Analysis of Human Land Use on Parque Internacional La Amistad in Cerro Punta, Chiriquí

Mariana Llanos and Eric Bolsch

McGill University

CIAM

STRI

2018

Host Information

Centro de Incidencia Ambiental (CIAM)

Calle 62 Oeste, Panama

236-0866

tecnico@ciampanama.org

Smithsonian Tropical Research Institution (STRI)

Roosevelt Ave. Tupper Building – 401, Panama City 0843-03092

https://stri.si.edu

212-8000

Days of Work

In Total: 38 days

In Cerro Punta: 7 days

Table of Contents

Introduction

Parque Internacional La Amistad (PILA) is an internationally protected area lying in both Costa Rica and Panama. The federal governments of both nations established the area in 1988, and PILA was then inscribed as a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site (WHS) in 1990.[1] A WHS is a property determined by UNESCO as having Outstanding Universal Values (OUV) of scientific, natural, or cultural importance to the international community.

PILA is recognized by UNESCO for its extensive biodiversity and unique geographic landforms. Located along the Mesoamerican Biological Corridor (MBC), it contributes to an international initiative to connect protected areas for migrant species across Central America. It contains the Talamanca Mountain Range of which have produced a complex mix of valleys, cliffs and peaks. This intricate mesh of landforms creates a complex mosaic of habitats and microclimates including tropical lowland rainforest, montane forest, cloud forest oak forest, and tropical alpine grasslands. The mixture of highland and lowland ecosystems leads to high levels of endemism and biodiversity within the park. The justifications for PILA being named a WHS include its "exceptional natural beauty and aesthetic importance", richness of endemic species, placement as a corridor for North and South American flora and fauna, unique environmental conditions creating a complex mosaic of habitats, and its importance for the preservation of biodiversity.[2]

Many indigenous groups also call PILA home, including the Ngöbe, Naso and Bribri peoples. A 2016 study conducted by Centro de Incidencia Ambiental (CIAM), a law firm composed of scientists, activists and lawyers focused on environmental policy in Panama, focused on quantifying the number of indigenous peoples living inside PILA. It was found that most communities practice traditional subsistence agriculture while supplementing their income by working on other farms within the park.[3] There are also records of pre-ceramic archeological sites that have been found within the property, indicating that humans have inhabited the area for thousands of years.[4]

---

[1] "Parque Internacional La Amistad." Ministerio De Ambiente De Panamá. Accessed April 20, 2018. http://www.miambiente.gob.pa/index.php/109-parques-nacionales/350-parque-internacional-la-amistad.

[2] Hofstede, R. (2016). *Report on the Reactive Monitoring Mission To Talamanca Range La Amistad Reserves/ La Amistad National Park (Costa Rica/Panama)* (Rep.). IUCN.

[3] Quiel, Jonathan González. Diagnóstico Preliminar Social En El Área Del Parque Internacional La Amistad (PILA). Report. Panama: CIAM, 2016.

[4] https://whc.unesco.org/en/list/205

UNESCO specializes in overseeing the status of WHS throughout the globe, and they have the power to place these sites on the World Heritage in Danger List, which is composed of world heritage properties being threatened by human activity. This status calls for extra attention from the host nation, pressuring an increase of property management to ensure protection. With reports of poor management, CIAM has commissioned research as part of an effort to gather information to send to UNESCO. This research on PILA is part of a civil complaint aiming to change the protection status of PILA. In the past few annual meetings, UNESCO has discussed the status of PILA as a potential in-danger site but has escaped this standing so far. Placement on this list would force MiAmbiente, the environmental government agency of Panama, to create a more efficient management plan for PILA.

Human activity within the park currently includes subsistence agriculture by indigenous peoples, cattle ranching, traditional agriculture, hunting, scientific research, tourism, man-made reservoir formation, and construction of hydroelectric dams. Since the area was first protected, there has been growing concern about the increase of land use within the park. Encroachment of human activity into the park has led to habitat loss, degradation, fragmentation and disturbance.[5] As well, human land use in riparian zones degrades the integrity of streams within PILA and could further degrade habitat. Land use encroachment within the park threatens the Outstanding Universal Value of the park and degrades its properties which the WHS status aims to protect.

Area of Study

221,000 hectares of PILA lie in Panama between the two provinces of Chiriquí and Bocas del Toro.[6] For this study, only the PILA area that overlaps with Cerro Punta, Chiriquí, will be analyzed (*Figure 1*). As Cerro Punta has traditionally supplied a majority of the produce consumed across Panama, much of the original forest had been cleared for intensive farming for decades. The 2004 PILA Management Plan cited the loss of transitory zones, sedimentation, reduction of fauna, reduction in vegetation cover and loss of natural attraction of the area as highly impacting effects from agriculture, cattle ranching and hunting in the Chiriquí region.[7] These effects have been encroaching the PILA limits since the park was first established (*Figure 3: Spatial Analysis of Land Use Change*).

[5] Matson, Pamela A., et al. "Agricultural intensification and ecosystem properties." *Science* 277.5325 (1997): 504-509.
[6] Centre, UNESCO World Heritage. "Talamanca Range-La Amistad Reserves / La Amistad National Park." UNESCO World Heritage Centre. Accessed April 20, 2018. https://whc.unesco.org/en/list/205.
[7] *Plan de Manejo Parque Internacional la Amistad*. (2004)

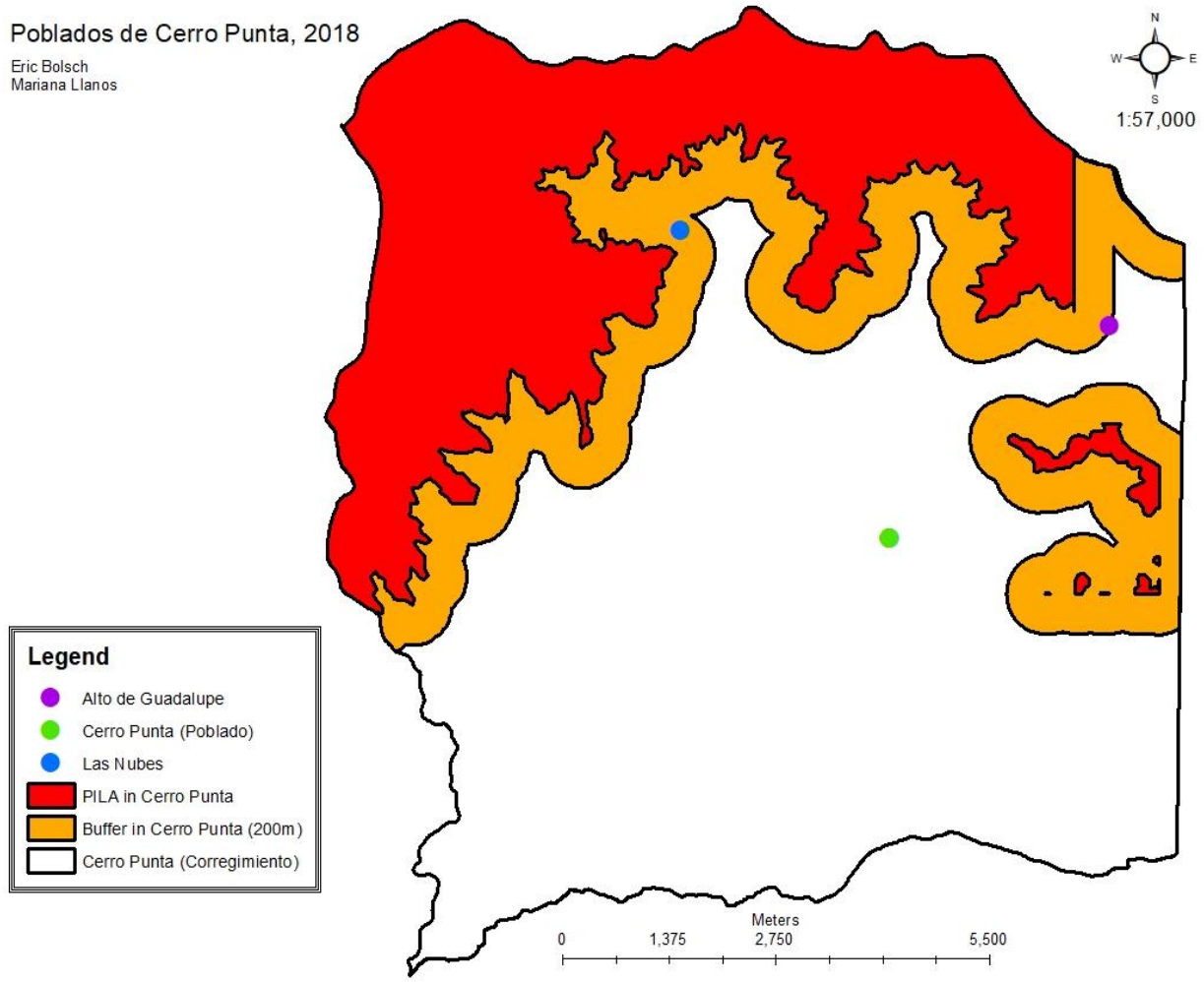
It is not currently known how many farms lay within PILA in the Cerro Punta region. The 2004 Management Plan estimates somewhere between 400 to 500 farms within all of PILA using information from La Dirección Nacional de Reforma Agraria, a 2004 study that detailed human activity within the park. This study found roughly 100 farms, but this information has not been updated in more recent years.[8] Areas of Cerro Punta within PILA where farmers have rights to private land have been delineated as sub-zones of intensive use, which are defined as areas where activities such as agriculture, cattle ranching, and other private projects are permitted. Cattle ranching, however, is not as common in Cerro Punta as it is in neighboring corregimientos.

Areas of the Las Nubes region of Cerro Punta specifically have been noted by the 2004 Parque Internacional La Amistad Management plan as sub-zone of extensive use. The objective of this zoning is to allow public access for educational and recreational purposes. In Las Nubes, there exists a ranger station at the head of PILA hiking trails *(Appendix A, Map 7)*. There also exist various private tourism parks within the boundaries of the park. [9]

When studying land use and encroachment within the park boundary in this area it is important to note how the PILA boundary has been established. In Cerro Punta, the beginning of the park is defined at 2200 meters above sea level (m. a. s. l.). There are no markers or fences which help to distinguish this boundary, and the altitude marker changes at different latitude and longitudes. Without a GPS, this delineation makes it difficult to recognize when entering the protected area. Agriculturalists, as a result, have trouble legally defining the boundaries to their own property. In addition, their rights and restrictions are unclear as there is no territorial ordainment for protected lands that defines legality for federally-maintained land.[10] For these reasons, encroachment into the park is not uncommon. As the lack of monitoring this issue continues, the question begins to form around the rate of change in encroachment and general land use.

[8] (Alvarado et al, 2004)
[9] *Plan de Manejo Parque Internacional la Amistad*. (2004)
[10] J. Pitty, A. Aguirre, and L. Sanchez to Senora Castro, Administradora General ANAM. July 4, 2004. FUNDICCEP, Las Nubes, Cerro Punta.

Figure 1: Communities in Cerro Punta



Research Question

What percent of PILA property in the corregimiento of Cerro Punta is being encroached by human activity? As well, what percent of land along the PILA border in Cerro Punta is being used by humans? How has this land use changed since 1986?

Objective

The purpose of this research is to analyze the land use change along the PILA border in Cerro Punta, a corregimiento of Chiriquí. Within this area of study, the primary human activities include agriculture, cattle ranching, and tourism. It is important to understand the role each individual impact has on the total land use. However, this study does not analyze these human activities individually, but instead analyzes their collect effect as general human impacts on land

and their total change over time. These individual effects are further explored in the discussion. To understand land use change, the objectives include:

1) To map and measure the current (2018) land use inside PILA, Cerro Punta, as well as within a 200-meter buffer of PILA using Geographic Information Systems (GIS) and satellite images.
2) To repeat this process with satellite images from 1986 and 2002 to understand how land use has changed within PILA, Cerro Punta, and the 200-meter buffer zone by comparing the three images.
3) To analyze land use around the 10-meter riparian zone within PILA, Cerro Punta, and the 200-meter buffer zone for 1986, 2002, and 2018.

Methods

In this research, "human activity" can be used interchangeably with "land use" as they both consider the more specific human activities in Cerro Punta, including agriculture, tourism, and infrastructure, in general terms. It is assumed that specific uses cannot be accounted for solely through satellite imaging. Access to private land is necessary to organize spatial analysis of each sub-use which requires permission that was not received. It was decided to use satellite images, which are publicly available, to analyze land use generally in hopes that further research can receive permission to analyze private properties with more precision. Though each sub-use can be further analyzed to determine each specific impact on PILA, this research concentrates on the amount of land dedicated to human activity as a whole. For this study, land use is defined by deforested regions where soil is exposed, as seen in *Figure 2*. Through this method, land use can be recognized consistently across all three years of interest.

The official buffer zone of PILA begins at 1,200 m. a. s. l. This includes most of the corregimiento of Cerro Punta, which has traditionally always been influenced by human activity, most notably agriculture. The land use within the 1,000-meter buffer (between 1,200-m. a. s. l. and the PILA border at 2,200-m. a. s. l.) had not drastically changed since 1986. The focus of this study, as mentioned above, is on PILA land use change, and to begin analyzing land that has been consistently used since before 1986 seemed unnecessary. For this reason, a smaller buffer zone was chosen to allow for a more concise analysis of land use change. The buffer zone for land use along the PILA boundary in Cerro Punta was narrowed to 200-meters because this area

has the most direct influence on the protected area. A buffer zone set at this range encompasses a mixture of both forested regions and human activity that can be measured to calculate how land has changed over time in Cerro Punta near PILA. This method disregards areas with no change so to focus on the areas that did change.

GIS was utilized to conduct a spatial analysis of land use change within and next to PILA using Landsat satellite images from November 30, 1986 (LANDSAT 4-5 TM C1 Level-1); December 20, 2002 (LANDSAT 7 ETM+ C1 Level-1); and January 22, 2018 (LANDSAT 8 OLI/TIRS C1 Level-1). These images were taken from USGS Earth Explorer. The years of 1986, 2002, and 2018 were chosen for this study as they are roughly distributed 15 years apart. Each has high quality images with little cloud cover, which presented issues in images from 1983 and 1984, for example. The image used from 2018 had 15 x 15-meter pixel size while the 2002 and 1986 images had a 30x30-meter pixel size. The Landsat 8 satellite (2018) is more precise with up-to-date satellite technology. The lower quality images may have a larger margin of error, but they were of the best quality available. In future spatial analysis studies with permission to access private lands, this error can be minimized.

Datasets of protected areas, corregimiento boundaries, province boundaries, rivers, and community locations were all downloaded from the Smithsonian Tropical Research Institute (STRI) GIS Portal as shapefiles.[11] These shapefiles were used in ARCGIS 10.5 to create a base map that was placed over the satellite images. From this, polygons were drawn over used land to easily represent areas of human activity. The polygons were drawn both inside PILA and in the 200-meter buffer zone that was created around the PILA protected area layer. From this, total areas were calculated from the sum of polygon areas. Comparing these polygons across 1986, 2002, and 2018 exemplifies how the land has changed over time.

The Panamanian Ley Forestal prohibits the use of an area around rivers and streams equal to the width of the river channel and stipulates a 10 meter minimum buffer zone around the banks.[12] Using the same GIS methods as mentioned above, riparian land use was mapped around rivers in the area of study by measuring the overlap of polygons of human land use and the 10-meter buffer that was created around all streams. This 10-meter buffer zone overlapping land use is labeled as the Riparian Zone Area Used.

[11]http://strimaps.si.edu/portal/home/
[12] Ley 1 de 3 de Febrero de 1994 Ley Forestal, Articulo 23 #2

Statement of Ethical Research

All research was conducted following the Code of Ethics outlined by McGill University. No formal interviews were conducted during the research period; however, names of the contacts from the area of study are intentionally left out of this report. The researcher's certifications from Canada's Course on Research Ethics (CORE) are attached in Appendix C.

Figure 2: Land Use vs. Non-Land Use

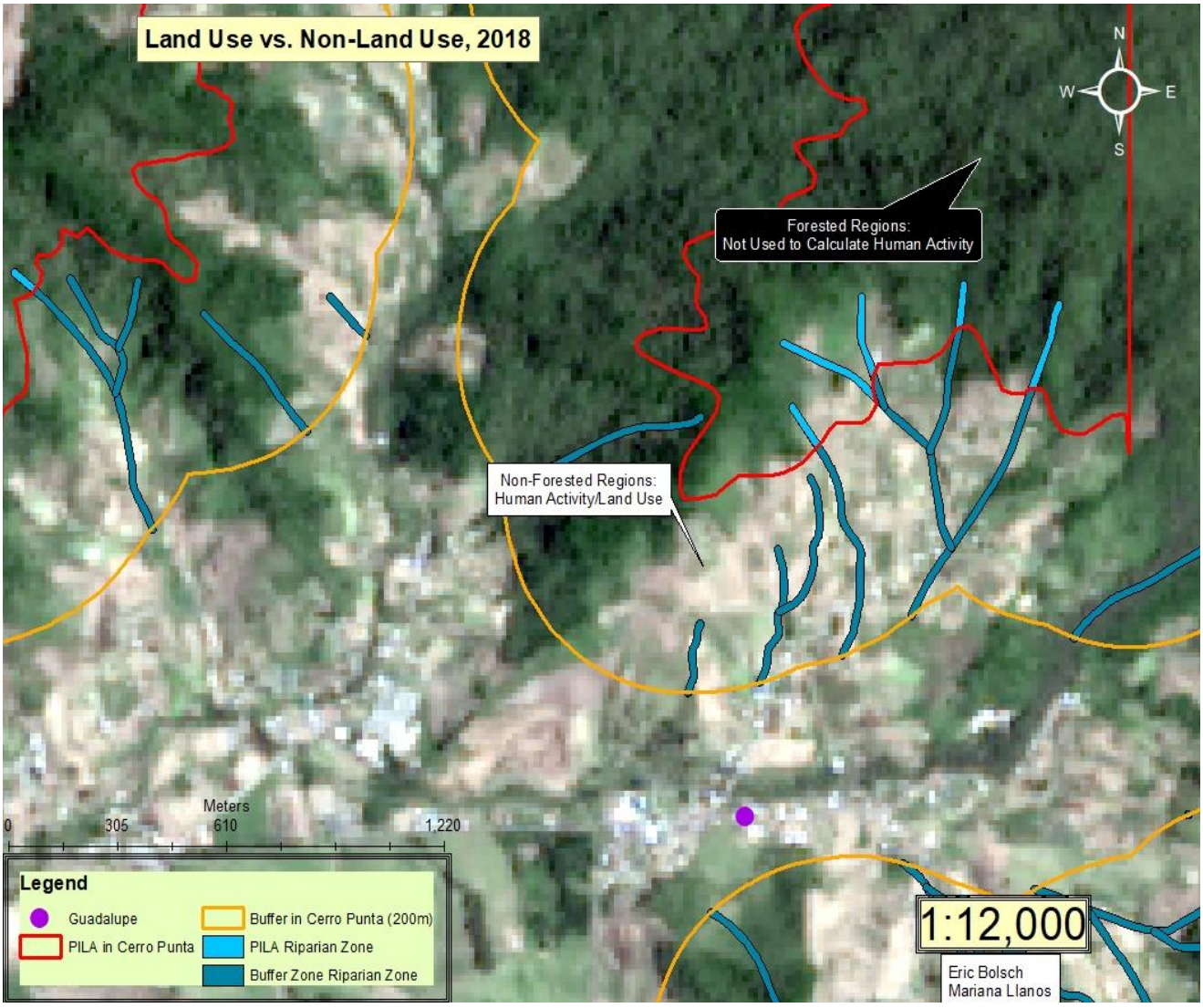
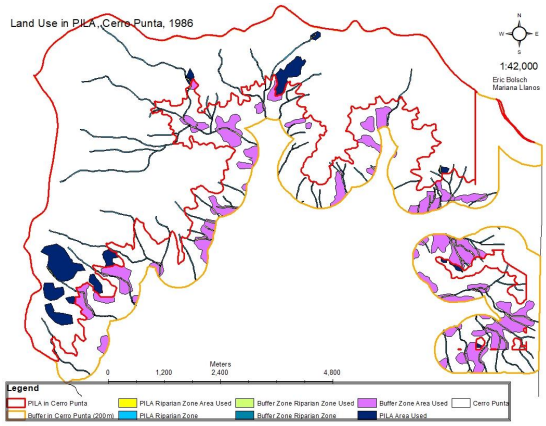
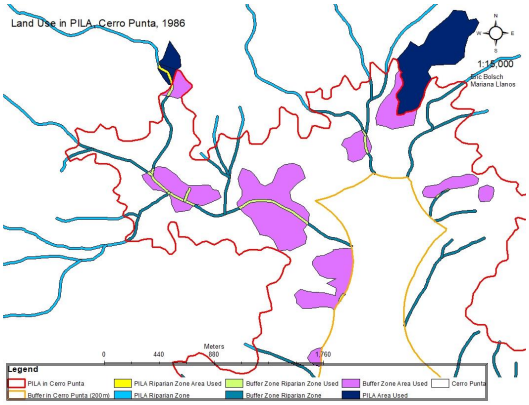
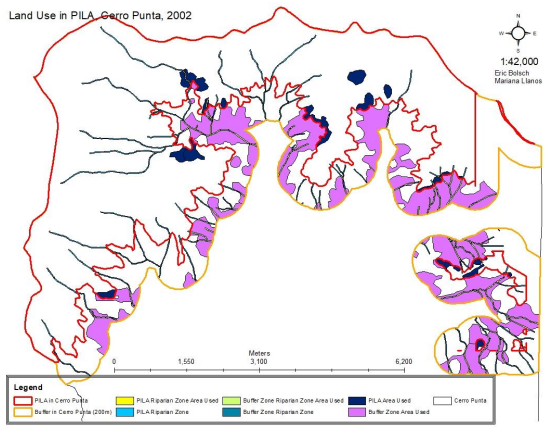
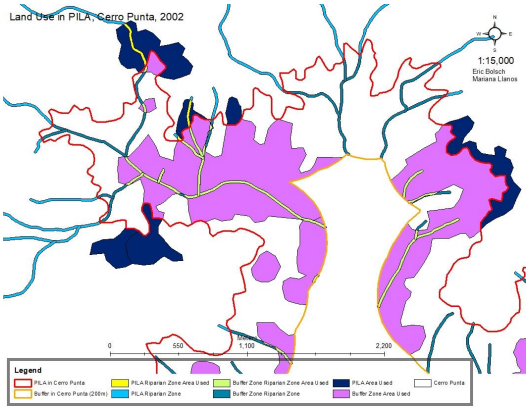
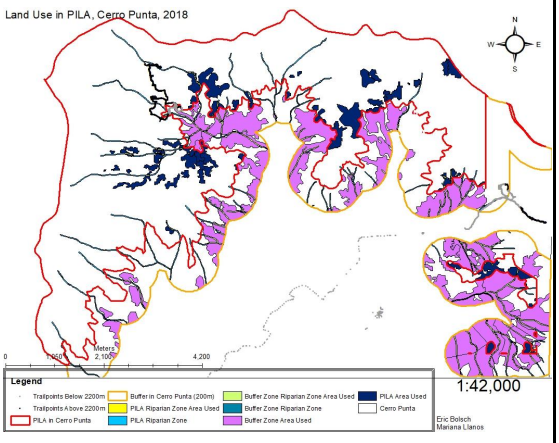
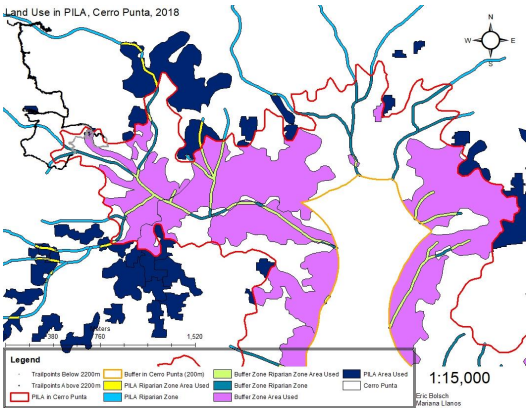


Image from USGS Earth Explorer

Results

*Figure 3: Spatial Analysis of Land Use Change**

	Cerro Punta	Las Nubes
1986		
2002		
2018		

**Detailed images of each individual map can be seen in Appendix A.*

Table 1: Land Use Calculations

Areas (ha)	1986	2002	2018
PILA Area	2946.331088	2946.331088	2946.331088
PILA Area Used	119.154535	97.893519	221.257291
Percent Used	**4.044166505**	**3.322556633**	**7.509586818**
Buffer Zone Area	1990.271175	1990.271175	1990.271175
Buffer Zone Area Used	393.092447	721.217886	816.509718
Percent Used	**19.75069789**	**36.23716683**	**41.02504866**
Total Study Area	4936.602263	4936.602263	4936.602263
Total Study Area Used	512.246982	819.111405	1037.767009
Percent Used	**10.37650908**	**16.59261495**	**21.02188821**
PILA Riparian Zone Area	50.21775	50.21775	50.21775
PILA Riparian Zone Area Used	1.764139	2.177699	5.179651
Percent Used	**3.512978977**	**4.336512488**	**10.31438286**
Buffer Zone Riparian Zone Area	96.441477	96.441477	96.441477
Buffer Zone Riparian Zone Area Used	28.836637	46.371827	49.208172
Percent Used	**29.90065882**	**48.08286688**	**51.02386808**
Total Riparian Zone Area	146.659227	146.659227	146.659227
Total Riparian Zone Area Used	30.600776	48.549526	54.387823
Percent Used	**20.86522384**	**33.10362873**	**37.0844877**

Figure 4: Land Use Percent Change

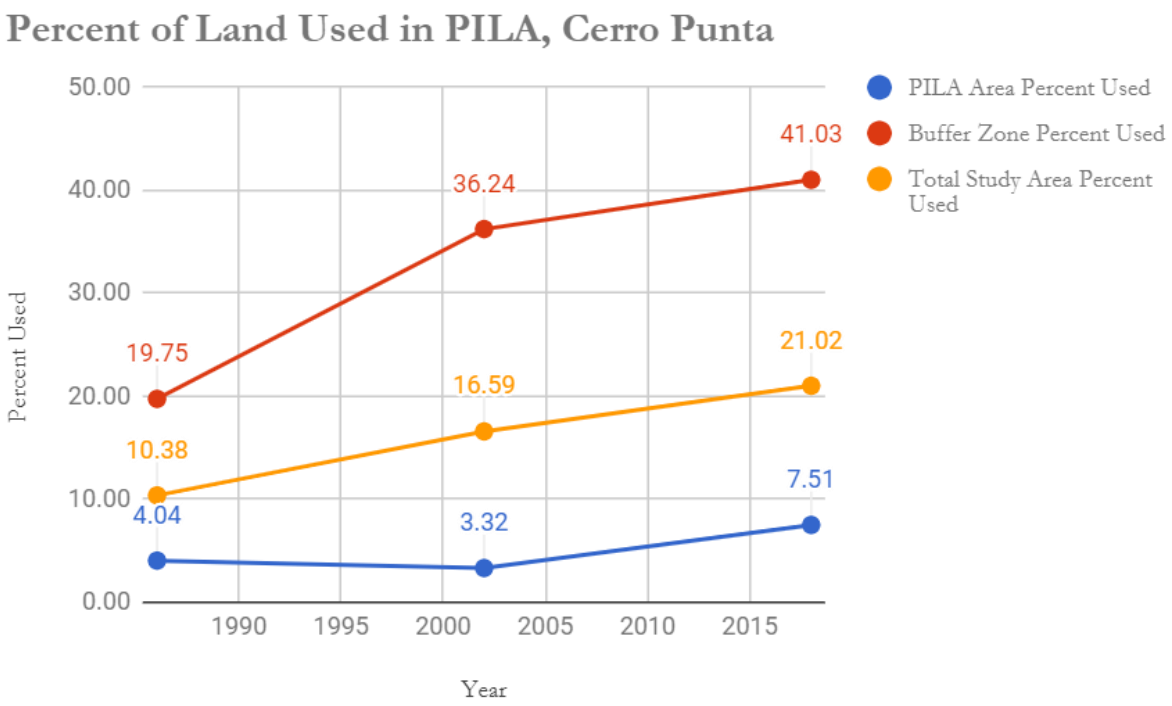
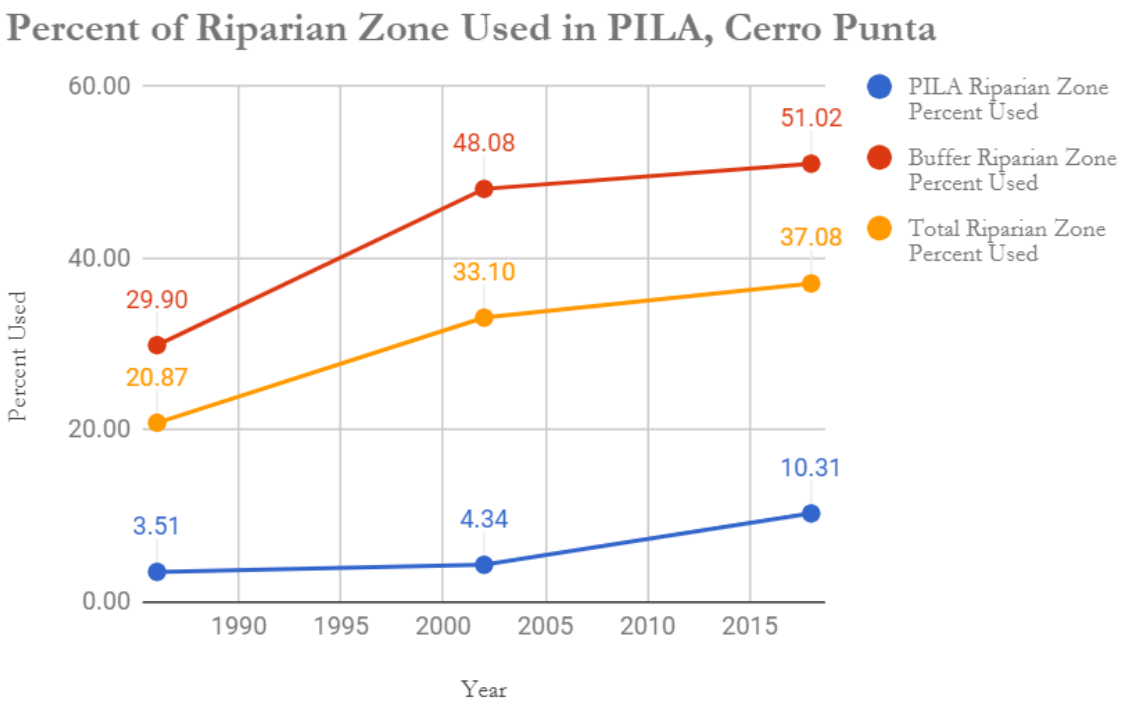


Figure 5: Riparian Zone Use Percent Change



Land used within the park in 1986 was 119.2 hectares. This decreased to 97.9 hectares in 2002, and ultimately increased to 221.3 hectares in 2018 *(Table 1)*. Relative to the total PILA area within Cerro Punta, measured as 2946.3 hectares *(Table 1)*, the percent of land use changes from 4.0% in 1986; to 3.3% in 2002; to 7.5% in 2018 *(Figure 4)*. Within the 200-meter buffer zone around the park, land use was 393.1 hectares (19.8% of the total 1990.3-hectare buffer zone) in 1986; 721. 2 hectares (36.2%) in 2002; and is currently at 816.5 hectares (41.0%) in 2018 *(Table 1, Figure 4)*. Overall, the total area used in the area of study, including area within PILA and the 200-meter buffer zone, was found to be 512.2 hectares in 1986 (10.4% of the total 4936.6 hectares in the study area); 819.1 hectares in 2002 (16.6%); and 1037.8 hectares (21.0%) in 2018 *(Table 1, Figure 4)*.

Within PILA, the percent of riparian land used went from 1.8 hectares (3.5% of the total 50.2 hectares of riparian zone in PILA) in 1986; 16.6 hectares (4.3%) in 2002; and 5.2 hectares (10.31%) in 2018 *(Figure 5)*. In the 200-meter buffer zone, 28.8 hectares of land were used around riparian zones (29.9% of the total 96.4 hectares in the buffer zone) in 1986; this increased to 46.4 hectares (48.1%) in 2002; and is currently 49.2 hectares (51.0%) in 2018. The total riparian zone in both PILA and the buffer zone, measured at 146.7 hectares was 30.6 hectares (20.9%) in 1986; 48.5 hectares (33.1%) in 2002; and 54.4 hectares (37.1%) in 2018 *(Table 1, Figure 5)*.

Discussion

Land Use

Overall, land use has increased since 1986 in the Cerro Punta region of PILA. Only within the protected area from 1986 to 2002 did the land use decrease from 119.2 hectares to 97.9 hectares *(Table 1)*. However, this increased to 221.3 hectares only sixteen years later, following the general trend of increased land use. This initial decrease may be caused by the 30 meters by 30-meter pixel images used in both 1986 and 2002, which could limit the accuracy of polygon measurements. The inability to identify individual farms is also a limitation to this study; however, this problem was present for all years, and the change in land use overall is still recognizable *(Figure 3)*.

An increase in land use around the protected area impacts the many ecosystems of PILA through habitat disturbance and loss, forest fragmentation, and soil degradation.[13] Human activities necessitate the logging of the natural forest on the property, leading to habitat loss and fragmentation.[14] Habitat fragmentation from human land use leads to the isolation of subpopulations and an overall decrease in species interaction, disrupting individual behavior and the flow of genes between populations.[15] Natural ecological processes are at a loss.

Table 2 (Appendix B) from UNESCO's list of factors that affect WHS highlights all known factors applicable to the outstanding universal value of PILA, including agriculture, infrastructure, and tourism. For example, tourism, though important for education, brings an industry of attractions near the park, such as hotels and private trails that advertised, and these lead to environmental exploitation and noise pollution.[16] Though the exact percent of each sub-use of land is unknown, it is assumed that the exposed land measured from the satellite images is used mostly for agriculture as it is the main economic activity in the area. It is also assumed that the deforested regions increased over time in order to increase space for agricultural production. These assumptions are drawn from observations in Cerro Punta, where the highland forest was often met with cultivated land rather than homes and buildings. This highland forest is the locally-perceived PILA boundary, as the limits themselves are not visibly defined.

Photo 1: Land Use from a PILA Trail in Las Nubes (March 13, 2018)

[13] Matson, Pamela A., et al. "Agricultural intensification and ecosystem properties." *Science* 277.5325 (1997): 504-509.
[14] Fischer, J., & Lindenmayer, D. B. (2007). Landscape modification and habitat fragmentation: a synthesis. *Global ecology and biogeography*, *16*(3), 265-280.
[15] YANG, F., & HE, D. H. (2006). Effects of habitat fragmentation on biodiversity [J]. *Ecologic Science*, *6*, 021.
[16] Stone, E. (2000). Separating the noise from the noise: a finding in support of the "niche hypothesis," that birds are influenced by human-induced noise in natural habitats. *Anthrozoös*, *13*(4), 225-231.

The resources required for inorganic agricultural production and cattle ranching, such as heavy machinery, road accessibility, and chemical fertilizers, all play a role in the biological degradation of PIL.A[17] [18] From observations within PILA, much of the agriculture on the Talamanca slopes, both within and along PILA, were not practicing soil conservation techniques, such as planting along the contour. This intense agriculture along the border could be a result of the steep slopes which prevent infrastructural construction but provide viable land for planting crops. It was common to see rows of crops organized down the steep slopes, which would lead to high soil erosion and removal of soil nutrients.[19] As well, many homes in Cerro Punta may have already been established downhill before 1986, whereas the increase in land use in the buffer zone had increased to clear land for agricultural production *(Table 1, Figure 5)*.

Riparian Zone

Photo 2: Riparian Land Use in Cerro Punta (March 13, 2018)

As mentioned in the Methods section, Ley 1 de 3 de febrero de 1994 "Ley Forestal", Article 23, point #2 prohibits the use of an area around rivers and streams equal to the width of the river channel and stipulates a 10-meter minimum buffer zone around the banks. [20] This law is not respected in 50.0% of the river banks in PILA and the Cerro Punta buffer zone. The use of the riparian zones in PILA lead to the environmental degradation of a WHS. Highlighted in *Table 2* (Appendix B) are the harms placed onto the park's hydrology, flora, and fauna

Riparian zone land use prompts non-point sources of pollution. For example, as agriculture production in Cerro Punta continues with fertilizer use, these fertilizers can lead to the runoff of pesticides and erosion into streams, polluting them.[21] A polluted hydrological system is harmful for the local people and species in the area of study, but also effects those downstream.[22] As trees are removed to clear more land, carbon sequestration decreases, and

[17] Ware, H. E., McClure, C. J., Carlisle, J. D., & Barber, J. R. (2015). A phantom road experiment reveals traffic noise is an invisible source of habitat degradation. *Proceedings of the National Academy of Sciences*, *112*(39), 12105-12109.
[18] McLaughlin, A., & Mineau, P. (1995). The impact of agricultural practices on biodiversity. *Agriculture, Ecosystems & Environment*, *55*(3), 201-212.
[19] Harden, C. P., & Hyman, G. G. (2007). Agriculture and Soil Erosion. *The physical geography of South America*, *7*, 289.
[20] Ley Forestal
[21] Moss, B. (2008). Water pollution by agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1491), 659-666.
[22] Mesnage, R., Defarge, N., Spiroux de Vendômois, J., & Séralini, G. E. (2014). Major pesticides are more toxic to human cells than their declared active principles. *BioMed research international*, *2014*.

excess nitrogen fertilizers are not absorbed in the porous soil.[23] These trees promote soil fertility and decrease erosion with a deep root system, increasing porosity for water retention and nutrient uptake.[24] Though not covering as many hectares as general land use, riparian zones are vital to ecological conservation as it connects highlands and lowlands. The steady increase measured since 1986 can predict a continued increase in the future. This calls for better protection of riparian zones through an enforcement of "Ley Forestal" to promote healthy connectivity across forest fragments.

Conclusion

Using the measured data in land use from each of the three satellite images, along with the observations and knowledge of the economic activity in Cerro Punta, it is believed that most of the land use has increased in the Cerro Punta region of PILA for agricultural activity. Though residing in and along the boundary of a protected area, the growing human activity results from the lack of awareness and enforcement of park regulations. Park rangers are limited by their lack of resources and outdated management plan, while local landowners are not penalized for encroaching into park boundaries. It is recommended that a new management plan be written to consider the local stakeholders and their economic endeavors with agricultural production. However, the environmental value of PILA must be evaluated with agricultural production in mind as to not destroy the livelihoods of producers in Cerro Punta. An updated plan to ensure both the protection of PILA and the survival of local economic activity could ultimately stabilize the land use to prevent further encroachment within PILA's boundaries and minimize the impact of human activity within and near the park.

[23] Harvey, C. A., Chacón, M., Donatti, C. I., Garen, E., Hannah, L., Andrade, A., . . . Wollenberg, E. (2014). Climate-Smart Landscapes: Opportunities and Challenges for Integrating Adaptation and Mitigation in Tropical Agriculture. *Conservation Letters*, *7*(2), 77-90.

[24] Hernandez, I., & Sanchez, M. D. (2005). Silvopastoral Systems in Latin America and their Contribution to Sustainable Development and Biodiversity. In M. R. Mosquera-Losada, A. Riguerio, & J. McAdam (Eds.), *Silvopastoralism and Sustainable Land Management* (pp. 219-222). Wallingford: CABI.

Implications

This research has been conducted at the request of CIAM. The organization is interested in understanding MiAmbiente's management of PILA based on the policies organized by UNESCO. As a public service, UNESCO welcomes anyone to submit information on WHS globally as to monitor and adapt policy according to resources the specific protected area needs. CIAM is concerned with the management of PILA and are therefore offering UNESCO reports on human activity in PILA.

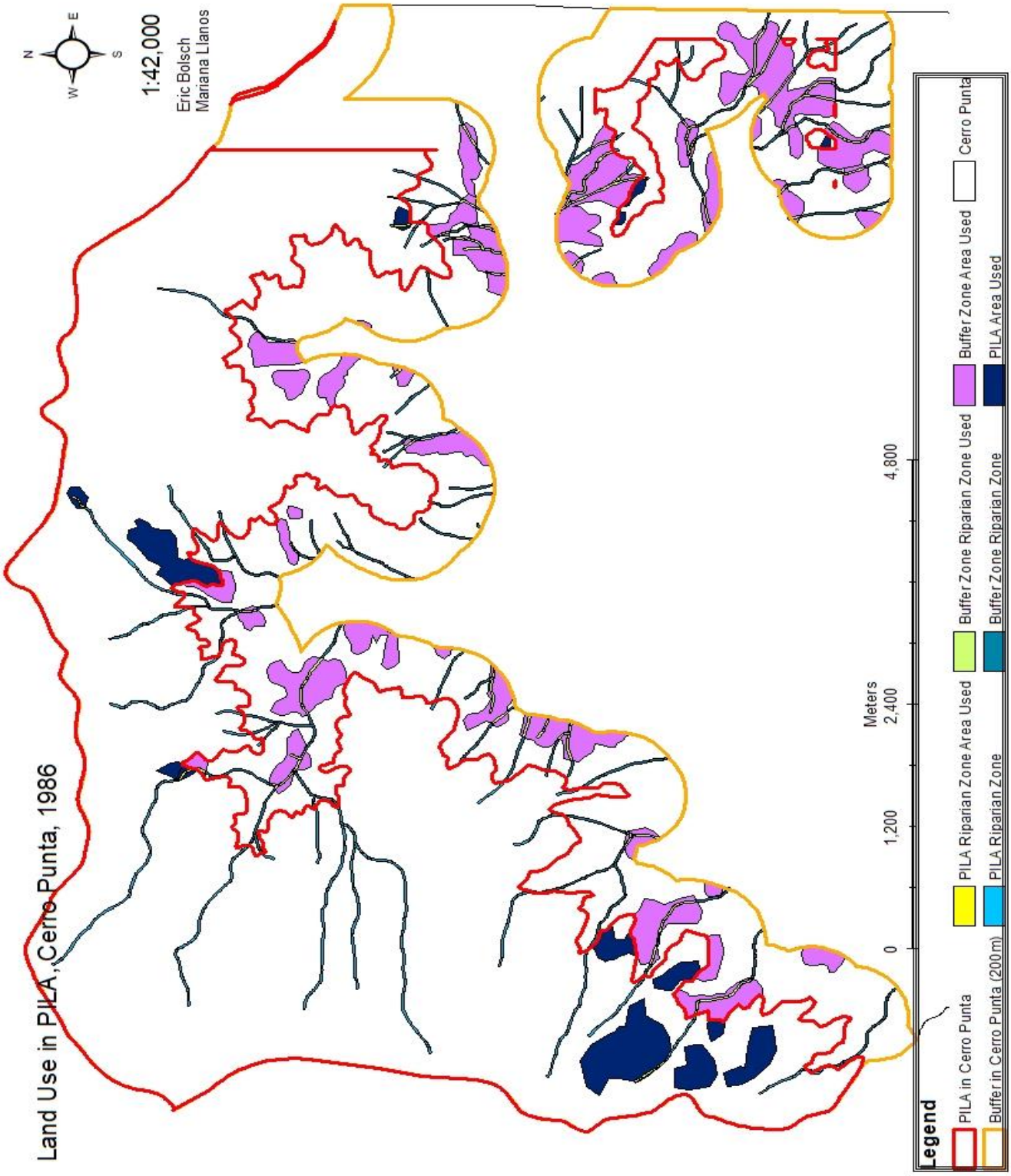
Along with a 2016 study on indigenous communities in the Bocas del Toro section of PILA, this research on land use in Cerro Punta will be submitted as preliminary studies.[25] It is hoped that upon recognition of poor management, UNESCO declares PILA a World Heritage Site *in Danger*. This pressures Panama's federal government to provide more resources to its protection. The logic behind CIAM's case is that this property holds ecological importance for the world, and Panama has an obligation to conserve its environmental value. As a WHS on the Danger List, a management plan would have to be created to prevent the increase of land use within the park boundaries.

This study presents data that shows how land use has changed along a small portion of PILA property. Not only will this study help CIAM with their case to improve management of PILA, but it would ultimately assist in protecting the ecological and biological aspects of PILA as well as maintaining the MBC. As well, the border may be redefined thus allowing private landowners along the border and within the limits of PILA to compromise with MiAmbiente on a resolution that is beneficial to them and the wellbeing of the park. This study is the beginning of an ongoing discussion between MiAmbiente and the people of Cerro Punta, and it is hoped that together they can create a plan to ensure the longevity of PILA.

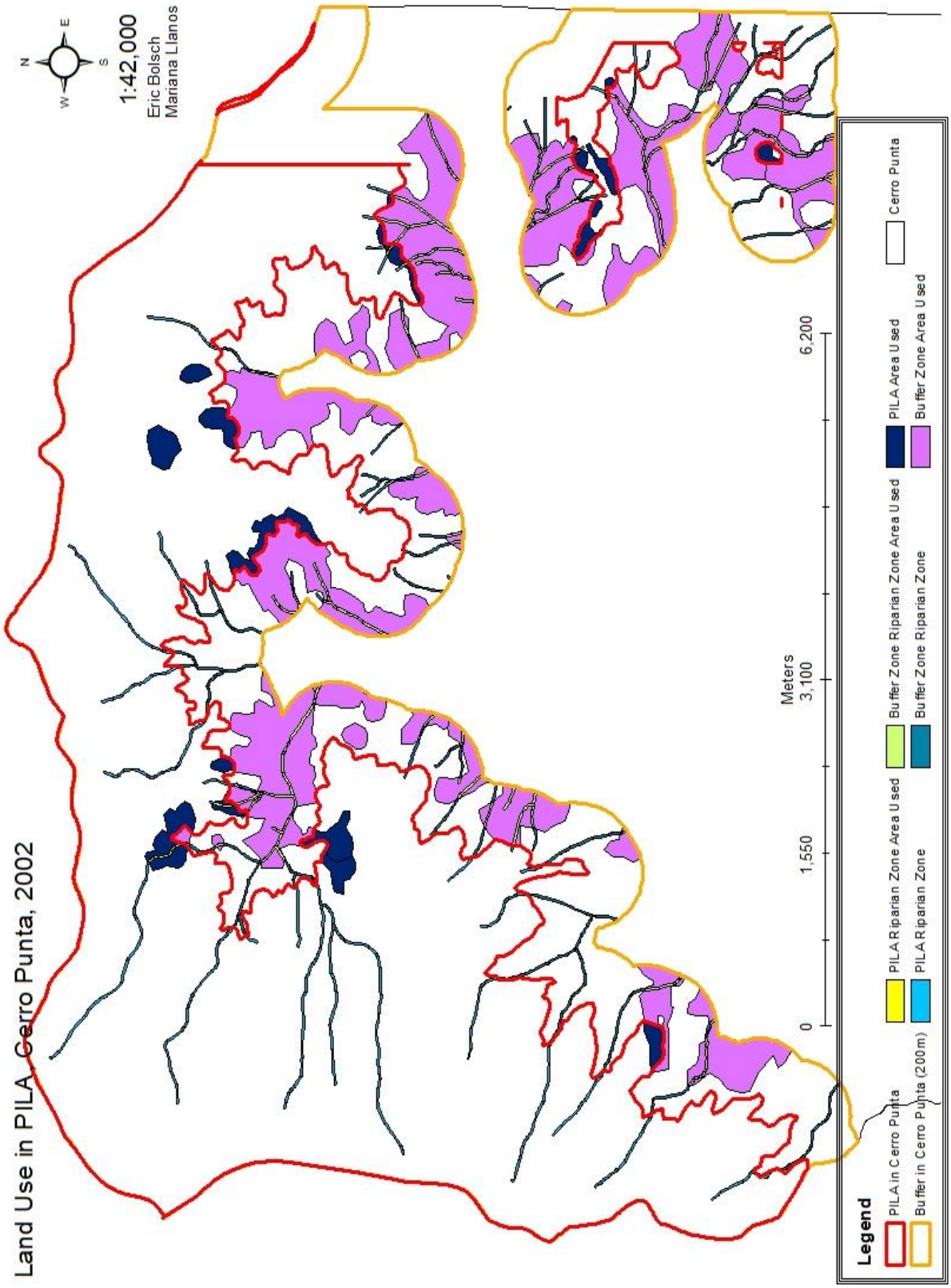
[25] Quiel, Jonathan González. Diagnóstico Preliminar Social En El Área Del Parque Internacional La Amistad (PILA). Report. Panama: CIAM, 2016.

Appendix A: Spatial Analysis of Land Use, Enlarged

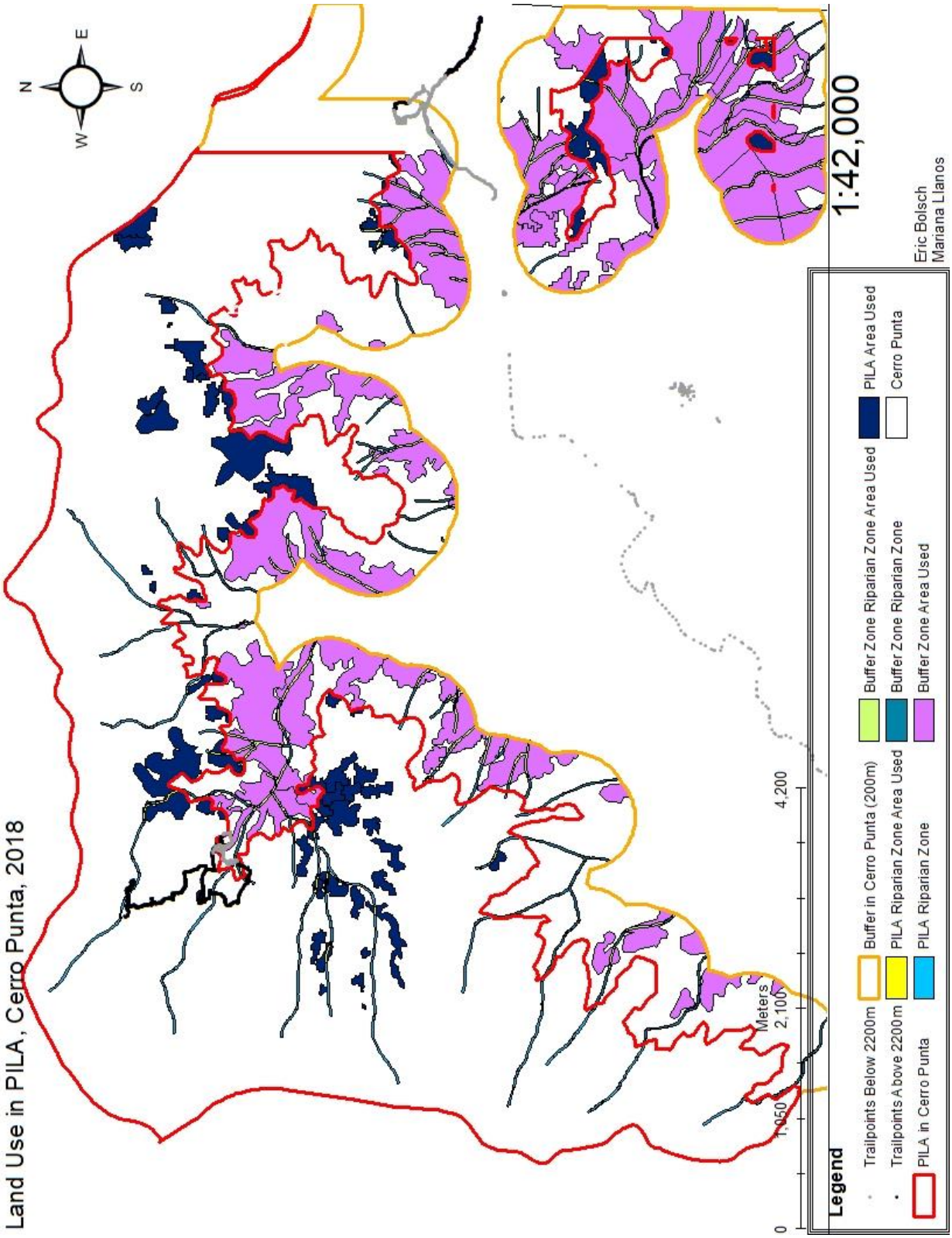
Map 1: Land Use in PILA, Cerro Punta, 1986



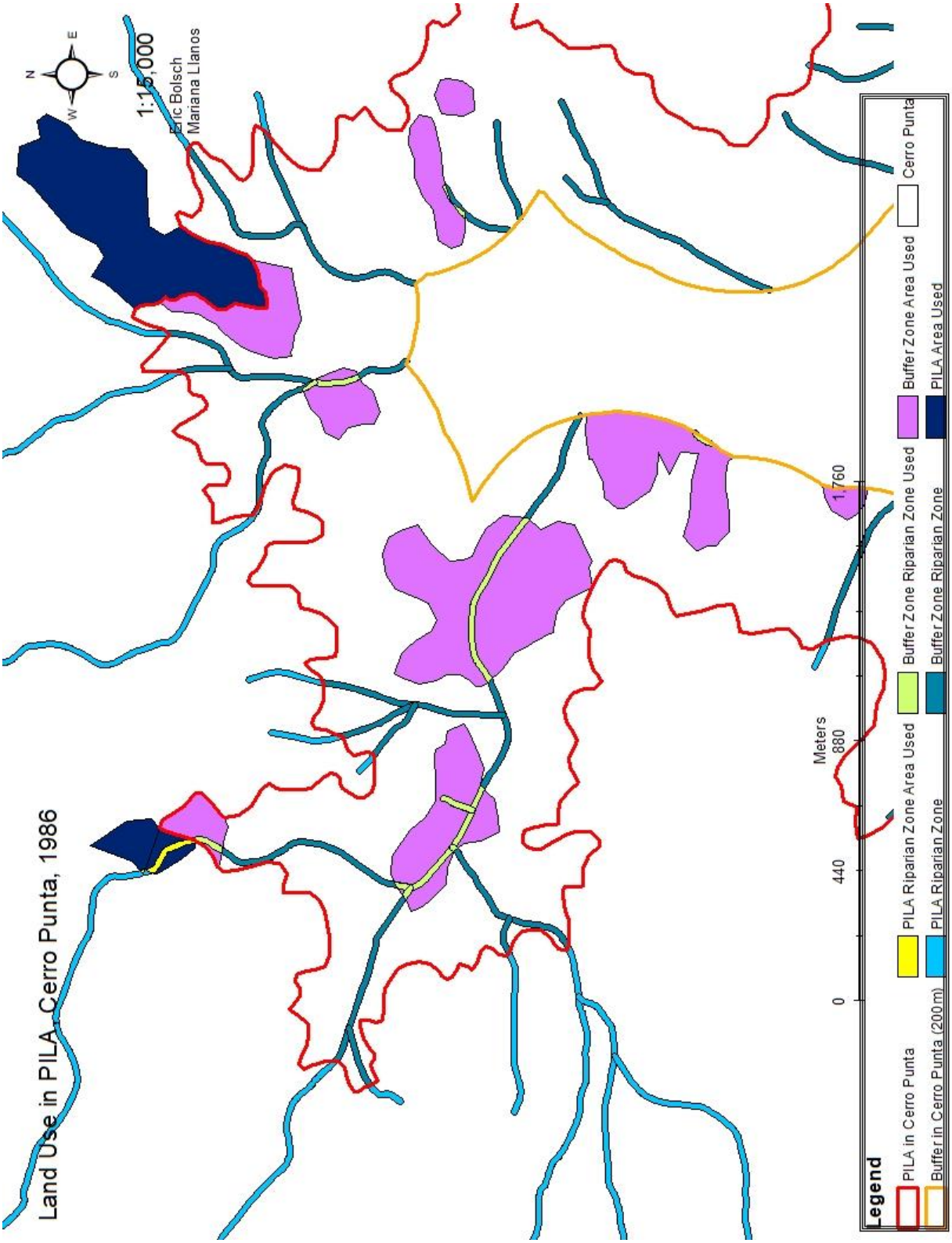
Map 2: Land Use in PILA, Cerro Punta, 2002



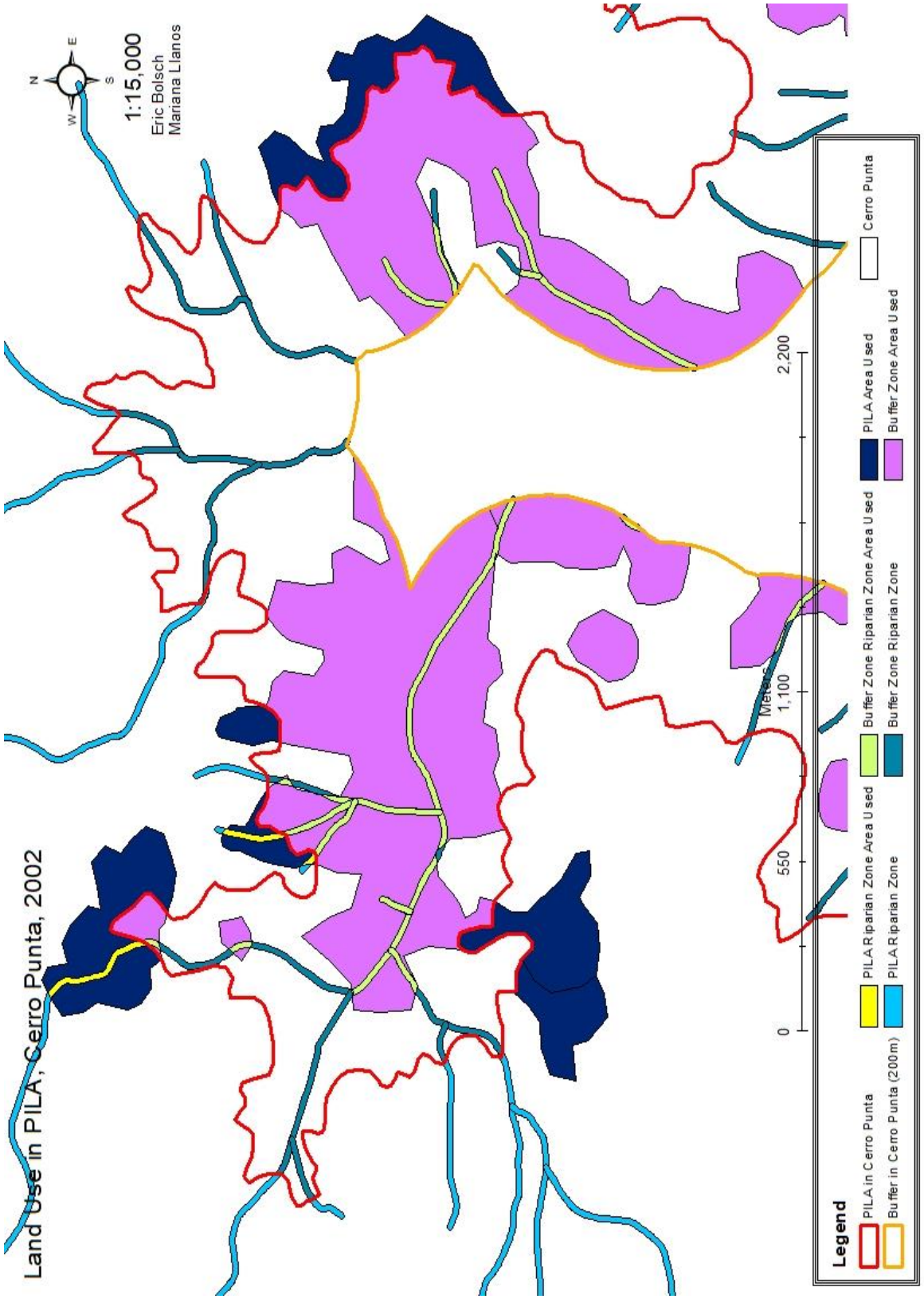
Map 3: Land Use in PILA, Cerro Punta, 2018



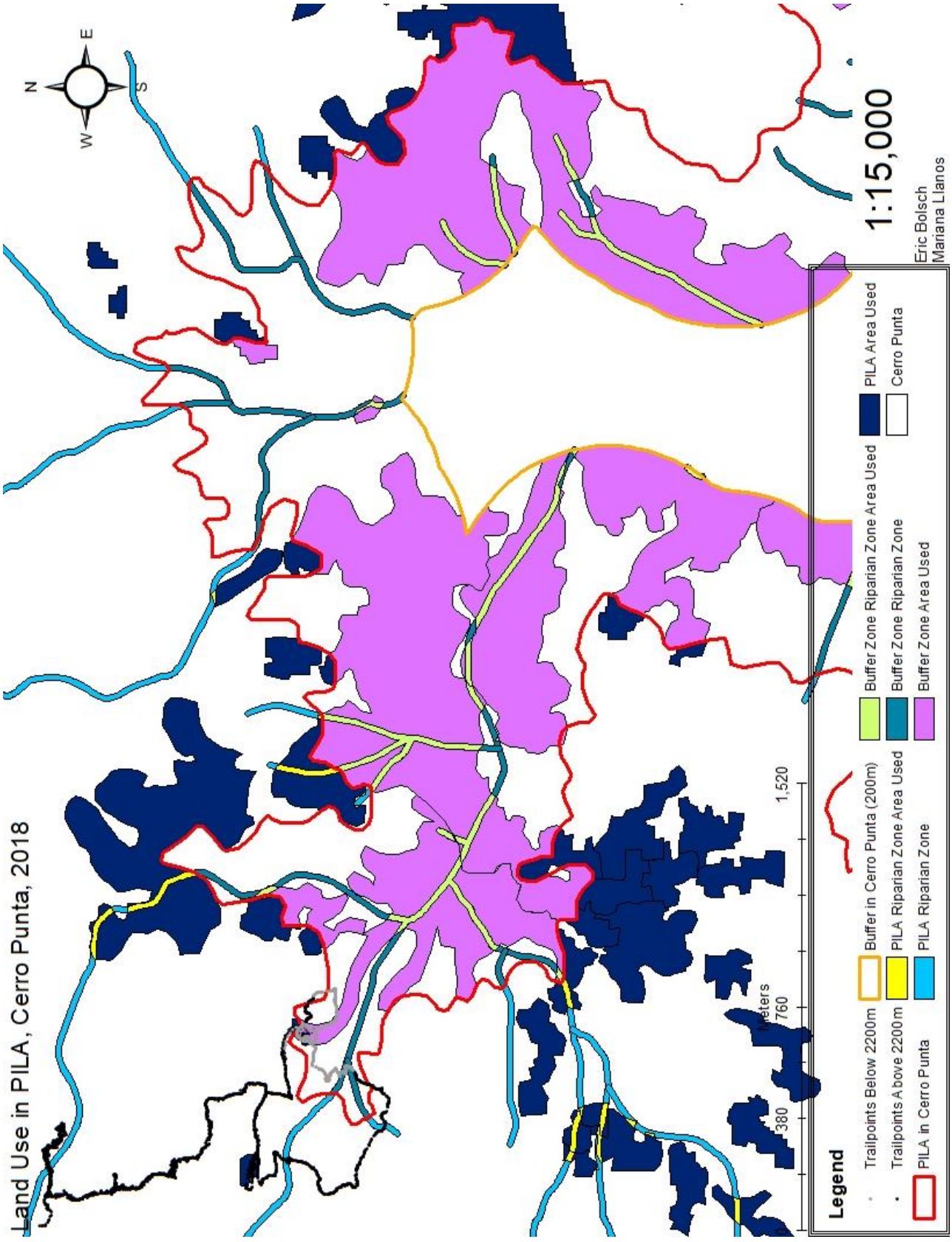
Map 4: Land Use in PILA, Las Nubes, 1986



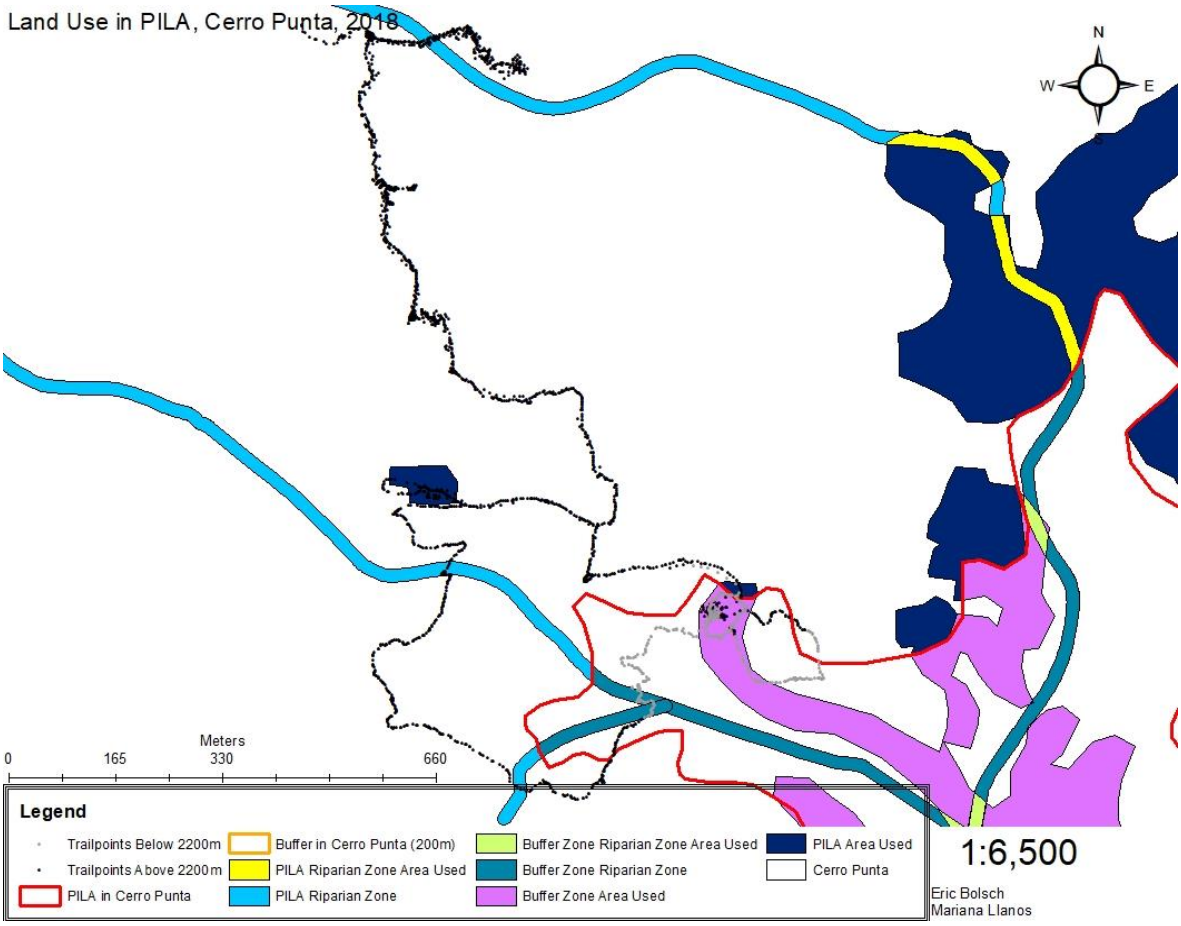
Map 5: Land Use in PILA, Las Nubes, 2002



Map 6: Land Use in PILA, Las Nubes, 2018



Map 7: Hiking Trails in PILA, Las Nubes, 2018



Appendix B: UNESCO Criteria for WHS

Table 2: UNESCO General Factors Affecting WHS

UNESCO Primary Factors	Secondary Factors	Details Affecting PILA	Details Affecting Cerro Punta
Buildings and	Major Visitor Accommodation and Associated Infrastructure	eco-lodges	hotels, restaurants
Development	Industrial Areas		produce depot
	Interpretive and Visitation Facilities	signage, trail markers, minor camping areas	
Transportation Infrastructure	Ground Transport	roads	Roads, car parks
Utilities or Service Infrastructure	Localized Utilities		cell phone/radio towers
Pollution	Ground Water	agricultural runoff	agricultural runoff
	Surface Water	agricultural runoff	agricultural runoff
	Solid Waste		litter, household rubbish
Biological	Land Conversion	agricultural (crops and livestock)	agricultural (crops and livestock)
Resource Use	Livestock Farming/Grazing	pasture	pasture
And Modification	Crop Production	intensification of planted agriculture, deep ploughing, traditional systems	intensification of planted agriculture, deep ploughing, traditional systems
	Subsistence Hunting	hunting	hunting
	Wood Production	logging, silvicultural operations	logging, silvicultural operations
Physical Resource Extraction			
Local Conditions	Wind	erosion	erosion
Affecting	Water	erosion, rain	erosion, rain
Physical Fabric	Impacts of Tourism	soil compaction	soil compaction
Social/Cultural	Society's Valuing of Heritage	expansion of current use of heritage uses, conflicting values	expansion of heritage resource use, change in value
Uses of	Changes in Local Population and Community		migration away from Cerro Punta
Heritage	Changes in Traditional Knowledge System		loss of traditional practices
Other Human Activities	Illegal Activities	occupation of space, construction, hunting	
Climate Change			
Sudden Ecological or Geological	Translocated Species	inappropriate plantings	

Appendix C: CORE Certifications

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

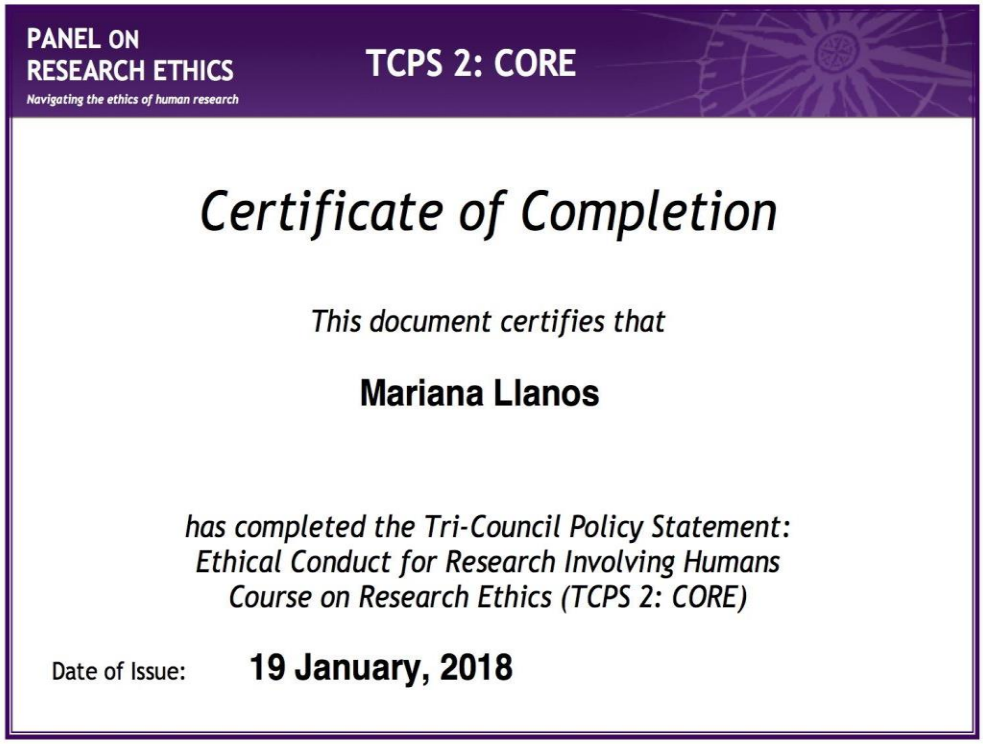
Certificate of Completion

This document certifies that

Eric Bolsch

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **12 April, 2017**



PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Mariana Llanos

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **19 January, 2018**