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CREATING WEB MAPS OF FOREST RESTORATION PLOTS AT IRACAMBI ATLANTIC RAINFOREST RESEARCH CENTER, MINAS GERAIS, BRAZIL

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CREATING WEB MAPS OF FOREST RESTORATION PLOTS AT IRACAMBI ATLANTIC
RAINFOREST RESEARCH CENTER, MINAS GERAIS, BRAZIL

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DEGREE WILL BE CONFERRED MAY 2018

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Environment

And accepted on the recommendation of

Yelena Ogneva-Himmelberger, Ph.D., Project Advisor

ABSTRACT

CREATING WEB MAPS OF FOREST RESTORATION PLOTS AT IRACAMBI ATLANTIC RAINFOREST RESEARCH CENTER, MINAS GERAIS, BRAZIL

DANIEL LASSILA

The purpose of this report is to provide a detailed account, discussion, and analysis of my internship at Iracambi Atlantic Rainforest Research Center in Minas Gerais, Brazil during the summer of 2017, where I worked under the direction of GIS Supervisor Mr. Cliff Jones. The central focus of my work dealt with consolidating existing GIS data on the organization's rainforest restoration effort into a single normalized database - based on the Atlantic Forest Restoration Pact, creating a structure for future forest restoration volunteers including enabling offline field collection using Collector for ArcGIS, then creating an ArcGIS Online web map based on this new single database. I also was educated on environmental issues related to mining in the area, including taking a guided tour of bauxite mining.

This internship was a great environmental and cultural educational experience that afforded me the opportunity to work on environmental issues in the field, in a very unique setting. I developed GIS technical skills in web mapping, field data collection, and database management, using a number of new software tools. Following the requirements of the Master of Science in Geographic Information Science for Development & Environment program at Clark University, this report provides information on the purpose and structure of the organization, a detailed account of my internship, and a personal assessment of my internship.

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Date: August, 2016

Baccalaureate Subject: B.A. Geography, Magna Cum Laude

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Chapter 1: Introduction

Clark University's Geographic Information Science for Development and Environment (GISDE) Master's program has been an excellent program to learn important geospatial skills, which I then applied in-the-field at Iracambi Atlantic Rainforest Research Center, located in the Serra do Brigadeiro mountain range in rural Minas Gerais, Brazil. I have always been interested in geography and maps since a young age. I would read road maps whenever I could as a boy. Growing up, I won my middle school's National Geographic Bee and participated in the Massachusetts state finals at Clark University. This track record led me to declare a major in Geography as an undergraduate. This led to my return to Clark University about 10 years after my performance at the National Geographic Bee Massachusetts state finals, with my acceptance to the M.S. GISDE program at Clark University. As part of the requirements of Clark University's M.S. GISDE program, I chose to pursue an internship to apply my geospatial skills as well as develop my professional skills working in-the-field. The connections I have made at Clark University gave me the opportunity to go on this amazing journey to the southern hemisphere and use new GIS software to help Iracambi Atlantic Rainforest Research Center's mission of environmental education and conservation.

Chapter 2 provides details on the organizational structure and history of Iracambi Atlantic Rainforest Research Center, a small environmental NGO in Minas Gerais, Brazil. Chapter 3 explains my activities at Iracambi Atlantic Rainforest Research Center in-depth. Chapter 4 provides more information on the skills I learned at Iracambi Atlantic Rainforest Research Center and my assessment of the GIS internship.

Chapter 2: Description of Organization

Iracambi Atlantic Rainforest Research Center is a working farm and rainforest research center located near the town of Rosario da Limeria in the state of Minas Gerais, Brazil. The mission of Iracambi Atlantic Rainforest Research Center is to discover better ways to care for the forest and to protect the extraordinary biodiversity there while generating forest based incomes and improving rural livelihoods (“About us”, 2017). The area consists of coffee farms, eucalyptus tree farms, cow pastures, swamps, and both old-growth and succession forest.

Iracambi Atlantic Rainforest Research Center is led by the husband-and-wife team of Robin and Binka Le Breton. Robin’s official titles are Research Director and Public Policy Adviser, while Binka’s titles are NGO President, Director of the Iracambi Atlantic Rainforest Research Center, writer, and lecturer (“Who we are”, 2017). The Le Bretons formerly worked for the World Bank in Washington D.C. then decided to make a drastic change in their lives, deciding to relocate to rural Brazil in the late 90s. They moved into a rural farmhouse near the Serra do Brigadeiro, which is a mountain range containing one of the last intact patches of the Atlantic Rainforest. Since then, the Le Bretons have worked to further Iracambi Atlantic Rainforest Research Center’s mission of environmental research and rainforest conservation advocacy. Volunteers can work on many different projects, including reforestation, agroforestry, GIS, environmental education, and trail maintenance (“Volunteers”, 2017). Many foreign volunteers have come to volunteer over the years, including multiple Clark University GISDE alumni. Iracambi Atlantic Rainforest Research Center is a rather small organization, with no more than a handful of staff and/or volunteers on-site at any given time.

Iracambi Atlantic Rainforest Research Center provides an extremely unique experience for volunteers, as it is located in a very rural area over 10 kilometers from the nearest town via dirt road. It is a great place to experience a rustic, isolated lifestyle, free of most modern distractions. Iracambi Atlantic Rainforest Research Center provides environmental education for the local community and successfully conserves an area of the Atlantic Rainforest. They are working on rainforest regeneration and improving the land use management of the area to reduce environmental impacts. However, the organization is going through a transition with the planned retirements of Robin and Binka. As they are approaching retirement age, they are looking for a new director to continue the mission (Dornelas, 2017). Certainly, Iracambi Atlantic Rainforest Research Center has made a positive impact on environmental issues in the area, but with the lack of effective management, many initiatives are falling by the wayside. Trails around the area have become overgrown and many local urbanites are uninterested in volunteering in a rustic, rural setting. Without a new, dedicated director, it will be challenging to continue Iracambi Atlantic Rainforest Research Center's mission.

Over the last few years, GIS and mapping have become vital to the organization. Iracambi Atlantic Rainforest Research Center publishes web maps using ArcGIS Online visualizing relevant geospatial phenomena like bauxite mining activity in the region, forest cover, and rainforest regeneration plots. The GIS Manager, Cliff Jones, has experience working with the University of Alaska and manages the GIS system at Iracambi Atlantic Rainforest Research Center. Cliff Jones is the only GIS employee at Iracambi Atlantic Rainforest Research Center and typically works for a few weeks at a time, splitting his time between Peru and Brazil. GIS volunteers may or may not arrive when he is on-site. Without coordinating between the work of multiple volunteers, GIS projects become cluttered and disorganized, so he is attempting to

restore some order to the GIS projects at Iracambi Atlantic Rainforest Research Center by working to consolidate existing research.

Efforts are made towards the organization's mission, but with volunteers coming and going, the work on many projects is inconsistent. I personally worked with rainforest regeneration plots, which involves tagging and cataloging trees in the plots and measuring their dimensions. Volunteers have tagged trees in the past with metal tags, but many have become illegible by the time Cliff and I visited. In addition, trails have become overgrown and it is difficult to access many of the plots. GIS data regarding the plots was inconsistent and a huge part of my internship was consolidating all the past unstructured GIS data into a database. One important limiting factor was the slow Internet speeds at the center. Loading and editing web maps could take quite a while, which slowed down my work. Iracambi Atlantic Rainforest Research Center did successfully raise awareness of bauxite mining in the region with its web maps and a tour of the mine that I went on. It was an extremely unique experience. Overall, Iracambi Atlantic Rainforest Research Center does successfully raise awareness of environmental issues, but faces financial and management constraints.

Chapter 3: Internship Description

As a GIS Intern at Iracambi Atlantic Rainforest Research Center in rural Minas Gerais, Brazil, I was tasked with updating the Iracambi Atlantic Rainforest Research Center Ecosystem Monitoring ArcGIS Online web map with spatial information on Iracambi Atlantic Rainforest Research Center's Atlantic Forest regeneration effort. This included educating myself about the project and the associated Atlantic Forest Restoration Pact compliance protocol, Iracambi Atlantic Rainforest Research Center's GIS database, and new tools such as ArcGIS Pro, ArcGIS Online, and Collector for ArcGIS.

The Atlantic Forest is one of the world's top five biodiversity hotspots, but is threatened by deforestation and fragmentation. The Atlantic Forest in Brazil was a vast rainforest lying between the states of Rio Grande do Norte and Rio Grande do Sul stretching from the coast to the inland mountains. Over 93% has been cut down, threatening the many species that live there. Deforestation has left the Atlantic Forest in Minas Gerais severely fragmented. The theory of island biogeography states that the smaller the fragment of forest, the fewer species it will be able to sustain, and that as the fragments get smaller, species loss increases. Iracambi Atlantic Rainforest Research Center's first priority is preventing habitat loss and increasing fragment size through creating and managing protected areas, enrichment planting, and reforesting degraded forest land ("Brazil Rainforest Conservation Projects, Volunteers & Research", 2017).

Monitoring Protocol for Forest Restoration Programs & Projects

The Pacto pela Restauração da Mata Atlântica (Atlantic Forest Restoration Pact) works to monitor forest restoration projects throughout the Atlantic Forest. It publishes the Monitoring Protocol for Forest Restoration Programs & Projects with the aim of expanding both the scale and the quality of

forest restoration in one of the global hotspots of biodiversity. The protocol consists of three dimensions of restoration: ecological, socioeconomic, and project management (“Monitoring Protocols for Forest Restoration Programs & Projects”, 2013). The protocol states the proper way to distribute forest monitoring plots within a restoration effort. Each plot should encompass a fixed area of 100 square meters, either in a 25m x 4m rectangle or circle with diameter 11.3m. A large number of metrics are requested under the protocol. Under the ecological dimension of forest restoration, it asks for metrics of forest structure, tree and shrub species composition, edaphic properties, and degradation factors both before and after canopy development. In addition, a survey of trees within plots is requested. Under the socioeconomic dimension of forest restoration, metrics regarding work and/or income from implementation of areas under restoration process, revenues and financial incentives associated with restoration, source of resources for restoration, job opportunities, training and other services to local communities, well-being of workers in forest restoration, appropriate work safety conditions, and the relationship of the program with the surrounding community are requested. The management dimension of the forest restoration monitoring protocol requests metrics on planning and documenting program execution, technical ability of the restoration practitioners, existence of an adequate monitoring system, clear and free communication among the actors involved in the program, and promotion of technological and methodological innovations in tropical forest restoration.

Preprocessing and Cleaning Up GIS Database

The GIS database at Iracambi Atlantic Rainforest Research Center was poorly organized and contained projects from many different years upon my arrival. My task was to find the collected information on Iracambi Atlantic Rainforest Research Center’s forest restoration effort and consolidate them into an Excel spreadsheet that can be imported into a file geodatabase. I first had to copy all existing data into a new Excel spreadsheet with the column headings as the metrics requested by the

Atlantic Forest Restoration Pact's Monitoring Protocol for Forest Restoration Programs & Projects under the ecological dimensions of forest restoration. This data contained information on forest restoration plots, subplots, and individual tree observations within plots. I created a file geodatabase and imported feature classes on plots A-C and D. I consolidated these two feature classes into one feature class of all forest restoration plots. I imported the feature classes for subplots from plots A-C and plot D, and consolidated these into one feature class as well. I imported the Excel spreadsheet of tree observations into the file geodatabase.

Relational Database

I had to learn how to create a relational database that would relate the plots, to the subplots, to the individual tree observations. At this time, ArcGIS Pro 2.0 was just released, so I had to familiarize myself with an entirely new workflow, different from the ArcMap I was familiar with. ArcGIS Pro is tightly integrated with ArcGIS Online and makes it very easy to publish web maps. One of my first tasks was to create a relational database of the forest restoration plots, subplots, and tree observations. I did this by creating a relationship class, relating certain fields in the different items to create a pyramid-shaped relational database structure with plots feature class at the top, subplots feature class in the middle, and tree observations table at the bottom.

Site Visit

GIS Supervisor Mr. Cliff Jones and I visited forest restoration plots A-C. The trails leading to the site were unmaintained, and I tracked the route from the pasture to the forest restoration plots using my iPhone GPS. I imported this GPS track into my ArcGIS Pro map to show the way to the plots when there was no good description prior except for the raw GPS coordinates of the plots. The site

visit showed that there was little work done on these forest restoration plots in recent months, as the forest reclaims the trail quickly due to the lack of maintenance.

Collector for ArcGIS

I set up my web map to be editable using Collector for ArcGIS with offline editing. Collector for ArcGIS allows people to edit web maps in-the-field, but in areas with poor Internet such as Iracambi Atlantic Rainforest Research Center, offline editing is an important option. To enable offline editing, I had to enable sync and editor tracking on the ArcGIS Online web map, and then download the web map onto my phone with the ArcGIS Collector app. This will enable future volunteers to easily collect and add data in-the-field.

Web Map Publishing

When I was finished with my work creating my web map and relational database of Iracambi Atlantic Rainforest Research Center forest restoration plots, GIS Supervisor Mr. Cliff Jones and I publically uploaded the new feature classes and relational database of the forest restoration plots to Iracambi Atlantic Rainforest Research Center's ArcGIS Online account in the Ecosystem Monitoring web map. My work on mapping and creating a relational database of forest restoration plots is publically available on the Ecosystem Monitoring web map at <http://iracambi.maps.arcgis.com/home/webmap/viewer.html?webmap=dc96e99d6e3840e1afcafd189f4ffd0>.

Other Activities

I visited a bauxite mine in the area on a guided tour hosted by the mine. We were taken to the bauxite mine processing plant, areas of active mining, and areas of ecosystem restoration. Education on bauxite mining is one of Iracambi Atlantic Rainforest Research Center's top priorities, and there is

a completed web map published by Iracambi Atlantic Rainforest Research Center on their web site. This was certainly one of the most unique experiences of my life. I also did hiking on my own and was given Portuguese lessons by Alessandro, who teaches English and Portuguese part-time at Iracambi Atlantic Rainforest Research Center, which I am very grateful for.

Chapter 4: Internship Assessment

During my role as a GIS Intern at Iracambi Atlantic Rainforest Research Center, I gained extensive experience with ArcGIS Pro, ArcGIS Online, Collector for ArcGIS, and ArcCatalog. Almost all of these programs were not specifically taught at Clark University, but the skills I learned definitely came in handy. ArcGIS Pro is the new version of ArcGIS that Esri has released and is scheduled to eventually replace ArcGIS Desktop entirely. While I learned many of the ArcGIS geoprocessing functions in classes at Clark, I had to locate and use them in the all-new interface of ArcGIS Pro. I learned to create and manage a relational geodatabase in ArcCatalog almost entirely on the job, as well as configure it for online use in ArcGIS Online and offline editing in Collector for ArcGIS. None of these tools were really taught to any significant depth in classes at Clark, but I was able to quickly learn on-the-job and demonstrate competence. I also did GPS mapping with a smartphone app, which was taught in the Introduction to GIS course.

The tight integration of ArcGIS Pro with ArcGIS Online was something that I really appreciated. In ArcGIS Pro, it is extremely easy to upload a web map to your ArcGIS Online account with just a few clicks. This made publishing my results much easier and more intuitive. The functionality of Collector for ArcGIS was something that was really interesting, as it enables people to collect data in the field for web maps, even without an Internet connection. It is definitely something that can be used in future GPS mapping exercises.

Of course, taking an internship in rural Brazil involved learning some skills that can never be taught in the classroom. I had to learn how to navigate through Brazil and get to my destination with rather rudimentary Portuguese. I experienced a new culture with both similarities with and differences from American culture. Luckily, I had a Portuguese instructor on-site at Iracambi Atlantic Rainforest

Research Center named Alessandro who was able to teach me proper Portuguese pronunciation, grammar, and vocabulary while I was there. I was served the local cuisine of rice and beans almost every meal, which is different from what I am used to in the United States. I also had to learn how to deal with the extreme isolation of the rural, low-tech setting by finding activities to do on my own. Overall, it was an extremely interesting and unique cultural and environmental experience.

Being able to tour a bauxite mine near the site was certainly one of the most unique, interesting, and unexpected things I have ever done in my lifetime. Never would I have expected in my life to be going on a guided tour of mining and environmental restoration in rural Minas Gerais, Brazil. I learned a lot about the work mining companies do to restore the previous environmental conditions after the strip mining of bauxite, which is used to make aluminum. I will always be grateful to Iracambi Atlantic Rainforest Research Center for enabling this unique, unforgettable experience.

My internship did help me gain important skills in modern GIS software but the environmental/conservation focus was not in line with my overall career goals. None of the remote sensing environmental monitoring I learned at Clark was used at the internship; instead, I used vectors in ArcGIS exclusively. The Internet connection at Iracambi Atlantic Rainforest Research Center is too slow to download rasters in any event. My goal is to start an overseas career in urban planning or international development, so being able to travel to another country and broaden my knowledge of the world may prove extremely useful in the long run.

I would recommend this internship for other IDCE students with several caveats. It is a very interesting cultural experience to be able to work in rural Brazil, somewhere that is off the radar of almost all IDCE students. However, the extreme isolation of the site may not be for everyone. The only people I was able to see regularly while on-site were the staff at Iracambi Atlantic Rainforest Research Center, who mostly spoke Portuguese. It is difficult to enter or leave the site as it is a long

and expensive taxi ride from the nearest town down narrow dirt roads. The isolation can lead to some mental health challenges if you are someone who prefers the stimulation of an urban environment and many new things to see every day. Typically, Iracambi Atlantic Rainforest Research Center charges for staying on site, but I was offered free housing and food for my internship, which tipped the scales in my favor (“Volunteers”, 2017). I cannot recommend this internship if one has to pay to stay there, but if they are offering room and board, one should definitely consider this internship if they do not mind extreme social isolation as it is certainly an interesting cultural and travel experience. Housing conditions are obviously rougher than in comfortable houses in the United States, with my cabin full of insects and with no heating or cooling. The food is extremely repetitive and one may get tired of it after a few days. It is also primarily a self-guided internship where one may or may not be working with the GIS manager depending on if he is present on-site. One will definitely improve their skills in web searches and navigating the Esri online help significantly. I will certainly never forget my time at Iracambi Atlantic Rainforest Research Center and Brazil.

Chapter 5: Conclusion

Being a GIS intern at Iracambi Atlantic Rainforest Research Center was an unforgettable experience. I ventured far away from where I have ever been before, traveling to rural Brazil to do this internship. I experienced a rustic lifestyle much different than what I am accustomed to. I learned in detail about environmental issues facing the region and went on a very interesting bauxite mine tour.

I enjoyed working with the staff on-site at Iracambi Atlantic Rainforest Research Center, including Robin, Binka, and Cliff. Through this internship, I was able to gain experience working on GIS in the field as well as professional experience working with a supervisor. I greatly admire Iracambi Atlantic Rainforest Research Center's goal of restoring rainforest cover throughout the Serra do Brigadeiro area, and they have made substantial progress towards that goal.

Overall, interning at Iracambi Atlantic Rainforest Research Center has helped me become competent with modern GIS software and how they are used by real-world organizations today. I am very glad I went, and I hope I get a job internationally after I graduate from Clark University.

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