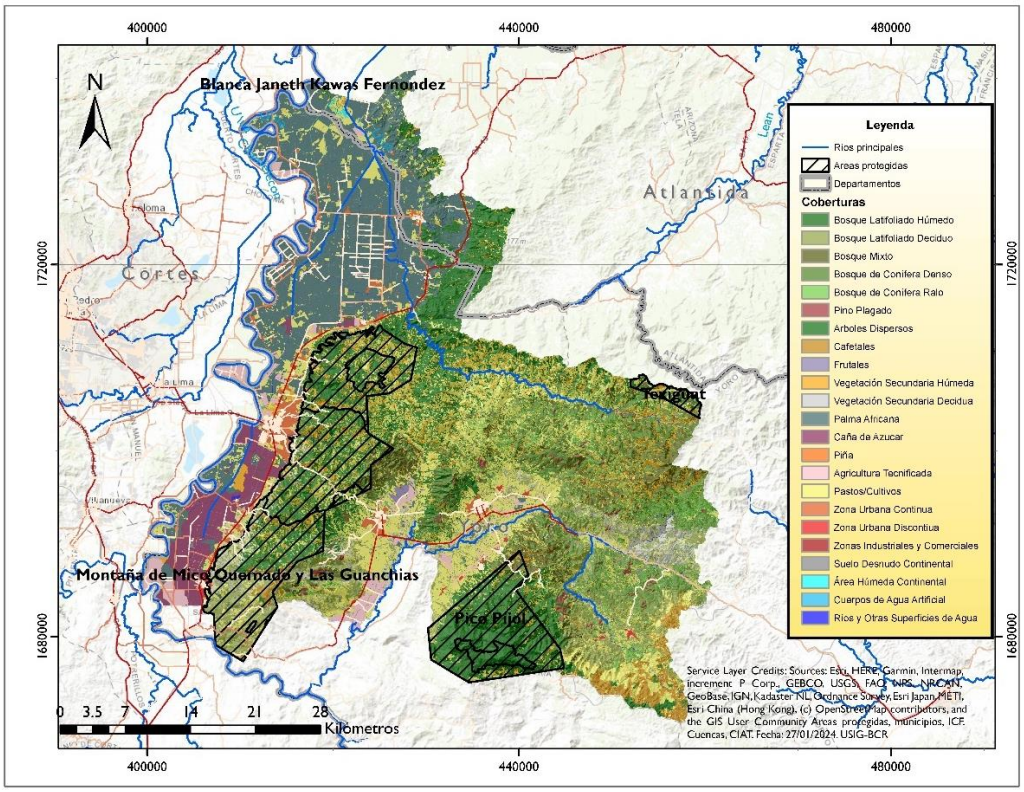
Threats to water systems rated by Scope, Severity, and Irreversibility			
Hydrological Systems	Threat	Scope, Severity & Irreversibility Score	Comment
	Expanding Coffee Cultivation	**12**	Coffee cultivation is concentrated in the headwaters of the nation's watersheds
	Contamination of water resources	**12**	Coffee also contributes to water contamination with de-pulping and washing operations in the coffee regions
	Cattle ranching	**9**	
	Expanding agricultural frontier	**9**	
	Illegal mining	**9**	
	Illegal urban development	**7**	

Appendix A: Maps Used in the EII Workshop

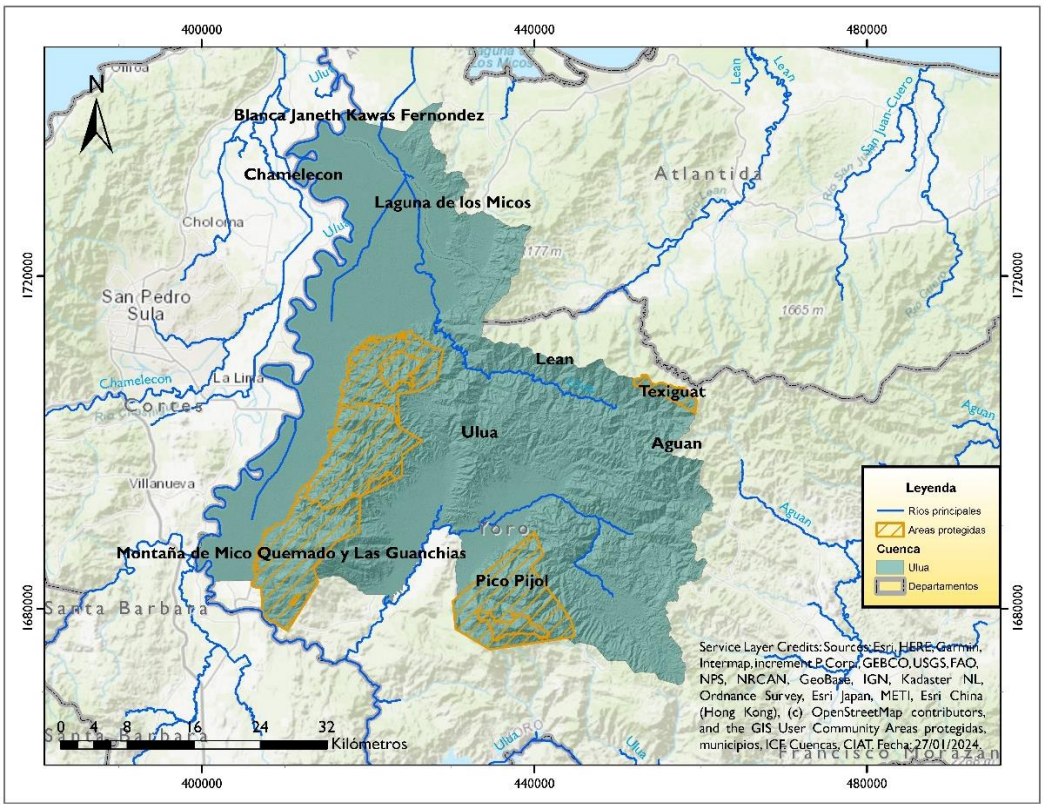
Villages and Municipal Capitals



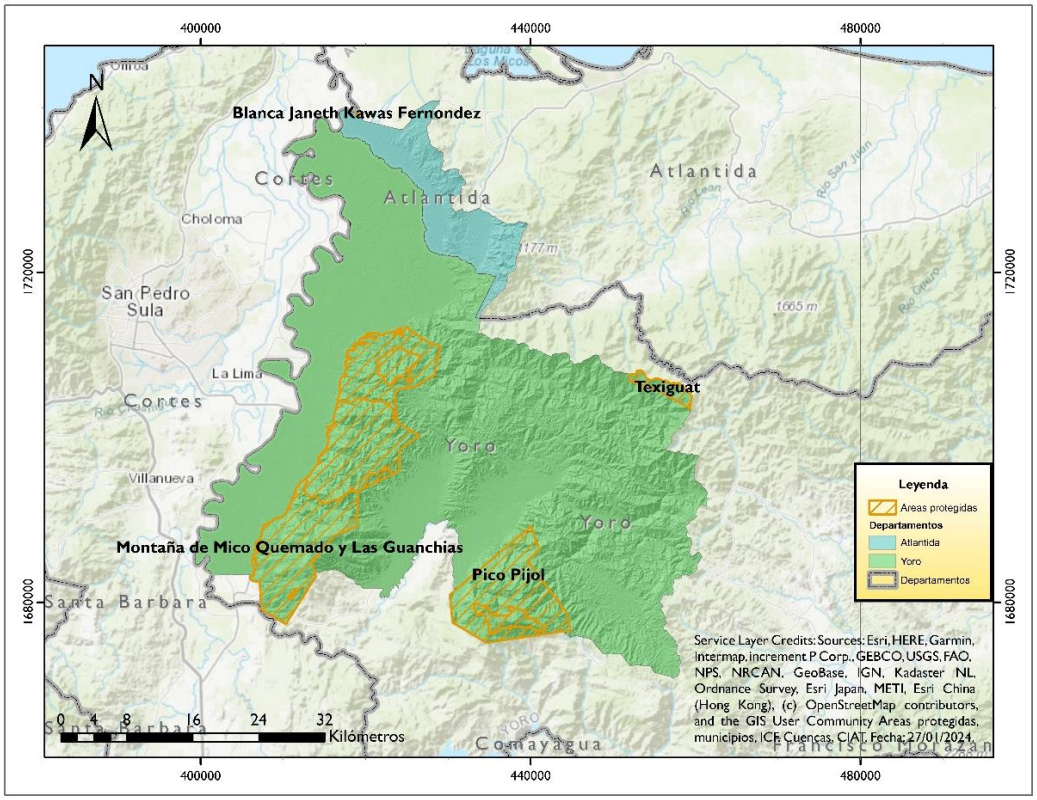
Land Cover Map



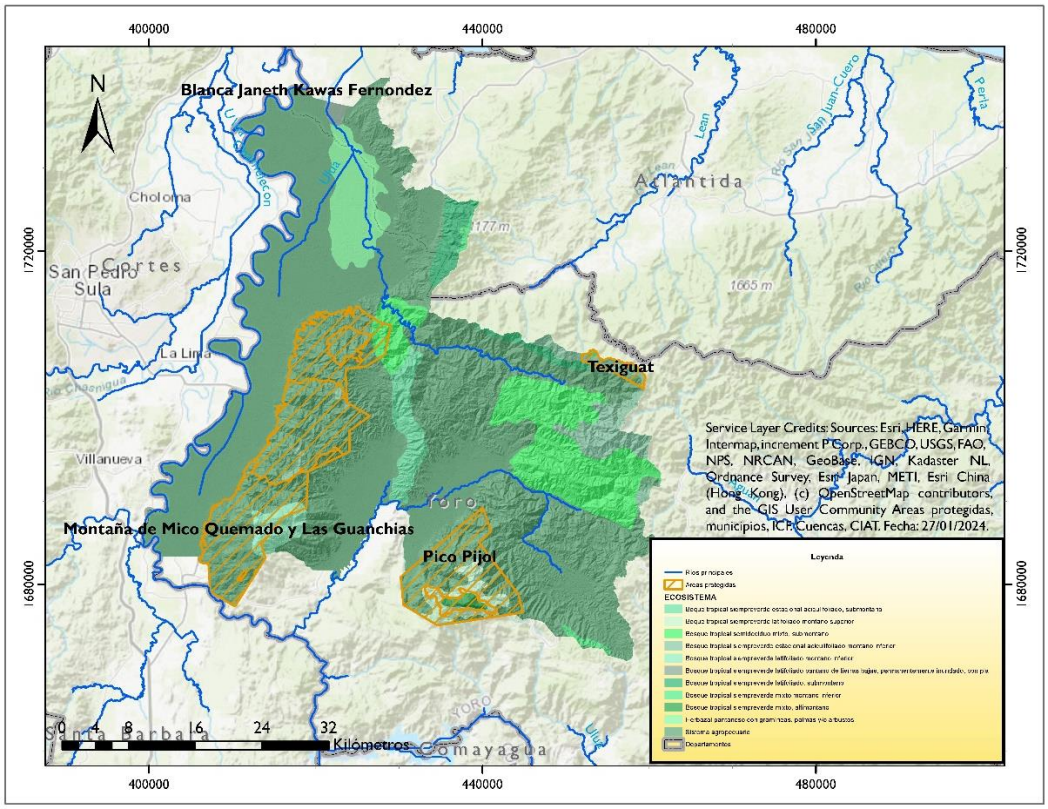
Watershed Map



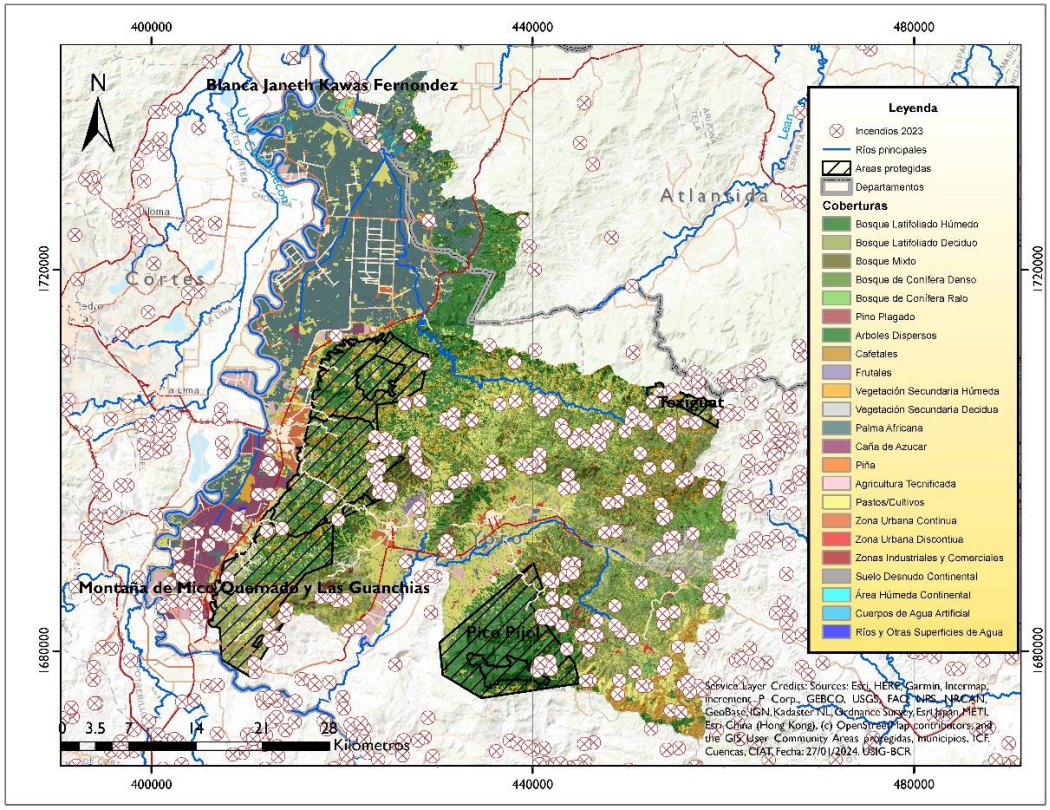
Department Boundaries



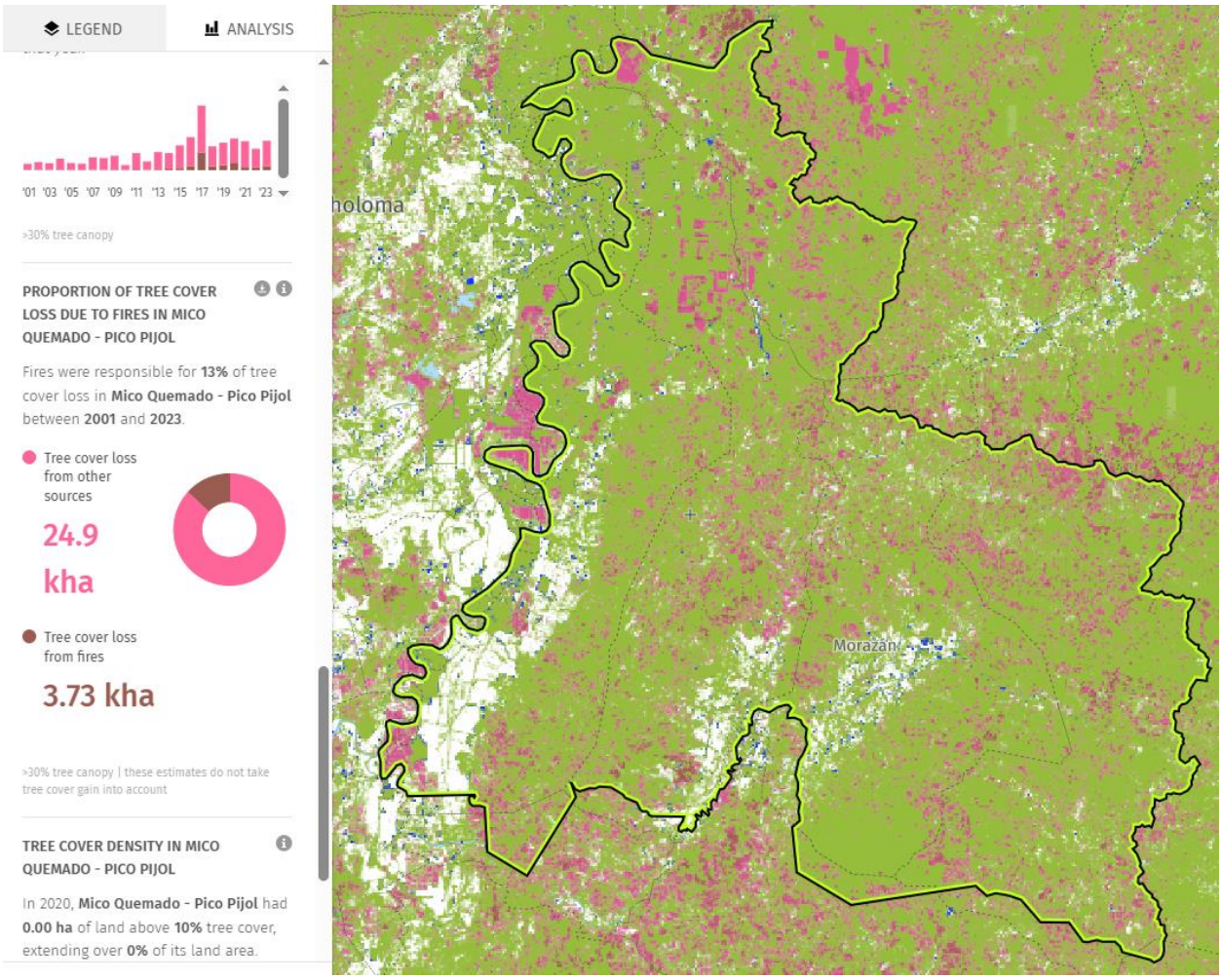
Ecosystem Map



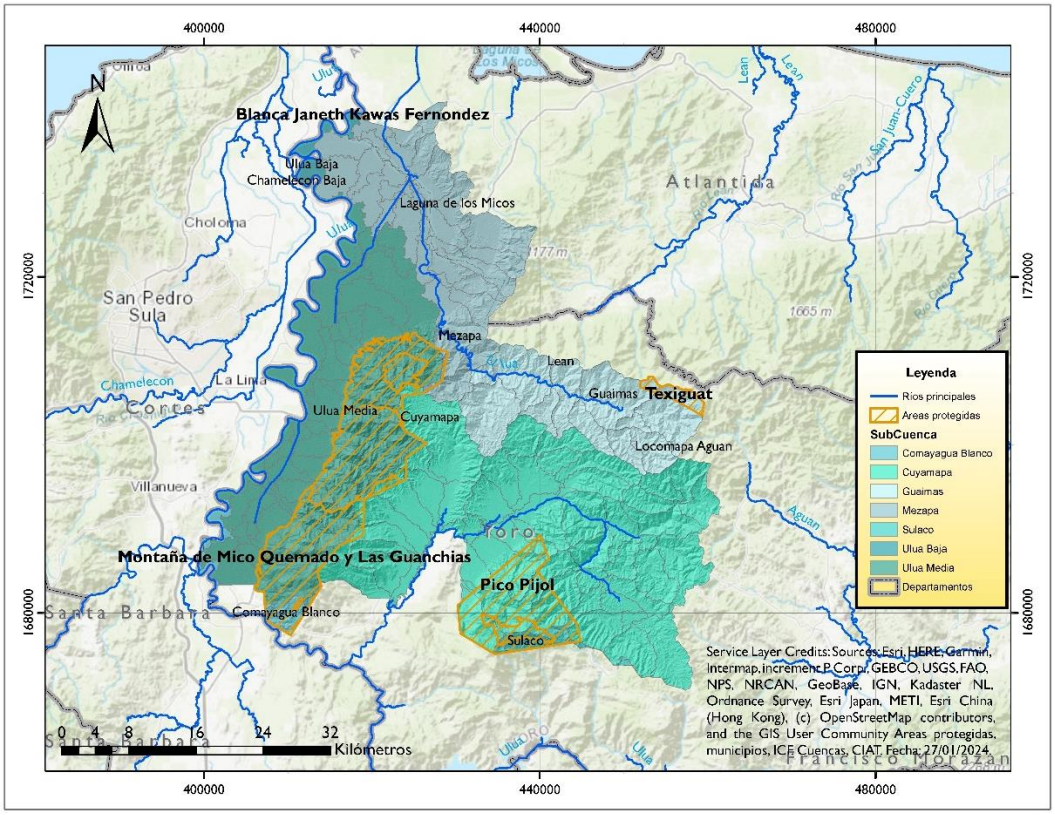
Forest Fires



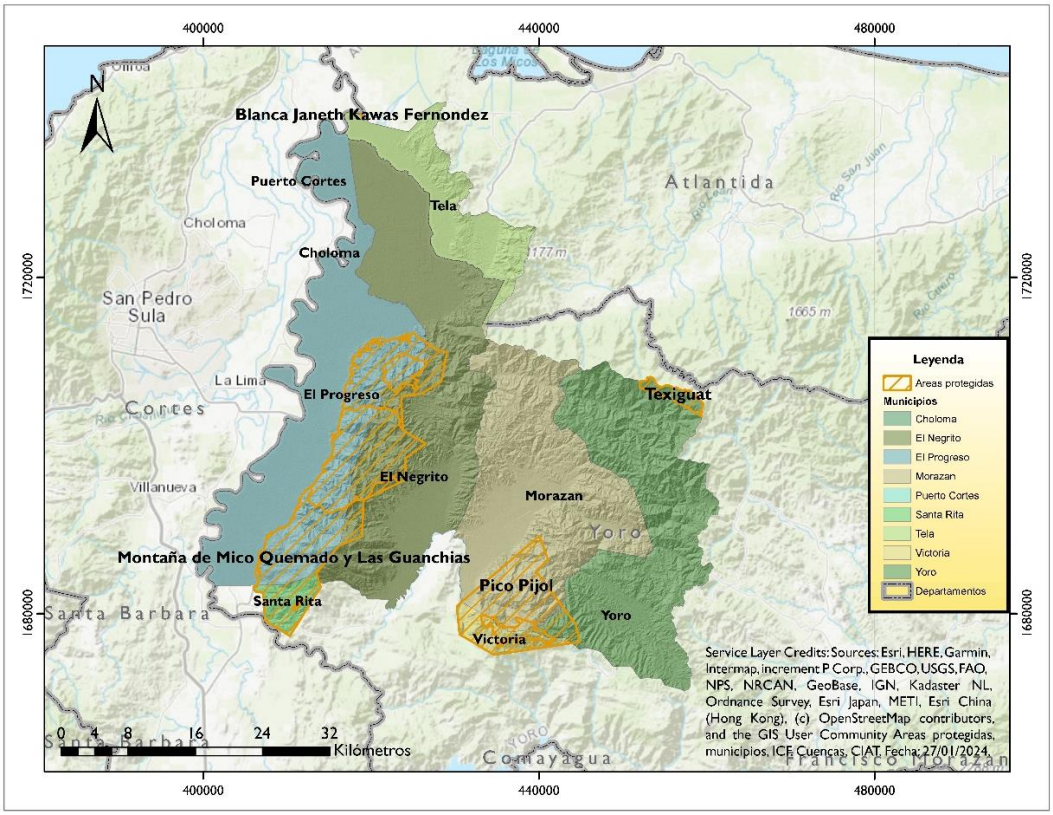
Forest Fires 2001—2023 Global Forest Watch



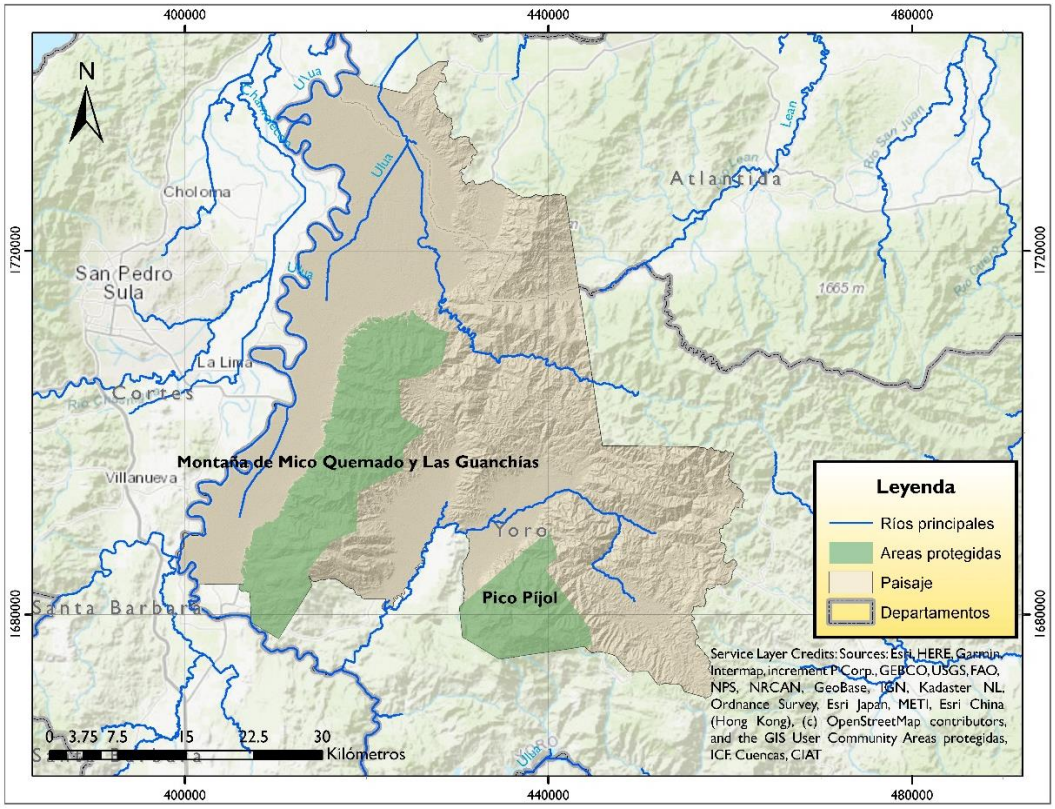
Micro Watersheds



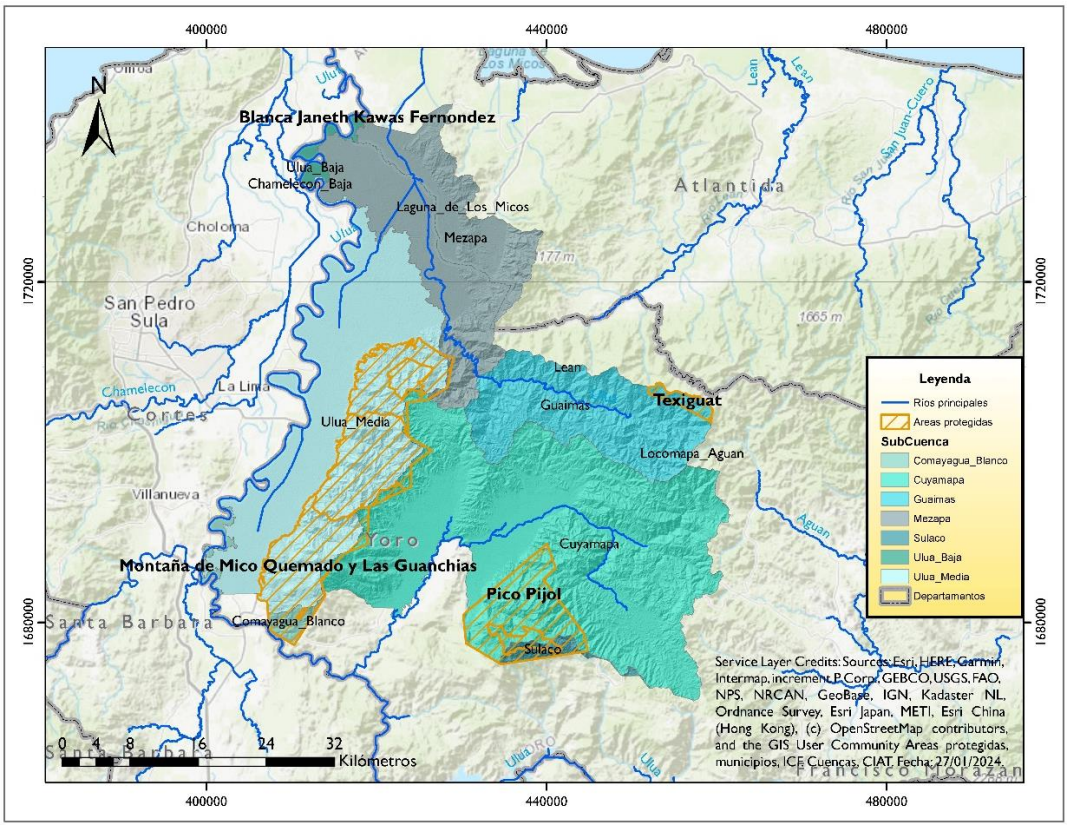
Municipalities



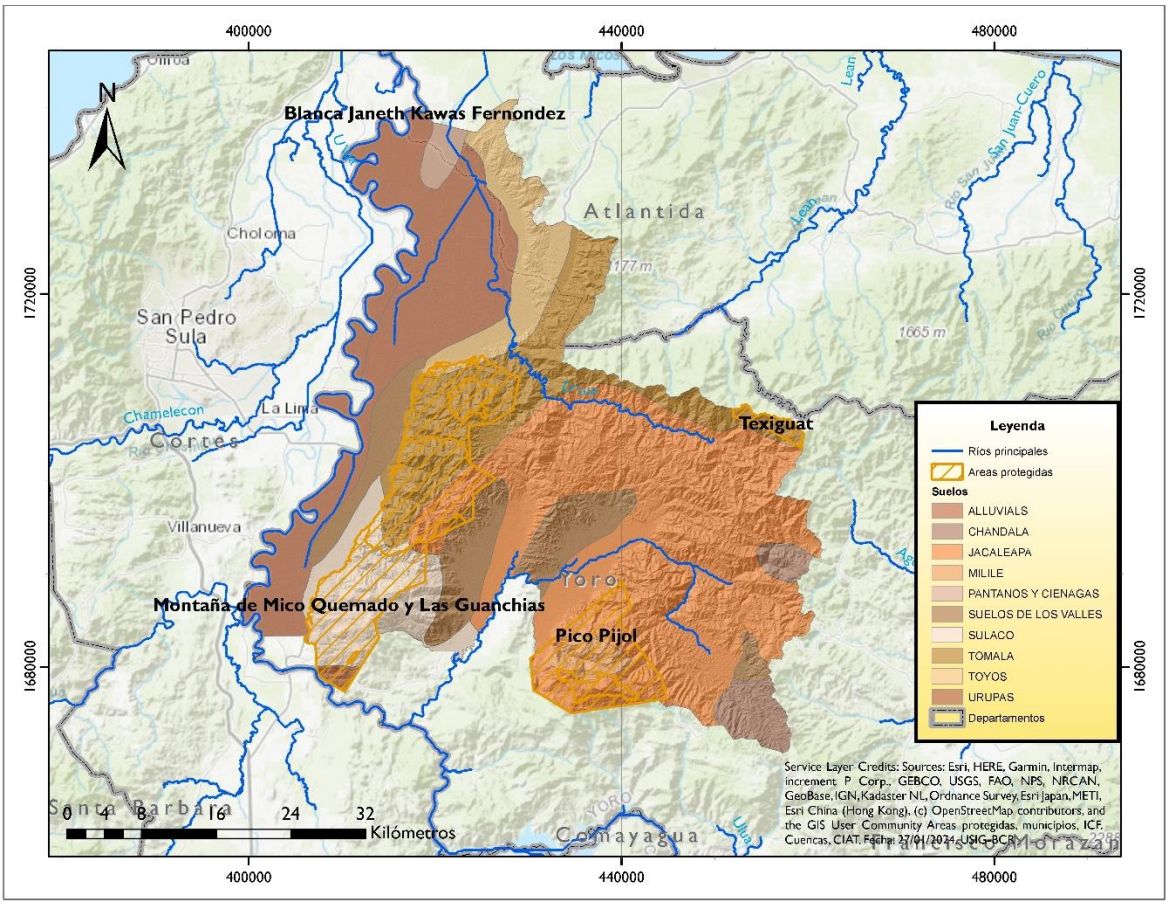
Landscapes



Sub Watersheds



Soils


400000
440000
480000
1720000
1680000
N
Blanca Janeth Kawas Fernondez
Atlantida
Choloma
San Pedro Sula
La Lima
Chamelecon
Cortes
Villanueva
Texiguat
Montaña de Mico Quemado y Las Guanchias
Pico Pijol
Toro
Comayagua
Santa Barbara
Leyenda
Ríos principales
Areas protegidas
Suelos
ALLUVIALS
CHANDALA
JACALEAPA
MILILE
PANTANOS Y CIENAGAS
SUELOS DE LOS VALLES
SULACO
TOMALA
TOYOS
URUPAS
Departamentos
0 4 8 16 24 32
Kilómetros
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community Areas protegidas, municipios, ICF, Cuencas, CIAT. Fecha: 27/01/2024. USIG-BCR

Appendix B: Photos of Ecosystem Integrity Index Analysis Workshops

Workshop 1 in the city of El Progresso January 29-31, 2024
This USAID facilitated workshop focused exclusively on Pico Pijol National Park



Participants from the Mesoamerican Development Institute (MDI)
1) Raul Raudales
2) Ana Quiñones
3) Cindy Dubon

Follow-On Workshop 2 in the city of El Progresso April 22-26, 2024
USAID facilitated workshop for *Mico Quemado-Pico Píjol region*
Facilitators: Oliver Komar y David Mejía, Adaptación Climática;



Participants from the Mesoamerican Development Institute (MDI)*: 1) Juan Ramon Rodriguez, 2) Don Agustin Acosta, 3) Cindy Dubon, 4) Maira Manzanares 5) Ana Quiñones (out of image), 6) Raul Raudales (taking photo).*









Follow-on meeting of USAID Climate Adaptation program, Morazan, December 2, 2024. The program's objective is to increase the resilience of the population and strengthen its ability to adapt to climate change, particularly those vulnerable groups. And, to achieve mutual benefits between the conservation of water resources, forest ecosystems and livelihoods. Note: This USAID-funded program was cancelled in February, 2025.