
*Implementation of education, sustainable technologies,
and healthcare in the remote Brazilian Pantanal*

*“If you want to go fast, go alone.
If you want to go far, go together.”*
-African proverb

**Undergraduate thesis for International Natural Resource Studies
(Individual Concentration Program) by:**

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Background & Acknowledgements

The project that provided the groundwork for this paper resulted from the support and efforts of many individuals at the University and abroad in Brazil. I would first like to give special thanks to my advisors, Dr. Jonathan Bulkley (School of Natural Resources and Civil & Environmental Engineering) and Melinda Matice (U-M Lecturer English Language Institute). I believe that the process of writing this thesis was possibly the most enjoyable that has ever happened at the University. Matice, who I will give more background on later, ingeniously started teatime at one of our first thesis meetings and it became a tradition for the remainder of the semester. Thank you Matice and Bulkley for many wonderful afternoons, and for your insights and meticulous edits with my thesis; all mistakes are mine.

Over Christmas break in my sophomore year, I decided to pursue a joint degree with an Individual Concentration Program (ICP) in International Natural Resource Studies and Civil & Environmental Engineering (CEE). In my search for an advisor to sponsor my ICP, I found Dr. Bulkley who in his undergraduate and graduate studies at M.I.T. had merged Political Science and Civil Engineering. After our first meeting in early January of that year, I knew that this was whom I wanted to see and work with as much as I could during my time at the University. Dr. Bulkley kindly agreed to sponsor my ICP, and showed great patience and support as my studies went from a broad, all-encompassing topic to a remote corner of Brazil.

Late in the summer after my sophomore year, 2009, a friend, Ethan Shirley, who I'd met at the very start of freshmen year, approached me with an idea to build a school and field station in a remote wetland in the heart of Brazil, the Pantanal. I'd like to thank Ethan for coming up with this crazy idea that transformed my undergraduate education and my life. Ethan had made many friends in the Pantanal from working at an eco-lodge for most of his high-school summers. The owner of the lodge, Sr. Eduardo Falcão de Arruda, had frequently talked to Ethan about building a school for the children of ranching and fishing families that were two-and-a-half to four hours away from the nearest public school. I give many thanks to Sr. Falcão de Arruda, whose support was instrumental to the project – his eco-lodge was our base, his relatives' homes were our home stays, and his dedication made our work possible.

That summer Ethan had been studying abroad in Uganda, and was inspired by a community-based field station with a school and health clinic run by Conservation Through Public Health (CTPH) in the remote Bwindi Impenetrable National Park. Ethan told me all of this while we were wandering campus one night, and we decided that we were as capable as we'd ever be to undertake this endeavor. The remaining month of the summer, we sought out support from any corner of the University that we thought might take an interest.

I'd especially like to thank Dr. Wessel Walker, my ICP concentration advisor for the LS&A Honors Program, who listened to and without hesitation encouraged our pipedream. Dr. Wessel Walker kindly agreed to be the sponsor for our student organization, Pantanal Partnership. I'd also like to thank Vicki Davinich from LS&A Honors Program who has patiently and enthusiastically dealt with Ethan and me through all of the financial logistics for our operations; we never thought accounting could be such an enjoyable experience!

One of the first contacts we made was the director of Global and Intercultural Experience for Undergraduates (GIEU), A.T. Miller. We met with him about two weeks after coming up with our idea, and he wholeheartedly encouraged us to find a faculty sponsor so we could run a GIEU program to help us construct a school the next summer, 2010.

That faculty sponsor was Matice. Ethan and I entered our meeting with Matice with big ideas and no details, and she joined our efforts with unmatched enthusiasm and ingenuity. Soon after, Matice submitted a proposal to GIEU to lead a group of undergraduates to build a school in Brazil for summer 2010, and in October 2009, the GIEU program was approved, lending our project great momentum.

I'd also like to thank many individuals at the College of Engineering (CoE) that we met in the fall of 2009, many of whom have since been steadfast partners. Evan Quasney, a graduate of the Energy Systems Engineering program, enthusiastically responded to our first email and we thank him for the great advice and support that he provided us early in the process. Dr. Lastoskie (Civil & Environmental Engineering) worked us with to create a project for a graduate student in Energy Systems Engineering, Alain Chakam, to do a preliminary design of the school's solar power system, many thanks to both Dr. Lastoskie and Alain Chakam. The Multidisciplinary Design Program (MDP) became a perfect partner for us, and I'd like to thank Dr. Skerlos

(Mechanical Engineering), who gave us very honest and helpful advice to further our project in CoE. Two fellow engineering undergraduates enrolled in MDP, Cory VonAchen and Greg Ewing, and joined Pantanal Partnership; and with guidance and support from Dr. Wooldridge became our experts for bio-sand water filters and general water and plumbing systems during the construction of the school. Many special thanks to Dr. Wooldridge who gave us great encouragement and advice in planning for summer 2010, and continued to give us enormous support the following year as we further pursued the bio-sand water filter and looked into bio-digesters.

With the vague notion that the school and field station, which came to be called the Pantanal Center for Education and Research, should be financially sustainable we turned to the Ross Business School and found two very willing MBA students, Rodrigo Mariani and Ilan Poonjolai. Mariani and Poonjolai kindly helped Ethan and me write a business plan to compete in the Michigan Business Challenge.

A huge thank you to our three graduate architecture students – James Chesnut, Nisha Patel, and Johnathan Puff. We approached Chesnut and Puff with our idea in fall 2009, and could provide them with only a few details. They ran with our idea and crafted a very adaptable blueprint. Patel joined the team in spring 2009, and the three architects joined us in Brazil. They accepted the unexpected ground conditions without complaint, and were the integral force for constructing the school.

And I'd like to thank my family in Ann Arbor, particularly Jacqueline Zillioux, for her good humor and great help in editing this thesis. Last, I would like to thank my family – my parents, sister Kate, and twin brother Andy - for their limitless support, patience, and love.

INTRODUCTION

The Brazilian Pantanal, one of the largest and most biodiverse wetlands, represents today's challenges in matching conservation with social justice in remote regions. Its rich biodiversity and expansive network of channels and rivers has attracted researchers to Brazil for decades, and more recently eco-tourists have joined in its exploration. The Pantanal and Amazon share many of the same exotic species, but the less dense foliage of the Pantanal creates a greater opportunity for sighting endangered animals, including jaguars and rare macaws. However, like many ecologically rich destinations of developing countries, communities in the Pantanal do not have access to education or healthcare, and lack infrastructure for electricity and telecommunication.

For over two centuries, the Pantanal has had a sparse population of traditional ranching and fishing families (in Portuguese called *Pantaneiros*) (Wantzen et al. 2008). Families, even those who owned large ranches, typically had low incomes and subsistence horticulture. There is rich culture and history surrounding *Pantaneiros*, and, in the past, a knighthood and its ceremonies bonded many of the far-flung families together. Beginning in the 1970s, the Brazilian government, which was in the process of demilitarizing, began to industrialize agriculture and ranching to better provide for the needs of the country. This transition from traditional to industrial ranching had many impacts on the Pantanal including large scale clearing of forests and planting of exotic grass species for pastures, chemical runoff into the channels and rivers, and reduction of many species' unique habitats (Junk and de Cunha 2005).

Additionally, over the past two decades, eco-lodges, called *pousadas*, have begun to surpass ranching as the major enterprise of the region. Many ranches transform into *pousadas*, and though they keep a small herd of cattle, the majority of their income comes from providing lodging, meals, and tours in the Pantanal. Most *pousadas* register their land as a federally registered reserve (*R.P.P.N. – Reserva Particular de Patrimônio Natural*), preventing it from being used for agricultural or industrial purposes. This transformation from ranches to *pousadas* has greatly changed how people make a living in the Pantanal. Traditionally, ranching had three employment categories: landowners, farm workers, and smallholders. Landowners either transitioned to a mix of extensive and intensive ranching or sold their large ranches.

Farm workers and smallholders faced greater turbulence as their expertise lost value or their smaller ranches could not compete; many accepted whatever work they could find in the region or migrated to cities, creating great concern for the loss of knowledge about the wetland that was traditionally passed from one generation to the next among those who worked the land. The other great concern is the welfare of *Pantaneiros* migrating into urban peripheries on the coast, which face great pressure as the cities respond to rural exodus. (Wantzen et al. 2008, Rossetto 2006). New jobs created by eco-tourism, especially *pousadas* established by *Pantaneiros*, is one effort to preserve the traditional knowledge of the Pantanal.

From the 1960s through the 1980s, a large contingent of workers and their families left rural areas for greater opportunities in cities. This flow subsided in the 1980s, when rural workers found that conditions and opportunities in the cities, particularly in the *favelas* of Rio de Janeiro, were not necessarily better than the countryside. Clashes in the fall of 2009 in the peripheries of Rio de Janeiro demonstrate the challenges that arise from cities stretched to their limits. In response to urban pressures, many rural areas have been urbanized with the construction of paved roads, shopping malls, and electricity and communication infrastructure (Oliveira, Monte-Mor and Ferreira Simoes 2005). Additionally, more Brazilians, both rich and poor, have decided to split their lives between the city and the countryside, creating a third population category, urban-rural.

The Northern Pantanal

Brazil has the biggest population and landmass in Latin America, with roughly 201 million people and a territory slightly smaller than the US. The country is divided into 26 states, with small heavily populated states on the east coast stretching to large sparsely populated states in the mid-west and west. The majority of Brazilians live in the east coast cities of São Paulo, Rio de Janeiro, and Brasilia, with between 500 to 1000 people per square mile. Moving westward, the Brazilian Pantanal is shared between the southern mid-west states of Mato Grosso and Mato Grosso do Sul; Mato Grosso translates roughly to “big forest”.

Our operations are in the state of Mato Grosso, which has the third lowest population density, at approximately 8 people per square mile. The state overall is sparsely populated, but has concentrated hubs in the capital city Cuiabá (population 500,000) and in a scattering of

towns. Traveling one-hour south from Cuiabá, there is the gateway town to the Pantanal, Poconé (population 31,778), and exiting from the south of Poconé is the regionally famous *Transpantaneira*, a 90-mile dirt road with over a hundred wooden bridges, which spans the accessible regions of the Northern Pantanal. Driving down the *Transpantaneira* one will find ranches, eco-lodges, and countless birds¹ of all sizes and colors. The end of the *Transpantaneira* is the small port village of Porto Jofre, a fishing community on the Cuiabá River. Porto Jofre is on the very southern edge of Mato Grosso; with the Cuiabá River creating the border between Mato Grosso and Mato Grosso do Sul.

The cattle ranching and fishing families along the *Transpantaneira* is the community that we work with in the Pantanal, resulting from a long friendship between a fellow undergraduate, Ethan Shirley (LSA '10) and Pantanal local (*Pantaneiro*) Eduardo Falcão de Arruda. Falcão's family has a long history of ranching in the Pantanal. Falcão's late father, Leirinho Falcão de Arruda, transitioned his large ranch to a privately owned reserve, and the father and son opened a small *pousada* under the guidance of an American eco-tourism operator, Douglas Trent². Falcão and his family now run the *pousada* independently of Trent, and simultaneously maintain a small herd of seventy-five cattle. The venture, Jaguar Ecological Reserve³ (the *pousada*), has been operating for over a decade and is committed to protecting the rich wildlife and culture of the Pantanal.

In summer 2010, Falcão partnered with Pantanal Partnership, a University of Michigan (U-M) sponsored student organization, started by Ethan Shirley and myself, Julie Bateman. Through this partnership, we constructed and registered a public school, which will open in May 2011 and serve many families who previously did not have access to education. Our plan is to integrate the school with a field station and small health clinic, which will be called the Pantanal Center for Education and Research⁴ (PCER) (in Portuguese *Pantanal Centro de Educação e Pesquisas*).

¹ Including the Jabiru Stork, Hyacinth Macaw, and a variety of hummingbirds and parrots.

² Douglas Trent is the director of Focus Conservation Fund: <http://www.focusconservation.org/>

³ Jaguar Ecological Reserve: <http://www.jaguarreserve.com/>

⁴ Pantanal Center for Education and Research: <https://sites.google.com/site/pantanalcer/>

On the next page, Figure 1, is our map of the region and its families. Red flags mark families with children who will likely be attending the school. The community consists of about forty fishing and ranching families. One wealthier family typically owns a large ranch (*fazenda* in Portuguese), and has several families that live and work on the *fazenda*. Some local landowners have transitioned from ranching to eco-tourism, many keeping only a small herd of cattle. The region is very sparsely populated, and great distances stretch between the families. The scattered population and inaccessibility of the region makes it challenging for the government to provide basic services to the community.

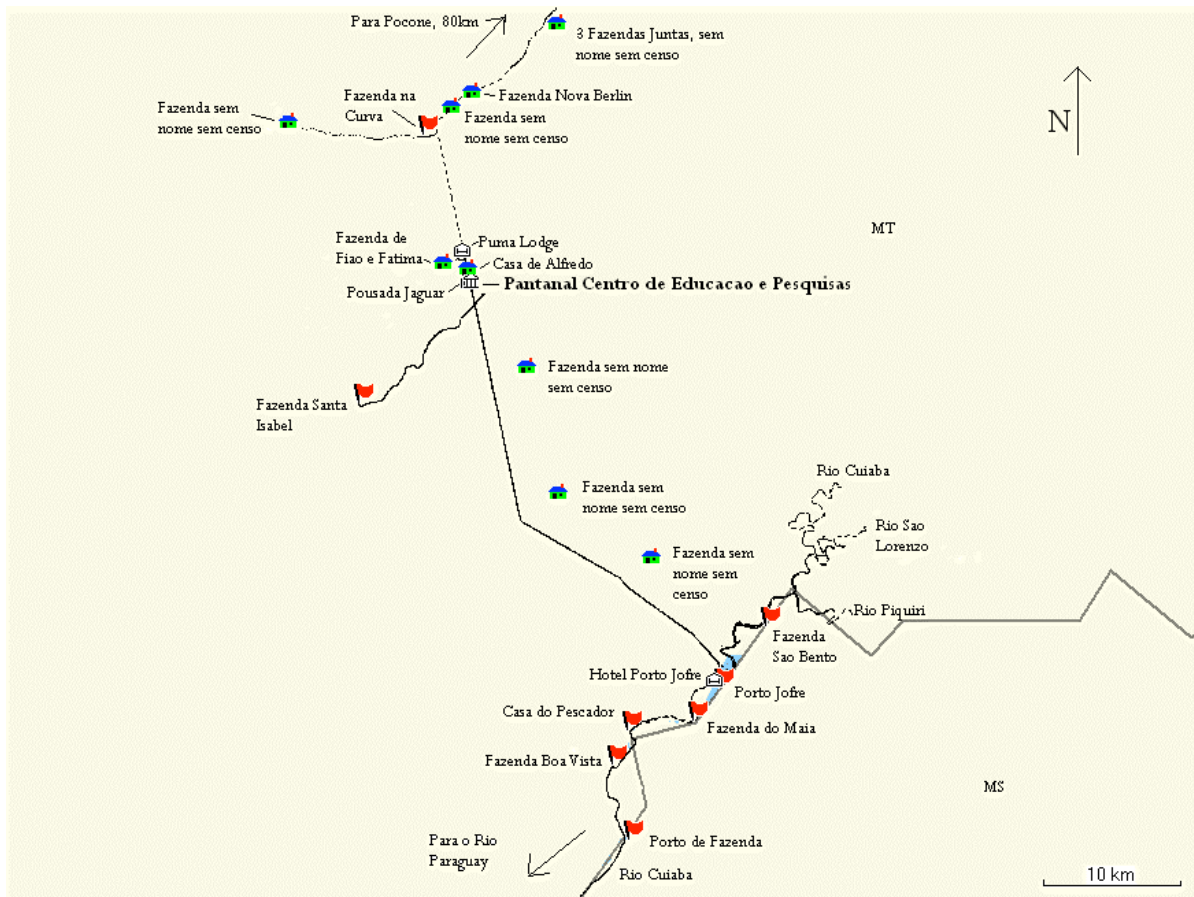


Figure 1: Map of the Northern Pantanal along the *Transpantaneira*

Basic questions

Falcão, the owner of the *pousada*, expects that the opening of a school will attract families back to the Pantanal; however, we agree with him that there is much that remains to be done to create the means for a high quality of life.

The community requires higher quality education than a single-classroom school for children ranging in age from six to eighteen. It requires access to healthcare, as the nearest hospital is four hours away from some families, and it requires basic infrastructure for communication, electricity, and waste disposal. So the first question is how to provide these basic services to a rural, sparsely populated region of the Pantanal?

The second question is in delivering these services, what roles can locals and international organizations play, and what responsibilities must be the government's to ensure sustainability?

Lastly, development and environment often appear to be at odds with each other. Improving living standards typically requires the exploitation of natural resources; so how can the environment and development interact to be mutually beneficial?

I will address these three questions within the categories of education, sustainable technologies, and healthcare.

EDUCATION

Introduction

Education empowers individuals and unifies communities and countries. Frederick Douglass, an escaped slave and 19th century American leader of the abolitionist movement, demonstrates the power of knowledge. Douglass clandestinely learned to read and write from white children in his neighborhood, and recalls his master snatching a newspaper from him, declaring, “education and slavery are incompatible with each other”. He went on to publish prolifically, and worked with many to unite the country in abolishing slavery. Their efforts coupled with the Civil War and President Lincoln’s *Proclamation of Emancipation* ended legalized slavery in the U.S.; however, the fight continues to this day to establish freedom and equality as a global standard. As recognized by Douglass and many before him, education is the pathway for establishing a free and prosperous society.

Brazil is plagued by contemporary slavery; from 1995 to 2009, nearly 35,000 workers were rescued from various ranches and urban businesses across the country. The workers were employed in rock and rubber extraction, fruit and soy production, clear-cutting of forests, and steelworks. They were subjected to beatings and intimidation, and many lived without access to clean water, toilets, or shelter. Even after being freed, some workers are lured back because no other economic opportunities exist for them. Cristovam Buarque wrote in 2009,

[Law] did away with the possibility of selling human beings, as well as the use of forced labor. But it didn’t do away with slavery...We authorize slaves to leave their shanties, but we free them to the *favelas*...We’ve stopped sending leftovers from the mansion to the shanties, and created hunger that slaves never knew. And the worst, we abolished the prohibition of the children of slaves attending schools, but we didn’t get them into schools. They were left to wander the streets, abandoned.

Buarque intimates that the denial of education is akin to the presence of slavery (Figueira 2009). Education gives citizens the ability to recognize and assert their rights, and the opportunity to have a good livelihood. Without access to education, humans are in as precarious of a state as slavery itself. In the Pantanal, with the loss of many traditional professions, the need could not be more pressing. Our discussion of education includes access

to quality public education, the school in the Pantanal, the school's societal and environmental impact, and collaboration between universities and the school through a research station.

Public education in Brazil

Providing access to education in Brazil is no small feat. The country has 27 states, 5,561 municipalities, and over 176,000 schools. There are over 170 million Brazilians, and over 55 million students. Of these students, 36 million are in basic education. The demand is enormous, and Brazil's geography is an additional challenge.

Organization and structure

The structure of the Brazilian government and education system is similar to that of the U.S. Brazil is organized into three levels of government: federal, state, and municipal. The federal government supplies the funds for schools, and the state and municipal government establish and administer the schools (Guimaraes de Castra , Gomes et al. 2009). There is optional pre-school, mandatory elementary and middle school, and optional high school and university. Elementary and middle school is referred to as fundamental education (Educação Fundamental). In 2006, Brazil passed a law increasing fundamental education from 8 to 9 years; municipal governments were given until 2010 to enact the change.

Fundamental education is for children aged six⁵ to fourteen. It is divided into years: Year 1 is for six year olds, and Year 9 is for fourteen year olds. Older children that are behind in their education can attend any year as necessary; students who are over eighteen are put into separate classrooms. Students are required to have two hundred days per school year ("Education in Brazil" 2011).

According to UNESCO, an individual with four or less years of formal education is likely to be illiterate. Recent advances in Brazil's education system are demonstrated by the literacy rates by age range: 97.5% for people age six to fourteen, 84.1% for people age fifteen to seventeen. The education system has improved substantially over the past few decades, with overall school enrollment for students aged six to fourteen increasing from 80.9% in 1980 to 96.4% in 2000, and for students aged fifteen to seventeen increasing from 49.7% to 83% in the same time period. In 2009, the average years of schooling for the country overall was 7.3 years

⁵ Children can enroll as long as they will turn 6 during the first academic semester.

out of the mandatory nine years; however, the average conceals a stark contrast between urban and rural areas (Salatiel 2009).

Urban and rural education disparity

Brazil's urban conglomerates and expansive countryside offer a variety of challenges to providing education. As with many large countries, Brazil has needed to focus on concentrated populations, leaving a large disparity between urban and rural education. As mentioned, the average schooling is 7.3 years. This average decreases to 4.5 years in rural areas and increases to 7.8 in urban areas. This urban-rural disparity is further demonstrated by high school attendance; in rural areas, 73% of the students do not attend compared to 48% in urban areas (Graciano and Haddad 2009). Rural schools are often viewed by the government as money pit because of lower student:teacher ratios and higher transportation costs.

Progress

Brazil has recently taken great strides to improve the accessibility and quality of schools. In 2001, the Brazilian government collaborated across federal, state, and municipal levels to pass the National Education Plan. The National Education Plan is based on three lines: education as a right, education as a tool of economic and social development, and education as a factor of social inclusion. It recognizes that education is “the most effective strategy to fight exclusion through the power that knowledge and acquired skills give an individual toward inclusion and social participation”. The Plan demonstrates that all levels of government recognize education as the means to Brazil's motto, “Order and Progress”. The government's commitment to expand and transform the education system is the base for enormous possibilities. From our interactions with the Secretary of Education in Poconé, it is clear that municipal governments are dedicated to the Plan if a feasible solution is presented to them. (Guimaraes de Castra)

The Pantanal Public School

The process for establishing a school in the Pantanal was unorthodox. Ethan Shirley had first visited Falcão's eco-lodge with his mother in 2002, Falcão had suggested that Ethan return to teach English to his tour guides, and Ethan returned for most of his high school summers. He lived at the eco-lodge and with the extended Falcão family in the Pantanal, and they often talked with him about the challenges of education in this remote region.

Families that were relatively wealthy have a house in the Pantanal and another in the nearest town or city, respectively Poconé and Cuiabá, both north of the Pantanal (see Figure 1). For the average family in the Pantanal, the drive to Poconé is approximately three hours, and to Cuiabá four hours during the dry season⁶, and considerably more or sometimes infinitely more in the rainy season.

Rural families that could not afford a second home are in a greater predicament. If they have close relatives in Poconé or Cuiabá, the children will live there and visit the Pantanal over holidays. Otherwise, the children have no access to education. Our partner, Falcão, has long recognized their need, and in summer 2009, Ethan told me about his experiences in the Pantanal, and approached Falcão with an idea. He proposed that we partner with Falcão and utilize resources at University of Michigan (U-M) to build a public school and field station. We hedged that if we put forth the capital costs for the school that the government would step in and take over the operating costs. Many of Ethan's friends expressed great interest in managing and operating a field station. With the assumed support of the government and the enthusiasm of our local network we began to set common goals and a plan of action with Falcão.

Back at U-M, we formed a multidisciplinary team to design the school and the energy and water systems. Ethan traveled to Brazil in October 2009 to confirm the plans with Falcão, survey land for the school, and discuss the plan with the Secretary of Education in Poconé. The Secretary of Education told Ethan that she was retiring that year, and that he would need to talk to the new Secretary of Education when he returned in the spring. It was not incredibly encouraging, but Falcão was confident that we should proceed and agreed to donate land across from his eco-lodge for the school. He was convinced that if we approached the new Secretary of Education in the summer with a census and construction photos, then everything would fall into place. Back at U-M, we continued to raise funds and by late spring, we had what we estimated to be enough. Our team arrived in Brazil in late May 2010, and over the summer

⁶ The dry season is roughly from April through September and is considered winter with an average temperature of 75°F. The rainy season is from October through March with an average of 79°F. ⁶ Dry season is true to its name, in our stay from late May through mid-August it rained for a total of five minutes. The average temperature can however take visitors by surprise, in mid-July a cold streak passed through and kept the temperature around 40°F for a very chilly week. An eco-tourism described that in wet season white walls are black with mosquitoes, and so many spawn that only the lucky ones reach air.

we were joined by fourteen undergraduates led by Melinda Matice (U-M Lecturer English Language Institute) on a study abroad program, three architecture graduate students, three engineering undergraduates, friends and family, and members of Falcão's family. By mid-August the semblance of a building was standing. After our departure in mid-August, two local builders finished tiling the roof, poured the concrete floor, and mortared the walls. In January 2011, Ethan returned to Brazil to complete the electrical system and plumbing and to conduct a more in-depth census.

The school, *Pantanal Centro de Educação e Pesquisas* (Pantanal Center for Education and Research (PCER)), is across from the *pousada* and located approximately an hour from the families on the Cuiabá River, and between ten and thirty minutes from the ranching families on the Transpantaneira (Figure 1). As boarding schools cannot be publicly registered, the municipal government will provide a bus and fuel to transport the students daily. The school will open in May 2011, and is expected to have between thirty-five and forty students. The differences in ages and education levels of the students provide an additional difficulty for the school. The students' ages range from 6 to 17, and their education level ranges from at grade-level, to below grade-level to no previous education. It will have one teacher, and be expected to serve the needs of among others an 8-year-old and a 15-year-old with no education, a 10-year old at grade level.

Construction (Appendix C)

The school utilized local materials and building techniques. The materials were similar to those used in the United States: cement, sand, aggregate, bricks, reinforcement bar (rebar), ceramic tiles, and wooden beams. However, bricks were considerably different from those found in the U.S.: ceramic bricks with eight holes so they could be easily integrated with rebar. The architecture students, James Chesnut, Nisha Patel, and Johnathan Puff, decided early in the design process to utilize local materials and building techniques, and once we were in the region, it was also the only practical way to get the structure up within three months. The building conditions were very different from what the architecture students had been trained for, Chesnut reflected,

The remote nature of the site is a logistical hurdle and had produced some anxiety as designers who seek a level of specificity

when defining key elements such as local building materials and methods. Early in the design process it became clear that much of the information on site specifics and rural building technologies in Brazil would be somewhat of an ambiguous field condition until the point when we arrived on site. Accepting that as a design opportunity the design team focused on what was known, mostly concerning climatic conditions of the region, its location in the southern hemisphere, and the programmatic demands. In doing so we formulated a performance specification that detailed how we envisioned the architecture to function and a general layout that would accommodate the anticipated program while maintaining flexibility in the same regard. (Chesnut 2010)

Chesnut and his partners gave much consideration to making the school as sustainable as possible. The only modification to the local building style was designing a half-roof monitor to improve ventilation and let in more sunlight. Much effort was spent figuring out how the fluctuating water table would affect the foundation, as the water level in this region shifts 2-4 meters seasonally, and is not a typical building condition found in the U.S. Builders in Poconé and at nearby sites kindly let us observe the techniques on their work sites and gave us an enormous amount of guidance and advice over the summer. The site was excavated by the group of U-M GIEU (Global Intercultural Experience for Undergraduates) students led by Melinda Matice. Two local contractors, João Batista and Jorge Mariani, arrived halfway through construction and assisted us in the construction of the concrete building frame and brick walls. The original plan was to have a crew of carpenters assemble the roof, but scheduling in advance is a big challenge in the region. When the original plan fell through in early August, we decided to move forward on the roof with Batista and Mariani. Construction relied enormously on the Chesnut's expertise. In his own words,

The agency of the designer within this collective was not determined by one's ability to mediate or adhere to the plan and the site specific building methods but rather by employing an understanding of material tendencies, e.g. the tensile nature of steel rebar and compressive nature of concrete, and universal techniques to creating square, plumb, and level components. The most basic tools were available to achieve this and included; measuring tapes to establish a 3,4,5 triangle, dry line, plumb bobs, and clear hose and water to level both long and short distances. (Chesnut 2010)

From Chesnut's "willingness to enter into the unknown armed with design skills and open to a collaborative process that engage[d] multidisciplinary and multicultural support", most of the school was constructed in the three months that our team was in Brazil.

Environment Impact

With the aid of Sima Pro⁷, I performed a basic Life Cycle Analysis (LCA) of the school's construction. All

materials except for the wooden beams

came from a construction store in Poconé, with five

truckloads each traveling 140 miles



Figure 2: Chesnut's Building Model

roundtrip. The concrete mixer was run off of a diesel generator, with diesel carted two-and-a-half hours from Poconé. We received LCA's permission from the local Secretary of the Environment (SEMA)⁸ to use local wood and hired lumberjacks to cut down dead trees and mill them into usable pieces. Although all materials were locally sourced, the indicators are programmed for European countries. I performed the LCA with the assumption that the environmental consequences of manufacturing cement, mortar, rebar, bricks, and tiles in Brazil were similar to those in the European countries. The building was divided into three major components for construction: (1) the structural frame including the foundation, (2) the exterior and interior walls, and (3) the roof (see Figure 2). Plumbing and electricity were not completed over the summer, and were not included in the analysis. From our construction data, I inputted the kilograms of each material into Sima Pro (Appendix C) for each component. With this data, Sima Pro analyzed each material for its environmental impact from manufacturing to installation to eventual disposal. The analysis was done with one of Sima Pro's methods, Eco-

⁷ Sima Pro: <http://www.pre.nl/content/simapro-lca-software/>

⁸ Secretaria Especial do Medio Ambiente: <http://www.brasil.gov.br/sobre/medio-ambiente>

Indicator 95, which measures the effects of an emission on an ecosystem, and uses a weighting system to assign point values to compare the environmental burden of products and services.

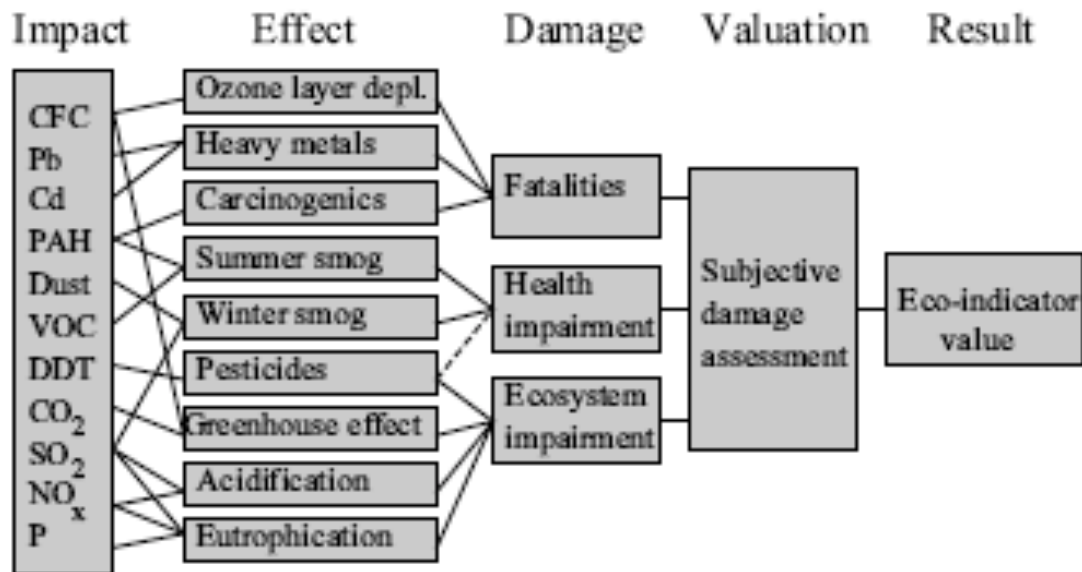
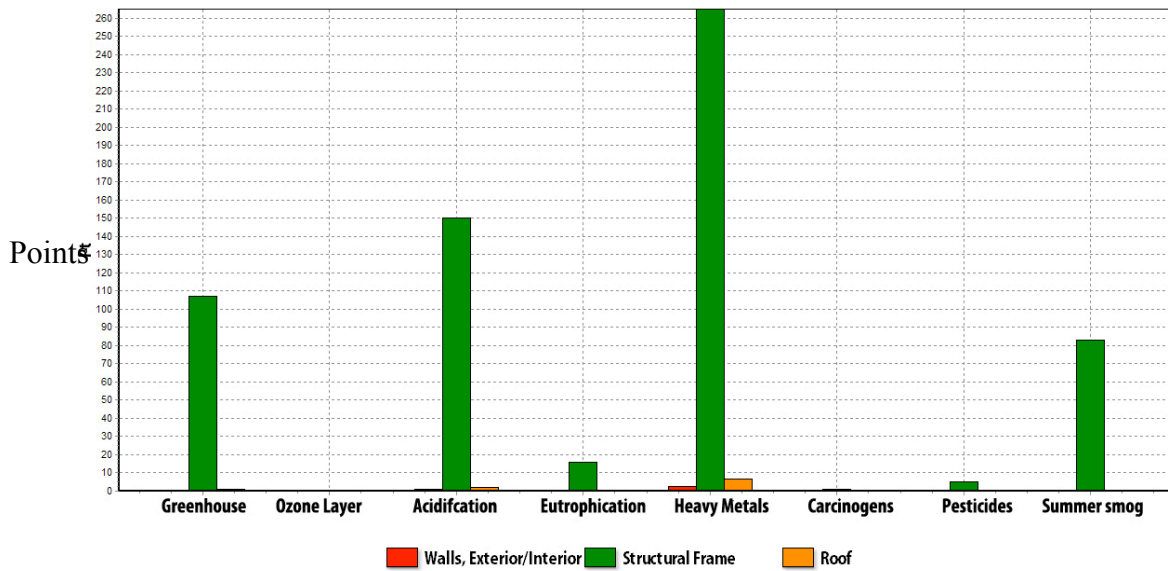


Figure 3 (Goedkoop 1996)

As seen in Figure 3, Eco-Indicator 95 looks at eleven detrimental chemical emissions, which are then related to nine harmful environmental effects. It uses a weighting system to determine the severity of the damages from these effects, and from this Eco-Indicator 95 assigns points. The points are purely for comparison: the more serious the impact, the greater the number of points (Goedkoop 1996). The local civil engineer and our architecture students split design of the building into the structural frame, walls, and roof. If the building were to be redesigned, I decided it would be most appropriate to see which component had the greatest environmental impact. From Eco-Indicator 95⁹, it was determined that construction of structural frame had the most detrimental impact on the environment.

⁹ Eco-Indicator 95: http://www.idemat.nl/Backgr/bi_eco95.htm

Building Components: Environmental Impact Assessment



Comparing 1 p 'Walls, Exterior/Interior', 1 p 'Structural Frame' and 1 p 'Roof';
Method: Eco-indicator 95 V2.06 / Europe e / Weighting

Figure 4

The graph above (Figure 4) demonstrates that the structural frame is the best candidate for design improvements, as it earned the most number of points in all effect categories. The structural frame was constructed from concrete (cement, sand, aggregate), mortar (mortar mix and sand), steel rebar, and clay bricks. Eco-Indicator 95 uses industry and environmental data to track the life cycle of a material, and I applied this information to the materials of the structural frame. Below are the results, and it is seen that the steel rebar, followed far behind by cement and diesel, were the greatest environmental damagers.

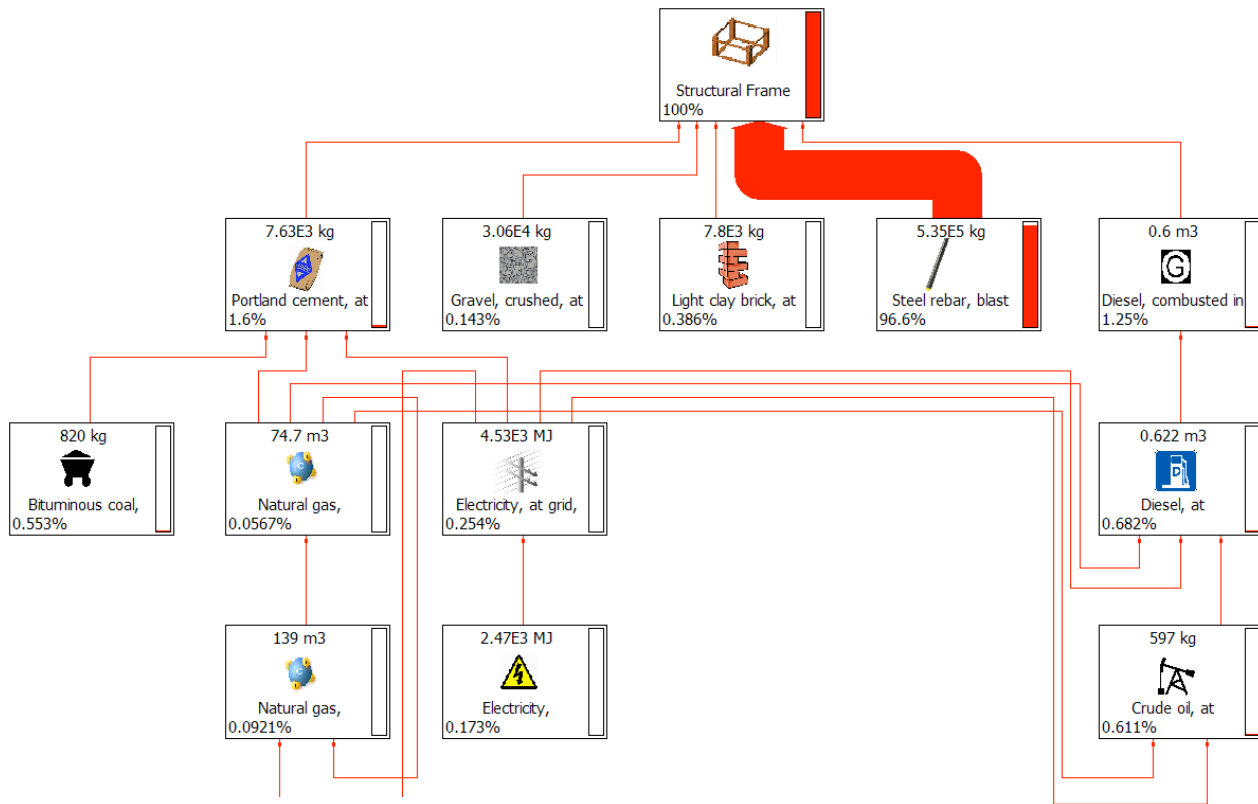


Figure 5: Structural Frame Process Tree

As the steel rebar contributed most heavily to the environmental impact, it is the material of most interest to designers. Rebar is the key structural material of the building. It provides structure and stability for the columns and creates an interconnected frame from foundation through the columns and up to the bond beam (Figure 2). It is formed from carbon steel, and in the past was a smooth rod, but over the past few decades has been engineered with ridges to better grip the concrete.

In Brazil, to our great confusion, measurement for rebar is predominately in the metric system, but is sometimes contaminated with the English system. The rebar in our building is of the following diameter sizes: \varnothing 5/16", \varnothing 3/8", \varnothing 4.2 mm. In our construction receipts, the rebar (depending on the store) was listed as 5/16, 3/8, 4/2 or 5.16, 3.8, 4.2 with no indication of units for diameter or length of the bar. Fortunately, a kind Brazilian company published an online table of measurements for construction products (Takano). From this information, the length and weight of the rebar was determined and is listed in Table 1.

Table 1

Rebar size	Unit	Kg/Unit	Quantity	Total Kg
Rebar 3/8"	12-m bar	7500	21	157500
Rebar 4.2 mm	12-m bar	4800	55	264000
Rebar 5/16"	12-m bar	1308	87	113796
Total Rebar				535296

Viewing the school now, no rebar is visible, but underneath it is large bulk of the structure. There is little substitute for rebar to ensure the structural integrity of the building. Interestingly, the local civil engineer recommended an alternative over the summer, which was filling PVC pipes with concrete. Our architecture students were unfamiliar with this building method, and preferred to stick with rebar to ensure that the building would have high structural integrity. For future projects, it will be useful have more in-depth knowledge of the ground conditions and local materials to determine how to construct a strong structural frame with the least environmental damage.

Operations (Appendix D)

The majority of the school's on-going environmental impact will be transporting students to and from school, and minimally from stocking the kitchen from Poconé and cooking lunch from stoves powered by propane tanks. The school is powered by a small solar power system, and water is purified by a biosand water filter built by U-M engineers (Appendix E).

The transportation had been the "elephant in the room" whenever we discussed the project with locals and tourists – a considerable start-up cost and a major on-going cost. Falcão and several fishing families have offered their boat to transport the students on the river, and the Secretary of Education, Luciane de Aquino Nunes, has assured us that the state has stockpiles of buses. As there are seven families with a total of twenty-four children living at a variety of locations up and down stream of the Cuiabá River, a boat will need to deliver our students to Porto Jofre, where they will catch a bus that goes an hour each way to school. Additionally, there are four cattle-ranching families on ranches with a total of thirteen children ranging up to an hour-and-a-half in the opposite direction from the river and the school. With

these numbers tallying up, we thought a weekly boarding school would be a viable option, but the government only operates day schools. The on-going cost (converted into U.S. dollars) for the boat and bus, roughly twenty gallons per week amounting to \$110 per week for the twenty-six-week school year, coming to nearly \$2900 per year required of the Brazilian government for fuel. To put that number in perspective, the average teacher salary in the region is roughly double that amount at \$6000 per year. This environmental impact, though the largest for the school, is negligible when compared to eco-tourism in the Pantanal where buses and trucks are prevalent.

Conclusion

We hope the opening of the school in May 2011 will bring great change to the Pantanal. We agree with Falcão, the eco-lodge owner, that this is only the beginning to expanding access to basic services to the local community. Education will enable the community to advocate for themselves and to protect their environment. Conservationists interested in the Pantanal and families living there ultimately have the same goal to protect the wetland and its species. With a more educated populace, traditional knowledge of the Pantanal can be better preserved and there can be more effective collaboration on implementing sustainable technologies, as will be discussed in the next section.

SUSTAINABLE TECHNOLOGY

Introduction

In developing our project, we explored many technologies designed to improve living standards in remote regions. The top priorities for summer 2010 were potable water and reliable electricity, and after the summer, we added to the list waste-to-energy generation systems. In selecting a technology, we considered a number of factors: reliability, durability, maintainability, availability of materials, and environmental impact. One of the goals of PCER is to experiment with sustainable technologies to identify effective systems for providing basic services in remote regions.

Water: Bio-sand Filters (BSFs)

Background

Obtaining safe water in developing countries is nearly always a concern. The concern is equal in cities and rural areas, and is shared by locals and visitors. Although locals frequently have high tolerance to bad water, it still takes a significant continuous toll on their overall health. It is estimated that over a billion people in the world lack access to safe water, which leaves them with poor overall health and puts them at risk for often-fatal water-borne diseases. These diseases include fast-acting cholera and dysentery, the slow-acting bilharzias, and the indirect killer from stagnant water, malaria. (Musaazi 1/19/2010)

Bad water was indicted as a disease carrier in the mid-1800s after a severe outbreak of cholera on then-called Broad Street in London, England. Dr. John Snow discovered the link and wrote in a letter, “nearly all the deaths had taken place within a short distance of the [Broad Street] pump...families of the deceased persons informed that they always sent to the pump in Broad Street...in other cases, the deceased were children who went to school near the pump in Broad Street...”. Snow convinced city officials to dismantle the pump, which many believe abated the spread of the disease ("Broad_Street" 2011). The emphasis on identifying the Broad Street pump in his letter demonstrates the power of a contaminated source of water. In the crowded cities of many developing countries, a water source is often contaminated by a precariously- situated latrine at a higher elevation or refuse that seeps in from the streets (Musaazi 1/19/2010). Additionally, development projects, such as hydroelectric dams, can have

unintended consequences, such as the construction of a dam in rural Haiti that introduced and propagated the chronic disease bilharzia, also known as snail fever, to the surrounding community (Kidder 2003).

Dr. Moses Musaazi, a Ugandan electrical engineer, has dedicated his life to innovating technologies to improve quality of life. He has studied the issue of water extensively, and in Kampala, the capital city of Uganda, found that 100% of the natural springs and wells in the city were contaminated by

harmful strains of *Escherichia coli* (*E.coli*), which cause gastroenteritis, urinary tract infections, and other gastrointestinal diseases. Tap water is not widely available in Kampala, and even when it is, is too expensive for the intended users. Rural communities

have similar contamination problems as the city, and

very rarely are connected to a tap water provider. To combat this problem, Dr. Musaazi has streamlined the designs of rainwater harvesters and bio-sand water filters. In 2006, Dr. Musaazi set up a biosand filter at an orphanage outside of Kampala, now in 2011 it is still the orphanage's source for clean water. The biosand water filter is appropriate for the Pantanal because the materials are readily available and cheap in the region, and Dr. Musaazi has demonstrated that the technology is reliable and easy to maintain. (Musaazi 1/19/2010).

Design

The basic idea of the bio-sand water filter (BSF) is many centuries old. It utilizes slow sand filtration to remove suspended solids and microorganisms from water. BSFs are a very attractive technology in remote regions because they require no electricity for operation.

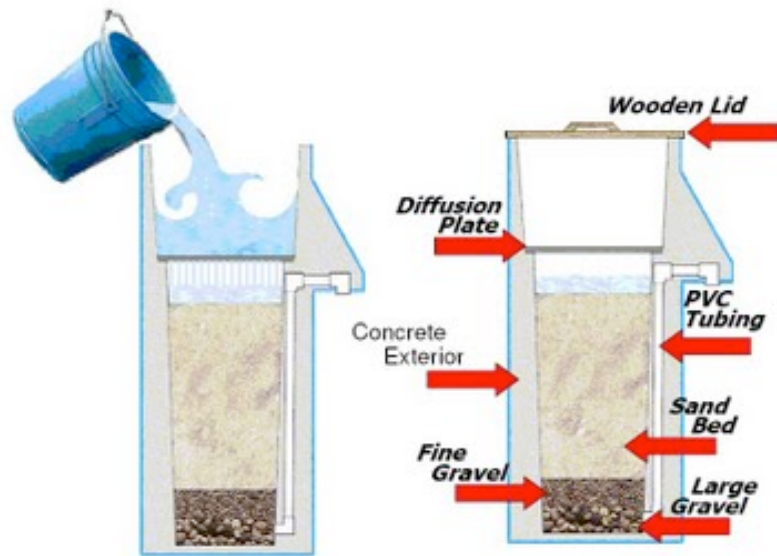


Figure 6 (Musaazi 1/19/2010)

Today's BSFs come in many shapes and sizes, but share the same basic structure and principles. The container is constructed and filled as shown above, and the most important part is the growth of a biological layer at the top of the sand bed. As seen in the Figure 6, water is poured over a diffusion plate to equally distribute the water across the surface. It then runs through layers of increasing grain size from fine sand to large gravel until it reaches the bottom of the container and is pressurized through a PVC pipe to the spout. The BSF initially captures 60% of bacteria and 100% of parasites, and as the biological layer becomes fully established the BSF improves to 100% bacteria capture (Musaazi 1/19/2010).

Implementation

Most ranches and eco-lodges either have a 10-15 meter deep well, or have a hose attached to a pump running straight into a nearby swamp. The water is then pumped into 500 to 5000 L durable plastic basins planted on 5-10 meter wood or concrete stands. The water is gravity-fed to supply sinks and showers. The *pousada* experimented with an artisan well, which is typically 100-mm pipe drilled 30-60 meters deep and considered to provide cleaner, safer water. However, they found that the *pousada* is located on soil with high iron concentrations, and the water was metallic tasting and rusty-colored. At a nearby ranch, we were able to drink water straight from the well without problems. However, after the failure of the artisan well, the *pousada* extracted their water from a nearby swamp and it needed to be charcoal-filtered before it was potable. Although charcoal filters are effective purifiers, they are considered inconvenient. The swamp water is very turbid and the charcoal filter must be cleaned two to three times daily, and replaced once a month with replacements available in Poconé.

Our water system engineers, U-M undergraduate engineers Cory VonAchen and Greg Ewing, selected the bio-sand water filter as the best technology to implement in the Pantanal. Through U-M's Multidisciplinary Design Program, the water systems team designed the system, and then joined us in Brazil to build and test their designs. We found a plastic barrel in Poconé, and used the same sand and gravel that was used for making concrete. The sand and gravel had to be washed several times; additionally, many labor hours were needed to produce fine sand with a mesh sieve. Until the last month of our trip, we were unaware that the BSF technology

existed in the Pantanal until we were doing a census at a ranch owned by Adelinar, called *Fazenda do Curva* (translated to Ranch on the Curve). I recorded our discovery in the blog:

...so us being hot-shot college students thought we were introducing new technologies to this remote region, but guess what Adelinar had sitting on his porch – a bio-sand water filter! A layer of rocks, then calcium, then charcoal, topped with a thick layer of sand, and *presto* bio-sand water filter fixed with a tap at the bottom and mounted on a tree stump for ease of use. And talk about ease of use, Adelinar has used this system for nine years with essentially no maintenance. Curious, we tried the water, and found out that with the addition of calcium or maybe it was charcoal (we'll find out), there's no sand taste as there is with our current filter on site. In hindsight, a bit more exploration of the current systems in the region would be worthwhile. I should mention here that Adelinar lives ten months of the year in the Pantanal, and there's a good chance that he has immunity to bacteria that could take a good hit at our stomachs. I've had great health the majority of my time here, but later that night either dinner (which I hadn't yet had problems with) or that half glass of water took me and my stomach out for the night. Full health was restored by the morning, along with a renewed enthusiasm for filtration and water tests. (Appendix B: Summer 2010 Blog)

We took away three important lessons: to do a more extensive survey of the existing technologies in the region, to gain an understanding of the typical level of maintenance of technologies, and to recognize the difference between local and visitor immunity to contaminated water. We ran tests on our BSF's at the end of the summer, and found that swamp water (greenish-yellow) would come out of the filter clear; however, the chemical tests tested positive for bacteria. We were unable to find an ultraviolet light in Poconé and Cuiabá, and could not confirm whether or not the bacteria were harmful. Our team did drink the BSF water, and although it tasted a bit sandy, it did not cause us harm.

Over fall 2010 and winter 2010, our water systems team tested scaled-down BSF's. In summer 2011, now that the biological layer is fully developed, we will return with an ultraviolet light to determine if BSF's are a viable option for producing potable water in the region. The BSF system will be tested by our water systems engineers, we will then work with families, eco-lodges, and other schools to propagate the technology.

Energy: Photovoltaic Solar Power System

Background

As the majority of the Pantanal is off-grid, we explored hydropower, wind power, and solar power as viable options for providing electricity. Hydropower and wind power were ruled out because the scale of our project was too small to make the technologies cost-effective, so we pursued a solar power system.

Utilizing the sun as an energy resource in remote regions was started over two hundred years ago when crown governments realized its industrial potential in distant lands. In the mid-1800s, Swedish-born engineer, John Ericsson invented the “parabolic trough collector”, which gathered solar radiation to power engines. His basic design powered engines in remote colonies for more than a hundred years. Though solar-powered civilization continued to fascinate many engineers and inventors in the twentieth century, solar energy technology development stalled until Hubbert’s peak, a statistical model demonstrating that U.S. oil production peaked once and for all in the 1970s, challenged the belief in abundant fossil fuels (*John_Ericsson 2011*). Over recent decades, efforts for sustainable development and rural electrification generated renewed scientific interest in solar energy. Rural electrification is designed for scattered low-income consumers, which translates into an electricity provider’s nightmare: high cost of transmission and distribution, low electricity demand, and low consumption. Technological advancements in photovoltaics (PV) and solar thermal technologies have made great strides in making renewable energy financially feasible for remote regions. Installing these technologies, however, has not equated to implementing sustainable rural electrification. Renewable energy systems installed in remote regions rarely provide their intended services for their expected lifetime (Stapleton 2009). This problem results from inadequate national and local energy policies for rural electrification, resulting in a lack of structure and framework for development projects and market solutions.

Solar power systems have been very popular among government programs, non-governmental organizations and international donors for development projects including health clinics, schools, and community facilities since the 1970s (Stapleton 2009). Systems are provided at a very low cost or free of charge because electrification is recognized as a major

contributor to increasing the economic and social welfare of communities. However, the majority of development projects do not provide a framework for the sustainability of their system. Plans for maintenance and replacing failed components are not included in the scope, and educational infrastructure for technicians is not established in the community. Additionally, providing the system for free frequently compromises the financial sustainability of the system. Slogans such as “Free Energy from the Sun” have created great dissatisfaction in communities with failed solar power systems when they are given the cost of replacing the battery (Stapleton 2009). As the system was provided by the development project, the majority of communities expect the aid organizations to pay for the on-going maintenance of the system. This creates a gray zone for ownership of the system, the dangerous consequences of which are demonstrated by a recent case study in Fiji. In 2002, the governments of Japan and Fiji jointly funded a Rural Electricity Service Company. In 2003, a survey by Fiji’s Department of Energy found that the program had a positive economic and social return for 85% of respondents. Three years later, a survey interested in understanding the factors that contributed to the program’s success recorded that 80% of systems were found to be not working due to component failures (Urmee 2009). Policies for project planning must be developed to ensure effective and sustainable use of technology.

Entrepreneurs with renewable energy businesses in remote regions of developing countries are the other key player in rural electrification. Their major challenge in operating a successful business is the lack of consistent energy policy and legal framework. Many of these businesses are threatened by politicians’ frequent promises during election periods that grid extensions are on the horizon (Stapleton 2009). Potential customers anticipating the grid to come in the near future have no reason to invest in off-grid solutions. In many developing countries, extension of the grid is uncoordinated and is the result of political rather than economic reasoning (Urmee 2009). And frequently, promises of grid extensions are not fulfilled and the community has delayed off-grid solutions long enough that the budding rural electrification businesses are forced to shut down operations. In the regions where these businesses have stayed alive, there are mixed signals from the government on energy policy, including import taxes on renewable energy equipment and renewable energy premium feed-in tariffs (Moner-

Girona 2037). Within their own operations, renewable energy businesses have created problems for themselves by false advertising. In these situations, the sales person either states that the system can provide more energy than it actually can or does not explain the limitations of the system to the customer. In both cases, customers unknowingly overuse their system, resulting in a flat battery (Stapleton 2009). This results in dissatisfied customers, and the perception that solar power systems are second-class electricity.

Solar power at first appeared to be the magic bullet for a clean energy system, but we realized that the success of the system would depend on coordination with local suppliers and technicians. With this in mind, we set about figuring out what we needed for a small solar power system.

Design

With support from an Energy Systems masters student, Alain Chakam, we created an appropriate solar power system for the school. The system consists of three 85-Watt solar panels, a deep cycle 1600-Watt battery, a charge controller, and an inverter. The solar panels capture the solar energy and turn it into DC (direct current), which is known as the Photoelectric effect. The charge controller then manages the DC power that goes into the battery, to ensure that the battery is not fried if the solar panel has a glitch. The battery stores energy collected from the sun, so that it can be used any time after sunset or when the solar panels malfunction. The battery can

only deliver DC power, and most appliances (televisions, laptops, radios, etc.) require AC (alternative current). The inverter converts DC to AC power. The inverter, which has outlets just like those one might find in a wall, can be used to plug-in

appliances. The battery ensures that the school can be powered

at nighttime, or for a few days if a panel breaks or there is a series of cloudy days. (Chakam 2009)

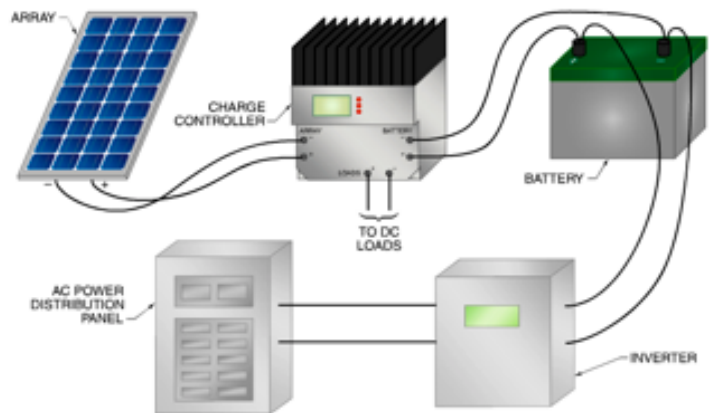


Figure 7 (Chakam 2009)

Implementation

Rural electrification and grid extension has been a discussion in the Pantanal since the *Transpantaneira* was constructed in the 1970s. Currently, the grid stops at the Mato Grosso Hotel, about 20 km down the *Transpantaneira* from Poconé. The families beyond this point utilize small diesel generators (usually 10 kW or 30 kW) to power their homes and *pousadas*. Families with generators must purchase their diesel in Poconé, typically in 200-L oil drums, and transport it back to the Pantanal. For the largest business in the region, the Porto Jofre Hotel, at the very end of the *Transpantaneira*, trucks carry diesel from Poconé daily, approximately 300-km roundtrip. Keeping a steady flow of diesel is a big challenge, and we believe the solar power system will provide the school with more reliable, greener, and over time, more cost-effective energy.

Ideally, we would have purchased solar panels from a local provider. However, Ethan discovered in his October 2009 trip to Brazil that solar power equipment was prohibitively more expensive in the region than in the U.S. We sought out panels in the U.S., and in the spring, a solar panel testing company in the Arizona generously donated twelve solar panels. Unfortunately, strict customs on technology and problems with an alternative technology black market, prevented us from shipping these panels to Brazil. We discovered this on location in Summer 2010 and ordered three 80-W panels, a charge controller, and an inverter to be delivered to Bonnie Shirley, Ethan's mother. Ms. Shirley brought one panel, the charge controller, and the inverter as checked luggage in early August 2010. We purchased a deep cycle battery from a solar power provider in Poconé, to establish a relationship with a local technician and also because acid batteries are not airplane-friendly. We set up our one-panel solar power system in early August and were able to charge laptops and run a stereo on site, but did not have the necessary wattage for our power tools or the concrete mixer.

The *Fazenda do Curva* offered another surprise with its energy system. Until then, all of the ranches and *pousadas* we had visited in the region had the diesel generators. *Fazenda do Curva* had a small diesel generator to power the water pump for their well, but also had an 80-watt solar panel mounted on the roof and connected to a charge controller and car battery for their lights and appliances.

Falcão estimated that he spends US\$3700 per month at the *pousada*, during tourist season for diesel for his generator. Falcão is almost due to replace his diesel generator, and after seeing the low on-going cost of our system, is now strongly considering going solar to avoid his enormous diesel bill. Adeline of the *Fazenda do Curva* told us that switching to solar power had a payback period of two years. We did a preliminary electricity analysis of the *pousada*, and found that by switching all of his bulbs from incandescent to fluorescent, and purchasing an energy-saving refrigerator and fans, he could run his eco-lodge on 40 85-watt solar panels, and 20 deep-cycle batteries. Not only would the system pay for itself within two to three years, it would also eliminate the loud hum and many fumes that the diesel generator currently emits at night (Bateman, IIFG Report 2010).

The school was designed to maximize daylight with large windows and a open roof monitor, so electricity is primarily needed for a water pump, computers, and for extended hours. The energy needs are estimated to be 3 kWh/day, which will sufficiently be provided by three solar panels and the deep cycle battery. On a sunny day, it takes approximately a half-day for one of the 80-W panels to fully charge the battery. This leaves the school with a safety buffer in case one of the panels malfunctions or it is cloudy and the panels are not operating efficiently. In addition, we plan to connect one of the solar panels directly to the water pump so that it can utilize DC power to slowly drip water into the water tank. Lastly, the *pousada's* diesel generator will ensure that if the solar power system fails, the school has a back-up power supply.

Waste-to-energy generation systems: Trash Incinerators, Bio-digesters

The biggest problem we recognized at the end of our trip was disposal of plastic and other non-biodegradable waste. This waste consists primarily of packaging materials (plastic and cardboard) for food, drinks, cleaning supplies, toilet paper, and other daily products. It also includes broken equipment and materials that cannot serve a purpose at the *pousada*. The *pousada* is very good at reusing most broken materials, such as using worn-out tires for hanging flowerpots. The remaining waste is incinerated in an open burn, which releases harmful toxins from the plastics into the environment. These toxins are dangerous for the nearby inhabitants and also detrimental to the wetland. In returning to campus, we investigated two technologies

that convert waste to energy: the trash incinerator and bio-digester. The trash incinerator was initially the most attractive because it burns plastic at a hot enough temperature to prevent toxin release, whereas the biodigester can only utilize organic waste.

Trash incineration can burn all solid waste except for glass and metal, and is burned to ash at a high temperature (850-900°C) to prevent the harmful release of toxins from plastics. Traditional incineration takes the heat generation from the burning process and uses it to power a boiler that then runs a steam turbine. These turbines are typically used in incineration plants that operate at a much larger scale than we are considering for the school and *pousada*. Although there are micro-turbines that produce between 25-500 kW, there is only enough trash to produce between 10-15 kW in the Pantanal. As the amount of waste decreases, the efficiency of the turbine falls dramatically. A team of engineering students studied this technology for a term project and found that the Pantanal did not have a steady enough volume of trash to justify the purchase of a micro-turbine, which cost between \$15,000 and \$20,000 (Ferro et al 2010). Fortunately, the steam produced from incineration can be used for other purposes such as heating water or sterilizing medical equipment (Musazi et al. 2007). As development continues in the Pantanal, especially if a health clinic is established, then trash incineration will become a viable technology.

With this knowledge, we focused our energies on a biodigester. Small-scale biodigesters have been utilized in many developing countries, with over 10 million in India and China to convert animal and human waste into electricity. Although the biodigester does not solve the problem of disposing plastic, it does offer an alternative to carting diesel from Poconé every few days. An anaerobic digester coupled with an internal combustion (IC) engine creates an environment where cow manure biodegrades to produce a methane-rich biogas. The biogas is then stored in separate containers until it is utilized in a spark-ignited engine for electricity generation. Biodigesters produce more gas in warmer environments, which makes them a good fit for the Pantanal. Falcão has kept a herd of about 75 cattle, which produces sufficient cow manure to make the biodigester run efficiently. Cows produce an incredible amount of waste, approximately 63 lbs per day (Anderson 2007). Considering that not all manure can be collected, the biodigester would produce approximately 150 m³ of biogas per day (Ferro, et al.

2010). Typically, biodigesters are large, cylindrical polyethylene bags that create an anaerobic environment to decompose the manure into biogas. Although polyethylene is an appropriate material for industrial bio-digesters, the field conditions in the Pantanal require a more durable material. We partnered with Vort Port¹⁰, an organization that develops sustainable technologies for India and Madagascar, to develop a more affordable, plastic-based biodigester constructed out of PVC pipes. A one-fourth-scale model is nearly operating in a Zingerman's warehouse in Ann Arbor; as soon as biogas is successfully captured, the model can be experimented with in Madagascar and Brazil. As it is expensive to do multiple design iterations between Brazil and Ann Arbor, we are working with Vort Port to perfect the system as much as possible in Michigan before implementing one at our remote location. Falcão has already expressed interest in purchasing a low-BTU internal combustion (IC) engine to utilize the biogas if the biodigester is successful. With manure from 75 cattle, there will theoretically be enough biogas produced to replace the diesel generator with the biodigester.

Conclusion

Remote access to electricity and clean water is a ubiquitous challenge in developing countries. With the successful installation of a solar power system and biosand water filter, we will survey these technologies to see if they are durable and reliable enough to make their environmental benefits worthwhile for the *pousada* and school. The biodigester and trash incinerators are still in their developmental stages, and it is our hope that these technologies will provide a method for clean waste disposal and alternatives for energy generation. Remote regions face many common challenges, namely lack of access to clean water, reliable electricity, and proper waste disposal, and with the proper modifications for each region, these sustainable technologies can significantly raise the standard of living and protect the environment of rural communities.

¹⁰ Vort Port: <http://www.vortport.org/about-vort-port/technologies>

HEALTHCARE

Background

Our original foci in starting our project in the Pantanal were providing access to public education and implementing sustainable technologies; healthcare arose as an objective during our summer in Brazil. To register the school, we conducted the final round of the census of the region for the Secretary of Education in early August 2010, when the construction of the school was nearly complete. The families had lived through many promises of a public school coming to the Pantanal, and were exhilarated to see the photos of an actual school under construction. The parents expressed many concerns for their children's education, and the conversation frequently flowed to their next greatest concern: healthcare. I recounted in our blog the description of medical services by one mother on the Cuiabá River, Señora Conceição:

...the only services offered is a medical boat that goes down the Cuiabá River in November. The next best option is to figure out transportation to Poconé - very expensive and difficult to arrange. There has been talk for a long while of a medical facility in Porto Jofre [the port village on the Cuiabá River] to serve the town and families on the river, and hopefully with increased awareness of the population in the area, there will be an opportunity to improve the current system. (Summer Blog 2010)

On leaving Brazil, with confidence that the opening of the school in May 2011 was in the Secretary of Education's control, we started to look into how healthcare is provided in remote, sparsely-populated regions; and began serious considerations to establish integrate healthcare.

Interestingly, when we started our project in July 2009, we took much inspiration from an endeavor to provide healthcare to a rural community in remote Uganda. Previously that summer, Ethan had stayed at a community center focused on improving the health of the community and the environment in a remote forest in Uganda known for its endangered gorillas, the Bwindi Impenetrable National Park (BINP). The community center had a school, hospital, and field station; and it was solar-powered and entirely staffed by locals. Gladys Kalema-Zikusoka, a wildlife veterinarian, had established the community center in 2003 as part of her non-profit organization, Conservation Through Public Health (CTPH)¹¹. CTPH was founded

¹¹ Conservation Through Public Health (CTPH): <http://www.ctph.org/>

with the recognition that there are complex interactions between people, their health, and their environment, an approach called population-health-environment (PHE). PHE is focused on the most underserved and marginalized communities, and the BINP was a prime candidate with some of the most impoverished families of Uganda and an imminent tuberculosis threat to the region’s critically endangered gorillas. The tuberculosis threat was growing as families needed to encroach on the gorilla’s territory to farm for sustenance. Rather than blaming the local population for threatening the gorillas’ health, Kalema-Zikusoka recognized that the land was shared and that health was also shared. This recognition of sustaining the community and the environment simultaneously resonated with Ethan and me. (Kalema-Zikusoka & Gaffikin, 2008)

When Ethan returned from Uganda in July 2009, he told me about his idea to combine conservation with education in Brazil. A year later, after conducting a census and talking with the families in the Pantanal, it was clear that the next step towards sustaining the community and their environment was improving access to healthcare in the Pantanal. Fortunately, the challenge of providing healthcare to remote and sparse populations is not unique to the Pantanal, and solutions have been explored in rural communities of many countries.

Background on Rural Healthcare

The majority of developed and developing countries have substandard healthcare in rural areas. In the Figure 8, the World Health Organization (WHO) demonstrated the severity of this problem by comparing the populations and distribution of physicians and nurses between rural and urban areas.

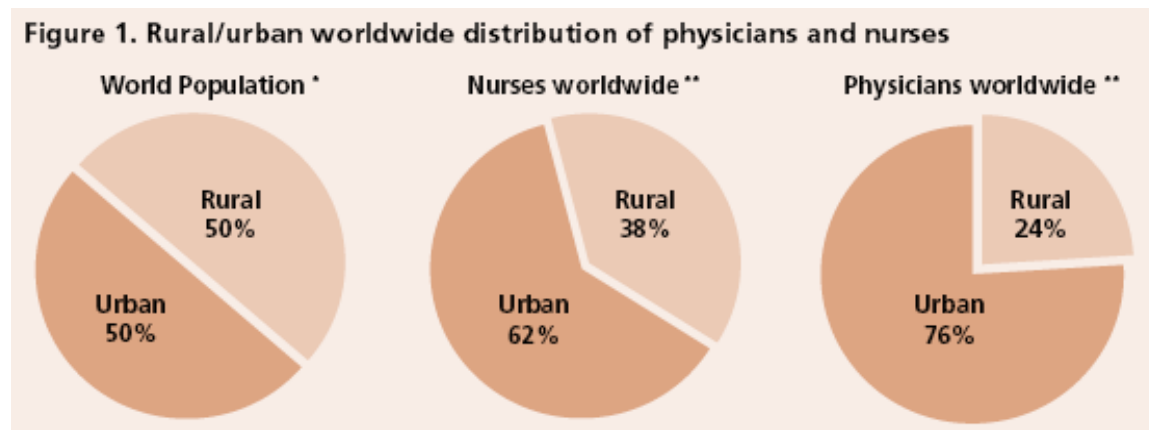


Figure 8 (WHO 2008)

In the United States, 20% of the population lives in rural areas, yet only 9% of physicians practice there. In a particularly stark example, 46% of South Africa's population lives in rural areas, yet only 12% of doctors and 19% of nurses work there. To make matters worse, in some sub-Saharan African countries, such as the Democratic Republic of the Congo, where there has been a great push for expanding healthcare, the cities have unemployed health workers, yet the rural areas remain without access to basic health services. WHO estimates that over one billion people have no access to basic healthcare services, and the majority of these individuals live in isolated, hard-to-reach, and often forgotten rural areas (WHO 2010).

I was unable to find hard statistics for the percentage of physicians or nurses operating in rural Brazil, where approximately 14% of the population lives (CIA_Factbook 2010). Fortunately, Brazil has very transparent data management and the Brazilian Institute of Geography and Statistics (IBGE)¹² records information about every municipality in Brazil, a total of 5564. Our municipality is Poconé, which is the name of both the nearest town and the municipality where the northern region of the Pantanal is contained. IBGE recorded both the population (31,778 in July 2010) and number of hospital beds (60) in the municipality of Poconé, meaning there is 1.89 beds per 1000 habitants. Brazil overall has 2.6 beds per 1000 habitants, and the largest city São Paulo has approximately 2.3 beds per 1000 habitants (IBGE 2011). The result of this basic analysis combined with our discussion with Señora Conceição, the mother on the Cuiabá River, demonstrates that Poconé has limited resources for healthcare. And with limited resources, innovative solutions are necessary to stretch services across a very sparsely populated region on an unpredictable road. A number of solutions have been tried in developing countries including: community health agents, incentives for rural health professionals, telecommunication applied to medicine, and corporate strategies to cut costs and improve services.

Community Health Agents

Brazil Rural Healthcare System

The Brazilian Unified Health System (SUS – Sistema Único de Saúde) was established in 1988, and has dramatically improved healthcare coverage in Brazil since its inception. Challenges in

¹² Brazilian Institute of Geography and Statistics (IBGE): <http://www.ibge.gov.br/>

providing health care to rural areas were addressed early in the process, in 1991, with the creation of the Program of Community Health Agents (PACS – Programa de Agente Comunitário de Saúde). In 1994, PACS became part of the Program of Family Health (PSF – Programa de Saúde da Família). PACS and PFS employ locals as community health agents (ACS – Agente Comunitário de Saúde) to collect health data, disseminate health information, and provide basic health services to underserved communities under the supervision of the doctors and nurses. Health services in rural areas, and also in urban peripheries, are provided at Basic Health Units (UBS – Unidade Básica de Saúde Básica de Saúde). UBS's have been very successful in employing locals as community health agents to have a direct link to the community, which gives doctors and nurses the ability to focus their efforts on practicing medicine rather than community organizing (Agente Comunitário de Saúde 1997). In Guarulhos, a periphery of São Paulo, there are 63 UBS's that provide low-income residents with life-saving drugs, have provided over 100,000 with dental care, and promote vaccination by having community health agents register families and remind them of vaccination campaigns (PAHO 2008). However, community health agents are employed by the municipality rather than the federal government, which can lead to job insecurity and lack of authority in the community. One community health agent from Poconé described that it is often a political game leading to very unstable employment in healthcare. On the upside, being employed by the municipality results in a higher level of accountability as the community health agent's livelihood depends on how well he is serving the community in his municipality (Poconé estuda efetivação dos agentes de saúde 2007).

China – the start of community health agents

The concept of community health agents developed as a Chinese policy measure in the 1930s, as part of the Rural Reconstruction Movement, which trained selected villagers in basic health services. Barefoot doctors typically graduated from the U.S.-equivalent of high school and then went on for six months of training at a community hospital. The health workers came to be called “barefoot doctors” because of their simultaneous work as rice farmers, who worked barefoot. It was not until 1965 that the concept became highly structured and integrated into the Chinese countryside. The program was named Rural Cooperative Medical Systems (RCMS)

and their primary goal was to have community participation in providing rural healthcare. During the Cultural Revolution, barefoot doctors received additional training from urban doctors that were sent to the countryside for six months to a year. By the late 1960s, 90% of China's rural villages had RCMS programs. Barefoot doctors maintained their community's trust by working simultaneously as rice farmers, and the system was self-regulating as the provincial government, rather than the federal government, paid the barefoot doctors for their labors (Barefoot Doctors 2010). The RCMS program was abolished in 1981, and, simultaneously, rural health services fell dramatically. By 2001, 80% of health services were concentrated in the cities, and over a 100 million people lacked access to basic health services (Public health-care in China 2011). The RCMS program resurfaced in 2005, renamed the New Rural Co-operative Medical Care System (NRCMCS). The resurgence addressed the decay of the rural healthcare system.

Despite the program being abolished for over two decades, barefoot doctors have shaped the Chinese healthcare system into the twenty-first century. China's current minister of health, Chen Zhu, worked five years as a barefoot doctor before entering medical school, and two-thirds of village's certified doctors began their training as barefoot doctors (Barefoot Doctors 2011). The NRCMCS is a hybrid of RCMS and modern insurance programs, as of 2007, the program covered approximately 80% of the rural population. NRCMCS coverage costs 50 yuan (US\$7) per person, with each person paying 10 yuan, and the remainder split by the federal government and provincial government. A person also pays for each visit with the system covering a certain percentage: 70-80% for the village clinic, 60% for the county clinic, and 30% for the city hospital (Public health-care in China 2011). The rising interest in rural healthcare in China and elsewhere is not only politics, but also grows from public health and economic concerns. As China constitutes 20% of the global population, and infectious diseases (tuberculosis, HIV/AIDS, Avian influenza, etc.) do not respect national borders, WHO and the Chinese government have recognized that one person's health is every person's health. Also, as low-income and marginalized communities typically have the poorest health, there is growing agreement with Dr. Paul Farmer, a Harvard-trained physician who operates health clinics in a

number of developing countries through his organization Partners in Health¹³, that a preferential option must exist for the poor in healthcare (Farmer 2005).

Incentives for Rural Health Professionals

As far back as 1978, WHO recognized the importance of community participation in providing health services for rural areas, specifically with the utilization of community health agents. However, the problem remained that community health agents are not licensed professionals and must be supervised by physicians or nurses. Attracting physicians and nurses to work in rural areas has been an enormous challenge, as the majority of them are trained in cities, and it is an unattractive prospect to make one's career in an isolated, amenity-lacking rural outpost. In addition to professional isolation, many health professionals find it a daunting endeavor, as they must be "extended generalists" who provide a wider range of services and carry a higher level of clinical responsibility (WHO 2010). In 2010, WHO released its first global recommendations to increase access to health services in rural and remote areas. The recommendations focus on training individuals from rural areas, and setting up incentives for them to return to their community to provide medical care (WHO 2010).

Medical School Exchange Programs

Medical schools in developed countries see international experience as a key component to each physician's education. At the University of Michigan Medical School (UMMS), the Global REACH (International Research, Education, and Collaboration in Health) was created in the late 1990s to "enhance opportunities for educational exchanges among students and faculty, facilitate international research collaborations, and provide opportunities for visiting scholars to benefit from expertise available at the University of Michigan" (About GR 2011). The exchange created by Global REACH is beneficial both to international universities and UMMS. Many prospective medical students desire to journey overseas to do international research (International Opportunities for Students 2011).

Fourth-year medical students have the opportunity to travel widely through Global REACH, with opportunities in Peru, China, Ghana, India, and Papua New Guinea among others. In Peru, fourth-year students work in the Upper Amazon Basin of Northeastern Peru with the

¹³ Partners in Health: <http://www.pih.org/>

U.S.-based non-profit Amazon Promise¹⁴. Since 1993, Amazon Promise has provided basic medical services to communities and has trained community health agents in remote and impoverished communities throughout the Amazon in Peru. Amazon Promise has established a self-sustaining medical clinic and training center in one of the most impoverished regions, Belèn. UMMS students work full-day clinics in Belèn, conduct canoe calls, and staff other clinics in remote jungle areas. Through Amazon Promise, UMMS students learn firsthand from community health agents the challenges of remote healthcare, community health agents receive additional training, remote villagers receive high quality medical care. (M4 International Clinical 2011).

These forementioned elements can be coupled with telecommunications infrastructure to address professional isolation and lessen the health professional's heavy burden of individual responsibility.

Telemedicine

Brazil's Telemedicine System

Telecommunications infrastructure has enormous potential to transform healthcare, education, and life itself in rural areas. The utilization of telecommunication for medical care is referred to as telemedicine, e-health, and telehealth. Telemedicine has been "considered the only feasible way to approach modern medicine services and systems in many underserved scenarios, notably those of developing countries." (Martinez 2005). The Brazilian government has been investing heavily in telecommunication infrastructure to improve healthcare, and in 2006 founded the Telemedicine University Network (RUTE – Rede Universitaria de Telemedicina) (Simões, et al. 2011). RUTE takes advantage of Brazil's growing network of federal universities, from 2001 to 2010 the number of federal universities increased from 45 to 59, and much of this increase is outside of state capitals and cities as students seek to earn a quality education near their rural hometowns (Pires 2011).

¹⁴ Amazon Promise - www.amazonpromise.org

Figure 9 shows the coverage of telemedicine in Brazil, with the green (or middle-shade of gray) showing the nine states originally covered by RUTE, which are mostly on the coast and in the far west state of Amazonia. RUTE started in nine Brazilian states that already had federal university hospitals with telecommunication infrastructure and collaborations with European institutions. Mato Grosso is highlighted in red (dark gray), and the remaining states are in light gray states. The telemedicine locations in the covered states

Telemedicine Coverage in Brazil

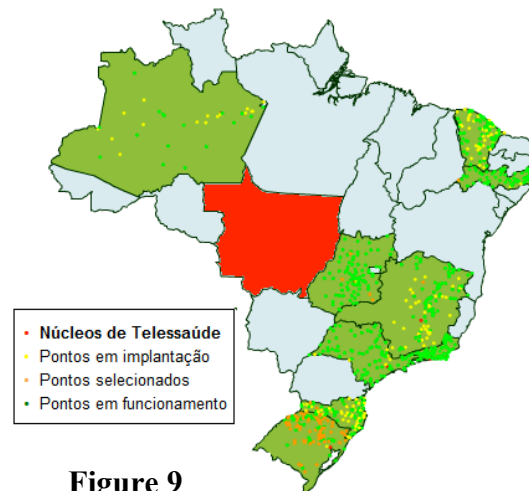


Figure 9

www.telesaudebrasil.org.br 03/22/2010

(green or middle-shade gray) are represented by red dots for telemedicine central stations, yellow dots for planned implementation, orange dots for possible implementation, and green dots for functioning outpost stations. For instance, to the southeast of Mato Grosso (the red or darkest gray state), in the state of Goiás, there is a banded cluster of green dots, representing remote telemedicine stations. As of 2010, RUTE was set up in twenty-three federal university hospitals in fourteen states, and has provided 170,000 diagnostics remotely by specialists and answers approximately 600 consults per day. Although Mato Grosso is not officially integrated into RUTE, a School of Public Health was established in the capital city, Cuiabá, in 2004, and there is an extensive state data management system for health indicators (Indicadores de Saude 2011). In Poconé, a three to four hour drive for the families in the Pantanal, there is already a small well-established hospital that could serve as a base for telemedicine for the outlying regions of the municipality. In summer 2011, we will explore this possibility, and as telecommunication infrastructure would also benefit students at the school, eco-tourists visiting the *pousada*, and researchers staying at the to-be-renovated field station, we believe that there is great momentum for bringing telemedicine to the Pantanal.

Telemedicine in Peru and Nicaragua

Telemedicine has been experimented with in a number of South American countries, and has seen success in Peru and Nicaragua. Like Brazil, Peru and Nicaragua have many remote and marginalized communities that receive little medical attention. The rural healthcare system in both countries is facilitated through rural health posts connected to an urban health center. Typically, these rural communities have worse health than their urban counterparts, and their ailments are fairly predictable: transmissible diseases, respiratory infections, and diarrheal diseases. Telemedicine's success, as realized by Dr. Martinez, who researched the two countries' rural health care systems, is limited primarily by lack of expertise, unreliable technology, and lack of feedback from urban health centers. (Martinez 2005)

Rural health posts are typically headed by infirmity technicians, who receive little training, and must provide care to several villages. The staff is typically young, and has little work experience and a high job rotation. Physicians avoid health posts at all costs because of professional isolation, and the remaining health professionals typically have little experience with computers and e-mail. (Martinez 2005)

Most of the rural areas in Peru and Nicaragua are off the grid, and telemedicine technology must be highly robust and sustainable. As photovoltaic systems frequently power these rural regions and supply a very limited amount of electricity, the telemedicine technology must demand low infrastructure, low maintenance, and low operating costs. Dr. Martinez has suggested low-speed internet as much of the health care assistance can be done through email and radio-based systems as good alternatives to high-speed internet access for all rural health posts. (Martinez 2005)

Even when the staff is well-trained and the technology reliable, an enormous challenge for health posts is lack of feedback received from their reference health center. Health posts are required to send data to the health centers, and rarely receive constructive feedback to aid them in improving health in their region. This problem is also seen in small municipalities of Southern Brazil, where rural health professionals commented in an interview:

It's often just a one-way flow of data, in which we don't get any feedback and knowledge about our work. This is very harmful because if we fail in some action,

how are we to know? Delays in getting feedback, when they occur, impair evaluations, decision-making and the team's action plan. (Vidor 2011)

Vidor found that the data input rate from the small municipalities was often much faster than the analysis and accompanying output data. There was growing concern that the data inputs were solely for health information systems, and the municipality's only reason for complying was to maintain funding for their health systems (Vidor 2011). In the view of Dr. Martinez and researcher Vidor, it is currently a one-way transaction, where rural health posts give and the urban health centers receive. For an effective telemedicine program, health centers need to provide useful and timely feedback to health posts.

One additional challenge is merely accessing the health posts in Peru, Nicaragua, and Brazil. The Alto Amazonas province in Peru is a prime example. It has just one road, which is not asphalted, and transportation to the rest of the province is by the means of river boats. There are 93 rural health posts in the province, and 85 of them must be reached by the river boats. Several health posts are attached to a reference health center. In Alto Amazonas it takes 11 hours on average to travel from a health post to the reference health center, and 8.6 hours for urgent patient transfer on average. The longest journey recorded from rural health post to reference health center was 72 hours. These travel times take on great importance in emergency situations. For cases of chronic illness, these distances can also be a challenge and innovative strategies need to be applied to provide effective care. (Martinez 2005)

Corporate Strategy Applied to Healthcare

What happens when a rural patient's illness is beyond the expertise of the local physician? Or when a certain illness requires repeat visits of advanced health care that cannot be provided in remote regions? Or a certain illness becomes overwhelmingly expensive to treat individual cases? Although some corporations have earned a bad name in developing countries, the strategies that they use to supply their products and services to some of the hardest to reach places are effective and should be applied to problems in providing rural healthcare. Two organizations stand out in applying corporate strategies successfully in rural regions: Coca-Cola and Aravind Eye Center. Coca Cola's strategies for consistently delivering their product to

remote regions stands out among corporations, with over 1.5 billion drinks served per day across the globe, and with operations in Africa since 1928 with over 15,000 Africans employed in their business today. The Aravind Eye Care System, founded in 1976, provides a remarkable and financially-sustainable service in rural India with over 2.5 million people treated for blindness in 2010.

Coca-Cola's Business Strategy in Remote Regions

Over the summer in Brazil, I was always amazed at the availability of soda-pop. Many times, it was easier to find a can of soda than a cold water. I became a soda drinker in Brazil; it was cold, refreshing, and potable. I was reminded of this while watching a TED talk by Melinda Gates, "What nonprofits can learn from Coca-Cola?". After visiting the homes of many families in developing countries, Gates remarked on a typical home in rural India, "[there were] dirt floors, no running water, no electricity, but one they do have: Coca-Cola" (Gates 2010). Gates brings up the great point that Coca-Cola provides consistent service to thousands of the world's most remote communities, and she goes further by breaking down their success into three things: real-time data immediately reapplied to their business operation, utilization of local entrepreneurs, and country-specific aspirational marketing. Gates then applies these three principles to demonstrate the power of corporate strategy in combating real-world problems with a stunning example of efforts to eradicate polio.

From 1988 to 2009, polio cases have decreased from about 350,000 to 1,600 cases: a ninety-nine percent reduction over twenty years. On August 18th, 2009 an 18 month boy, Shriram, in a northern state of India came into a clinic with paralysis. The doctors took a sample, and confirmed he had polio. As the polio could have been one of two strains, from the north or the south, it was immediately analyzed and on August 30th it was determined that the strain was from the north. With the success of real-time data, on September 4th a huge mop-up campaign ensued around Shriram's home, with over two million people vaccinated. India has invested heavily in vaccinators, with 2.5 million vaccinators for their country of approximately 1 billion people. The investment paid off, rather than a great outbreak of polio, there was only one more case in addition to Shriram's. Real-time data and the fleet of local entrepreneurs (the vaccinators) thwarted the disease. Aspirational marketing, the remaining component of Coca

Cola's strategy, is necessary for the eradication of polio. Coca-Cola studies the cultures of a country, and attunes its marketing to their values, for instance focusing on family life in Latin America and community respect in South Africa. Individuals want to be inspired rather than depressed by commercials, and non-profit organizations involved in polio eradication can use this to their advantage by demonstrating how far we've come for reducing polio, and how exciting it is that polio eradication is close enough to grasp (Gates 2010).

Coca Cola's corporate strategies of using real-time data effectively, engaging local entrepreneurs, and inspiring customers with aspirational marketing, have stood the test of time. These principles when applied to rural healthcare have the potential to create a sustainable, high-quality, and consistent health services for remote populations.

India's Aravind Eye Care System

The Aravind Eye Care System in India is one company that has already proved that compassion coupled with corporate strategies can powerfully transform rural healthcare for millions.

Aravind started as an 11-bed clinic to treat blindness in 1976, founded by

Dr.Venkataswamyenkataswamy who converted his entire life savings into a bank loan for the start-up capital costs. Dr.Venkataswamy's dream was to make eye care into a franchise as successful as McDonald's. Despite this strong sense of commercialization, on the philosophy of Aravind, he states,

When you grow in spiritual consciousness
We identify with all that is in the world
So there is no exploitation
It is ourselves we are helping
It is ourselves we are healing (Dr.Venkataswamy)

The company went several decades with revenue just meeting expenses, slowly expanding and listening to patients to improve their service. By 2009, Aravind had grown to be the largest and most productive eye care facility in the world, and was turning an annual profit of about \$9 million. A day of operations at Aravind speaks for itself: 6000 patients treated in their hospitals and 850 to 1000 surgeries performed; 5 to 6 outreach camps organized with 1500 examined and 300 transported to hospital for surgery with 500 to 600 telemedicine consultations; and classes held for 100 residents/fellows and 300 technicians who form the future staff of Aravind.

In a year, Aravind performs about 300,000 eye surgeries and provides eye care to 2.5 million rural villagers (Ravilla 2009).

Dr. Venkataswamy realized that providing eye care, like producing a hamburger, could be standardized to provide a more efficient service with higher-quality and lower cost. Like Coca-Cola's strategy for successful operations in remote locations, Aravind has used real-time data to fully penetrate the market. In the 1990s, Aravind was only reaching 7% of those in need in India; with this data the company knew they had to transform their operations. They utilized telecommunication and created paperless primary eye centers that provided tele-consultations with physicians at the larger base hospitals. The first year that this change went into effect, Aravind penetrated 40% of the market, over 50,000 people. The next year, it penetrated 75%, over 90,000 people.

Since its inception, Aravind also recognized that sustainability of the company relied on recruiting and training its staff from local villages. Aravind selects over 300 village high school girls each year to train as technicians. These technicians form the backbone of the organization and do skill-based routine tasks. And they do these tasks with remarkably high quality and at a very low cost. The efficiency of the technicians and the surgeons combined make Aravind a streamlined business, achieving the same quality of eye care as the UK for a hundredth of the cost (Ravilla 2009). Aravind has little need to advertise its operations: word-of-mouth spreads their reputation for high-quality and low-cost services at the speed of light. With the proper strategies in place, the current executive director of Aravind, Thulasiraj Ravilla, identifies "inspiration and a lot of hard work" as what continues to make the company a success (Ravilla 2009).

Conclusion

From these innovations in rural healthcare - community health agents, incentives and programs for rural health professionals, telemedicine, and application of corporate strategies – it is undoubtedly possible to bring quality healthcare to a sparsely-populated region of the Pantanal. Starting with the base of the Brazilian Unified Health System, we aim to establish a Basic Health Unit (UBS) at the Pantanal Center for Education and Research. We negotiated with the Secretary of Education to publicly register the school, and correspondingly we will approach

the Secretary of Health in summer 2011 to explore how UBS's are typically set up in the municipality of Poconé. We will also approach the Poconé Hospital to see if there is a shortage of health workers, which would potentially make it more difficult to justify sending technicians or professionals to the Pantanal.

We envision that our next step will be conducting a health census in the region to see what ailments are most prevalent, and to give the Secretary of Health an idea of the extent of the services that must be provided. We discovered in establishing the school that a physical building is an impetus for change in the region. We are renovating an abandoned field station near the school in summer 2011, and plan to convert part of it into a health clinic if the Secretary of Health agrees to our general plan. During renovations, we will continuously update the Secretary of Health and the Poconé Hospital to determine how the health clinic can be staffed.

Simultaneously, we will explore how to install a telecommunications system at the health clinic so we have the basic infrastructure to incorporate it into Brazil's telemedicine program. Before our trip in May 2011, we will contact professionals in Cuiabá at the School of Public Health and the Federal University of Mato Grosso (UFMT - *Universidade Federal de Mato Grosso*, UFMT) to determine the feasibility of connecting the health clinic to UFMT's hospital through telecommunication. As the hospital at UFMT is not yet officially connected into the overall Brazilian telemedicine program, we hope that our proposal will be another reason to extend the network into Mato Grosso.

With these professional connections established at UFMT, we will seek to work with University of Michigan Medical School (UMMS) to establish an international experience program with UFMT and PCER. Students both at UMMS and UFMT would benefit from an exchange program, and UMMS students would be able to learn firsthand how to provide rural healthcare.

As corporate strategies have shown to be very successful in sustainably addressing real-world problems, we will explore how Brazil addresses the treatment of rare diseases that are beyond the expertise of a rural physician. Public healthcare is established as right to all citizens in Brazil, and we will work to create greater access to these services from the Pantanal. In

creating this access, we will utilize the corporate strategies gleaned from Coca-Cola and Aravind to find the high-quality and low-cost solutions.

There are many uncertainties for establishing a successful and sustainable health clinic in the Pantanal, and as our architects learned from designing and building the school, ground conditions dictate the solutions. The architects came to the Pantanal with the basic knowledge of how to construct a building; accordingly, we are coming this summer with the knowledge of how to put in place a healthcare system. We hope that an understanding of the challenges and innovations in rural healthcare will enable us to work with the authorities and health professionals to deliver quality healthcare to the Pantanal.

CONCLUSION

Mid-way through the construction of the school in summer 2010 our U-M team was joined by a general contractor (*pedreiro* in Portuguese), João Batista. At this same time, we were conducting part of the census on the Transpantaneira and the Cuiabá River to register students for the Secretary of Education. João and I started talking about the census while we were laying bricks for the verandah's columns, and after the many busy weeks of construction logistics, he reminded us why we were in the Pantanal. I recounted in my blog:

Having our *pedreiro*, João, on-site has been a good shake. He speaks light-speed Portuguese and I need him to repeat whatever he says about five times, which doesn't matter a whole lot as we have many hours to kill. What's been a good shake though is all the time focusing on construction logistics took me away from what it is that we are really working on. As we were talking about the census in Porto Jofre, and an eight-year old named Lara that has never attended school, João repeated again and again, "*Cadê Lula?*" – Where is Lula, Where is the President? And in Brazil as it's been explained to us, whenever there is a problem, the President is to blame –similar enough to the US. I hadn't really focused on it, but where exactly is the government in rural regions? There's rarely a census out here, there isn't a school quite yet, and the government knows that families live here. Fortunately, that doesn't change why we are here – there needs to be a school in this specific region, and we have a sustainable solution to try – but it does demand us to consider the larger problem at hand. The lack of access to education in Porto Jofre is not unique in the Pantanal, and with good chance not unique in the many rural regions of Brazil, and for that matter not unique in the many rural regions of emerging and developing countries. Being here with amiable and generous people in a pristine wetland with gorgeous sunsets, it's difficult to put a price on providing education to a sparse, scattered population with transportation challenges. (Appendix B: Summer Blog 2010)

While this instance is specific to education, when I returned from Brazil in fall 2010, I kept having the same question, wondering how a high standard of living could be created in rural areas of developing countries when these areas are often "out of sight, out of mind" to the government. Dr. Paul Farmer, founder of Partners in Health, succinctly states, "[c]lean water and health care and school and food and tin roofs and cement floors, all of these things should

technologies. From understanding what needed to be established, the following questions arose: how could these basic services be provided; how could responsibilities be divided among the government and international organizations to sustain the service; and how could expanding basic services to a rural population benefit the region's environment?

How can services be provided and sustained?

For education and healthcare, it quickly became apparent that the easiest way to sustain consistent operation was with the government's support. When Ethan and I first started the project in summer 2009, we were warned by many about countless failed schools in remote regions started by well-intentioned individuals. We did not want the school in the Pantanal to be one of them, and started conversations with the Secretary of Education in Poconé several months before starting construction. From our conversations with the Secretary of Education, we understood that our responsibilities would be constructing the school and installing plumbing and electricity, and conducting the census of the region. The municipality's responsibility would include providing a teacher, outfitting the school with desks and chairs, and providing a bus, a boat, and diesel. In our minds, our team was in charge of the capital costs and importantly, the government in charge of the on-going operation costs. Much of the story remains to be written for establishing healthcare in the Pantanal, and in addition to approaching the Secretary of Health in Poconé, we will hope to join forces with the the federal university and federally-operated hospital in Poconé.

For implementing sustainable technology, specifically the bio-sand water filter and solar power system, there was little interaction with the government. However, the services that these technologies provide, clean water and reliable electricity, have the potential to be more reliable if addressed by the government. Currently, each family purifies their own water and generates their own electricity with either diesel generators or small solar power systems. As mentioned before, the government has considered expanding the electrical grid to the Pantanal. While we were there in summer 2010, the expansion of the grid was a very unlikely possibility. However, as electricity system would most likely be more efficient and possibly more reliable with an expanded grid, it was important to determine the government's potential actions. At ground-level, it was very important to work with Falcão 's employees in installing the

solar power system and the bio-sand water filter to ensure that the systems could be maintained and repaired if necessary.

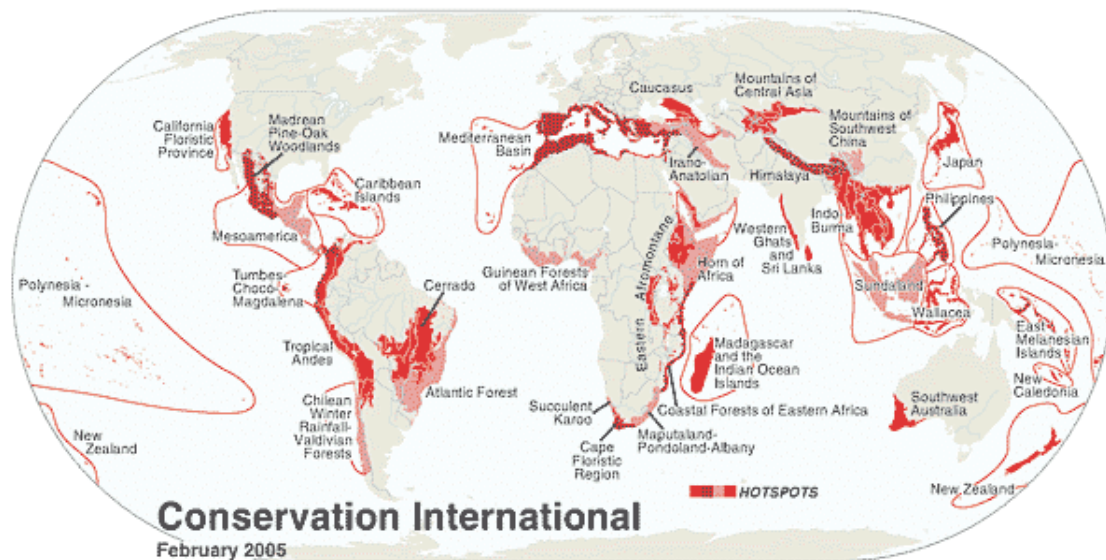
Basic services and the environment

At the center in rural Uganda operated by Conservation Through Public Health (CTPH), it was clear that the local population needed to move into the edges of the Bwindi Impenetrable National Park (BINP) to sustain themselves. Kalema-Zikusoka, the founder of CTPH, correctly identified that maintaining healthy gorillas in BINP could not be done without a healthy surrounding community. The balancing of human rights and protecting biodiversity is a tricky issue in many remote regions. The issue is well-addressed in *The Hungry Tide*, a novel written by Amitav Ghosh, where a biologist in search of an endangered river dolphin in the Sundarbans, a labyrinth of tiny islands on the easternmost coast of India, realizes the conflict of humanism and environmentalism when the government massacres a community in a remote island to protect the endangered tiger and dolphin populations.

This issue is readily applicable to the Pantanal, where large international organizations have enormous funds to protect jaguars and rare animals, and understand the demographics of the region, yet take no action to aid the local community. Dr. Paul Farmer has seen this problem in many remote regions, where either the government or a large organization, consciously ignores a region's poverty to pursue their own objectives. Farmer calls this decision "structural violence", and describes that "structural violence is visited upon all those who social status denies them access to the fruits of scientific and social progress" (Farmer 8). Access to education, healthcare, clean water and reliability electricity should be a top priority for any individual or organization operating in a rural region. Any effort that is made in that region without first addressing these challenges will be rejected by the local community and unsustainable in the long run. Conversely, in remote regions, a well-educated and healthy local community is the best advocate for sustaining a delicate environment.

Afterword

The intent of our work in Brazil is not only to provide one remote community with a school, but also to establish a model for collaboration on sustainability challenges. In starting this project, Ethan and I frequently thought about how similar ideas could be applied to conversation hotspots in developing countries. Our concept is called Centers for Education and Research (CER), with the Pantanal Center for Education and Research (PCER)¹⁵ as the pilot site. CER's goal is to work with rural communities to provide and improve access to education, healthcare, and sustainable technologies through partnering with universities and conservation institutions to create study abroad programs and research opportunities. Our aim is to provide rural communities with the resources to sustain their livelihoods and protect their environment. The map below shows conservation hotspots, with the Pantanal included; though recognizing the uniqueness of each of these regions, we see great commonalities in the challenges of providing a high quality of life and sustaining the environment. CER's ultimate goal is work with communities in many of these remote regions to create a network of centers to facilitate collaboration across all levels to solve each region's challenges.



¹⁵ Pantanal Center for Education and Research: <https://sites.google.com/site/pantanalcer/>

Appendix A: Team Members for Summer 2010

Brazilian partners:

Eduardo & Jucinete Falcão de Arruda
Tito Falcão de Arruda
Fabricio Dorelio
Fião & Fatima Falcão de Arruda
João Batista
Jorge Mariani

Masters Architecture students:

James Chesnut
Nisha Patel
Johnathan Puff

Multidisciplinary Design Program Engineering students:

Faculty advisor: Dr. Margaret Wooldridge
Cory VonAchen
Gregory Ewing

Global Intercultural Experience for Undergraduates:

Faculty leader: Melinda Matice (English Language Institute U-M Lecturer)
Melanie Adams
Robert Burack
Sanford Carton
Julie Chau
David Cortes-Olivares
Alexandria Cruz
Ronnae Duncombe
David Huston
Joseph Johnson
Elizabeth Ludwig
Nicole Prince
Kimberly Trombley
Jerecec White
Elizabeth Wilson

Appendix B: Team member's publications, blogs

Dichotomy by James Chesnut

Sustainable Development by Ethan Shirley

Summer 2010 Blog by Julie Bateman & Ethan Shirley

Architecture's Summer 2010 Blog by James Chesnut, Nisha Patel, and Johnathan Puff

GIEU's Summer 2010 Blog

Appendix C: Construction

Tables follow Appendix B

Appendix D: Estimated school operation costs

Tables follow Appendix C

Appendix E: Air travel emissions

Tables follow Appendix D

Pantanal Partnership

Building Education in the World

By James Chesnut

In developing sustainable architectural projects and communities, one's ability to understand the local economy of materials, labor, and construction techniques becomes a great asset. In many cases we are designers at a distance, and ambiguity with respect to the field condition is an obstacle. For the designer, obstacles become opportunities and the moment of exchange.

Over the course of a year a school was designed and built in a rural and remote region of the Pantanal in Brazil. The primary objectives of the project were to develop design strategies that are poised for unpredictable field conditions encountered when the site of construction is not fully accessible during the design process. In doing so the design document moves away from the rigidity of the construction document and is developed as a performance specification that sets up a tectonic framework while allowing for modifications to reflect the acquisition and exchange of local knowledge and fieldwork. This highlights the opportunities that arise when design from a distance meets specific field conditions and demands multiple strategies for representation and documentation (digital modeling, scaled drawings on site, photography, sketches, etc).

The project that follows provides, in built form, an alternative to the very heart of architectural practice and academic discourse in activist architecture. The notion that the construction details, materials, and methodology must be rigorously defined prior to engaging a design and/or construction process is one that has fundamentally enabled and constricted the agency of the architect at home and abroad. The reality is that the rigors of research cannot always avail

the architect the necessary information that can accommodate this traditional role and opportunity for innovation and education emerge from direct engagement in site-specific field conditions. The ability of the architect to adapt rather than prescribe, collaborate rather than command, and engage rather than intervene sets the tone for contemporary practice where agency is realized in spatial and social form. Through this process the architect as one who develops the document that is then abided by during construction is unavailable and the new role of architect accepts the unknown as such and engages the design and construction processes as a pursuit of emerging information in an unfamiliar site of production.

SITE / Survey

The project site is located at kilometer 114 of the Transpantaneira Highway in the Pantanal in the southwest region of Brazil. The Pantanal is the largest wetland in the world and is listed by UNESCO as one of the world's most ecologically sensitive and important sites. The Transpantaneira, a dirt road that stretches 150 kilometers, connects the small fishing village of Porto Jofre and the city of Poconé and is sparsely populated with cattle ranchers (pantaneiros), fisherman, and eco lodges. This distance from Porto Jofre to Poconé can take three to four hours depending on the condition of the road and the 107 wooden bridges that enable transport. Because the closest educational facility is in Poconé many of the locals must leave the area in pursuit of a proper education and those who lack the means for transport are left without. This trend has relocated a population who would otherwise stay and in doing so has removed those with the greatest knowledge of this highly sensitive region of the Pantanal.

The remote nature of the site is a logistical hurdle and had produced some anxiety as designers who seek a level of specificity when defining key elements such as local building materials and methods. Early in the design process it became clear that much of the information on site specifics and rural building

technologies in Brazil would be somewhat of an ambiguous field condition until the point when we arrived on site. Accepting that as a design opportunity the design team focused on what was known, mostly concerning climatic conditions of the region, its location in the southern hemisphere, and the programmatic demands. In doing so we formulated a performance specification that detailed how we envisioned the architecture to function and a general layout that would accommodate the anticipated program while maintaining flexibility in the same regard.

Sustainability

Pantanal Partnership and the design team are intent on the production of sustainable communities and defining sustainability in a way that goes beyond the environment. In a project such as this where design originates in the United States the challenge is to rethink the normative measures of architectural practice and discourse. Much of what we do as designers resides in the provisions of a service that is by its very nature top-down and reinforced by agencies such as Leadership in Energy and Environmental Design LEED that define sustainability and the criteria for its recognition. For architectural activism the ways in which sustainability is realized is a matter of how it is defined and abiding by the frameworks of architectural practice within the United States can be more restrictive than advancing. In this case sustainability is not only recognized through the metric that can determine how much solar power it takes to relieve a diesel generator but also as a strategy that demands a qualitative measure. This included a variety of ways to inject money into the local economies by utilizing local materials and labor and by implementing local building methodology as to provide a means for social sustainability, ownership, and the local reproduction of the introduced design tactics. The intent is not only to provide one village in Brazil with a school, but also to create a sustainable system that may be applied to similar communities worldwide. What would emerge from this process is not only an architectural object, but also an

exchange of knowledge and culture.

On the Ground

Although it is our position that design strategies can be both speculative and anticipatory the success of this project weighed heavily on a longer standing relationship of director Ethan Shirley and Eduardo Falcão De Arruda, owner of the Jaguar Ecological Reserve (<http://www.jaguarreserve.com/>). With this connection in place, the first days on the ground were used as a means of immersion, culturally and strategically. Our first step was information gathering by surveying local architecture using photography to document building details. We met with an architectural engineer, masons, and material suppliers and established these relationships immediately. Although Ethan is fluent in Portuguese, it was imperative that we all became more accustomed to the construction terminology and began putting it to use. We brushed up on the metric system of measurement to determine the building module and most importantly became quite aware of the laid back nature of Brazilian culture, daily naps, and the relaxed attitude towards getting scheduling and working. Time was also allowed for travel up and down the Transpantaneira and into the bush to get a feel for the ecology and cultures in the Pantanal. All of these engagements in the early days on the ground were not hindered by trying to accommodate a pre-figured design and were important not only to educate the crew but also to give a sense of where we were locally and in the world. This would set up long stints of rugged labor under the hot sun in a remote place without having access to the outside or Poconé for as long as 4 weeks at a time. Our work schedule was generally sun up to sun down with a 1-hour lunch 7 days per week. Physical stress and isolation would end up being one of the most challenging aspects of this design build project.

Early on, as a way to legitimize the project for the local government and the Secretary of Education the performance specification was taken to a local

engineer in Poconé. In collaboration with the design team and directors a “construction document” (one plan and one elevation) was produced and was used as a dimensioned template by which we would operate from and on, reworking it as we went. The design included a half monitor roof, which was one of the few design moves that was new to this area. Full monitors are used in barns and larger agricultural buildings for ventilation, as we realized in our survey of local architecture, and the half monitor was a way for our design to ventilate and provide additional indirect lighting.

Construction / Design

The construction process was executed in three basic parts that provided different educational experiences and exchange. Excavation and foundation work was essentially on us as a group to figure out and while digging is fairly self-explanatory the methods and materials of block work and concrete/mortar mixtures were sought out from local masons in Poconé and along the Transpantaneira. This is an important note in that the site conditions vary drastically and the wetlands of the Transpantaneira experience a water table shift of 2 to 4 meters seasonally, which demands a particular type of block for the foundation. Much of this information was gathered as we spoke with and worked along side the locals. All excavation and foundation work was done by hand and with the help of a group of GIEU (Global Intercultural Experience for Undergraduates) students led by Melinda Matice, an educator at the University of Michigan.

The concrete frame and walls were erected with the hands-on assistance and direction of local masons who were hired on to assist in the buildings construction about midway through construction. We expected the masons earlier in the process but we realized early that urgency in the Brazilian culture when it comes to scheduling is hit or miss. Nonetheless they were particularly helpful in the fabrication of the structural concrete frame, which we had very little previous experience with.

The half monitor and roof construction produced a flip in roles where its implementation and construction depended on our ability to communicate its functional advantages while working through a new typology with the locals. We discussed its fabrication with a local crew of framers who eventually failed to return to begin work. The task was then transferred to our crew and the masons who proclaimed proficiency in a multitude of trades including carpentry. This was not the case nor were we surprised at the unfolding of events that put the burden back where it belonged, on us.

Each phase was executed with a level of confidence and weary. Amidst the collective of students, professionals, and locals was a variety of knowledge that was leveraged appropriately. The agency of the designer within this collective was not determined by ones ability to mediate or adhere to the plan and the site specific building methods but rather by employing an understanding of material tendencies, e.g. the tensile nature of steel rebar and compressive nature of concrete, and universal techniques to creating square, plumb, and level components. The most basic tools were available to achieve this and included; measuring tapes to establish a 3,4,5 triangle, dry line, plumb bobs, and clear hose and water to level both long and short distances.

As we engaged each stage of construction and in order to supplement the basic plan and elevation drawings we spent the evenings sketching sections, axons, and elevations to help the non-architects and us better understand the makeup of the foundation, walls, the structural frame, and trusses. Digital modeling was also used throughout the construction process as a means to communicate the projected design, understand methods, and as a way to determine ballpark numbers for the quantity of materials that were needed for each phase of construction. Rendered detail drawings were specifically developed so future parties interested in Brazilian construction methods have a base to start from and are made available at our website (www.designbuildbrazil.com).

Reflections

Engagement in activist architecture abroad is often riddled with unknowns and assumptions that can be cause for anxiety amongst architects trained to rely on a course of action that is based on rigorously devising the construction document. A clear mission, in this case sustainability, defines the path and the ambition to be part of something bigger than oneself establishes the will. Architectural training provides the tools necessary to create opportunity from such anxiety and to realize built projects that cannot manifest from the traditional expectations of architectural practice. The willingness to enter into the unknown armed with design skills and open to a collaborative process that engages multidisciplinary and multicultural support aided in fulfilling this mission. In doing so alternative strategies for design processes and practice are developed and allow for greater agency to the architect who seeks to do similar design build work.

While the majority of construction was completed in October 2010, finishing touches and outfitting are near completion. With the architecture in place and deemed viable, funding from the Brazilian Secretary of Education has been determined and the school year will begin in May 2011 at the start of the dry season.

Pantanal Partnership is a University of Michigan multidisciplinary sponsored student organization with non-profit status that involves students in architecture, engineering, anthropology, international natural resources studies, and business. This project would not be possible without the ambitions and boldness of Ethan Shirley and Julie Bateman who are the founders of Pantanal Partnership and Directors of the Pantanal Center for Education and Research and the calm and collect of designer Johnathan Puff and educator Melinda Matice. More information on the project and how to get involved can be found at their website <http://sites.google.com/site/pantanalcer/home>.

Chegada no Brasil

posted May 24, 2010 8:01 PM by Ethan Shirley [updated May 24, 2010 8:51 PM]

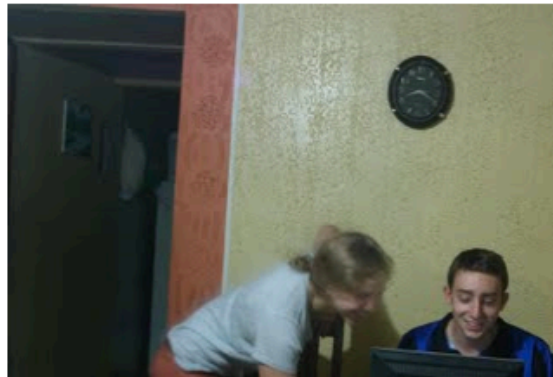
We arrived safely in Cuiabá, Brazil and have had a day of rest at Ethan's friend's house, and our first feast of arroz com feijão (rice with beans). We then figured out our finances at HSBC, and a test run with the ATM.

Our grand plans for the next week include meeting with our construction contractor and well-digger in Poconé (the gateway town to the Pantanal), determining transportation for construction materials and supplies, and arranging homestays.

After tomorrow, we will be lodging in the Pantanal where internet will be a bit patchy but we look forward to updating you once or twice a week from there.

Até a próxima vez!

Ethan & Julie



5/28/10

Gmail - Inbox - jbate07@gmail.com Bateman [updated Jun 8, 2010 9:45 AM]

Bom dia! Internet has been scare, so this is from a few days. We should be able to catch you up over the next few days, we leave the Pantanal tomorrow and will be in communication again. So here was last Friday, 5/28:

Today we left Fabricio's fazenda (ranch) outside of the city Pocone and will drive the two hous to Eduardo's lodge deep in the Pantanal near the village of Porto Jofre.

We have a had a busy few days between Cuiaba and Pocone. In Cuiaba, the truck that we rented from Eduardo is ready for the summer, and we will pick it up June 3rd when two of our three architects, James Chesnut and Nisha Patel, arrive at the airport.

The past two days in Pocone, we have talked with the former Secretary of Education (who retired two months ago) and has many teachers interested in teaching at PCER. Through her and the current Secretary of Education, will register PCER as a public school. The government pays the salaries of all registered schools, and also will subsidize transportation of the students.

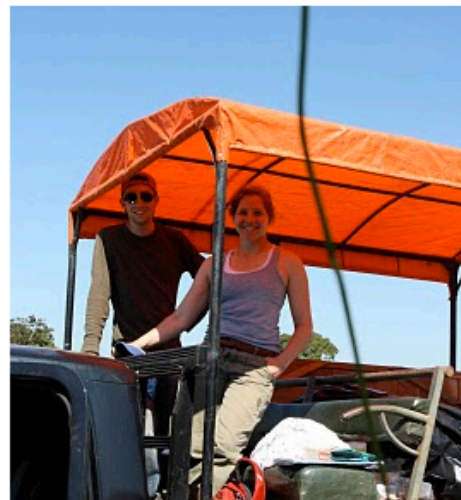
More pressingly, we have hired a local civil engineer / construction contractor, Carlos, who is helping us with designs, signing off on the project, and assuming legal responsibility if anything comes crashing down. By the time, Nisha and James arrive, he will also have a list of materials and price estimate for construction. Fabricio and his wife, Adillana, have taken us to the schools in and around Pocone to get a feel for foundation, ventilation, lighting, and space. Our next steps for construction include hiring a pedreiro (construction supervisor), who will oversee the project on a day-to-day basis. Construction looks set to begin in the second week of June.

This all has still left time for much food and games at the fazenda. Brazilians don't let their guests go hungry, and we have been lunching on arroz com feijao (rice and beans) with sausage, and squash with papaya and organge juice, and raisins and dates in farelo de madeira (breadcrumbs of a starch like potato), and finishing off with very, very sweet coffee (that everyone else sweetens still more with liquid sugar).

At the fazenda, we played with the water well and pump to understand a typical system in the region, fed a baby calf, and just returned from a ride with Lazao and Saeno, our horses.

We are going to the lodge now, and once there will survey the lot and arrange homestays for our GIEU students who arrive in mid-June.

Tomorrow will be 5/29 and onwards!



5/29 and 5/30

posted Jun 2, 2010 5:39 PM by Julie Bateman [updated Jun 8, 2010 10:07 AM]

We had a change of plans (seems to be the usual here), and are still in the Pantanal, but at a different lodge about an hour and a half away (Hotel/Fazenda Sta. Tereza) with internet connection! Here we are meeting Eduardo with some tourists for dinner, and then hitching a ride back to the his lodge. Tomorrow night (June 3rd), two of our architects will arrive at the lodge , and over the next week plans will be finalized with our construction contractor in Pocone.

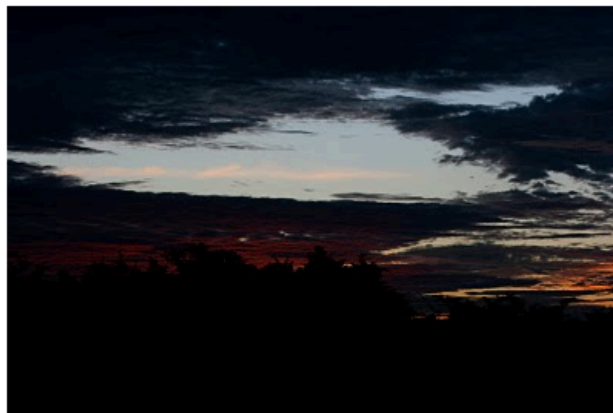
Alright, now 5/29 through 5/30.

Our two hour drive from Pocone to Jaguar Ecological Reserve was criss-crossed with toucans, macaws, parrots, parakeets, hummingbirds, jabiru storks in the sky, and crocodile-like caimans in the water - not to mention about a giant herd of cattle. No big cats yet, but we are on the look-out. We arrived in time for a dinner of rice with beans and Pantanal beef prepared by ground-manager and cook Milton with help from lodge assistant Maria.



The next day, our first activity was lot surveying. We walked across the road (Transpantanaleira) to Eduardo's home, next to which we will build PCER and now have our 40 m x 15 m lot. The rest of the day was spent bird and monkey scouting, helping make lunch while learning kitchen vocabulary, exploring an abandoned government field station about a half-hour walk away, and finally finding out that there's about twice as many stars as I thought there were – we see the Southern Cross, Gemini, and the Milky Way and many other constellations on clear nights.

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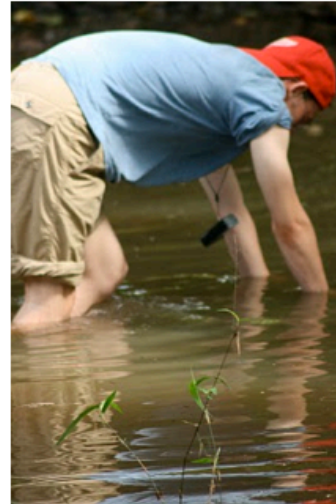
Milton, Maria, and local guides have all expressed interest in learning English and we will be working with Eduardo to figure out the best way to set-up adult night classes. Our other exciting piece of news is there is a school bus for sale in Pocone, which we may receive at a large discount or for free to transport kids from Porto Jofre to the Jaguar Ecological Reserve (a half hour commute each way).

Soon to come, 5/31 and 6/1.

5/31 - 6/01

posted Jun 7, 2010 6:06 PM by Ethan Shirley [updated Jun 8, 2010 10:01 AM by Julie Bateman]

Monday the 31st, early morning we traveled deeper into the Pantanal forests bordering the reserve to find monkeys – the four main ones are Capuchins, Howler monkeys, and the more rare Marmosets and Night monkeys. It's definitely a wetland – Ethan braved the swamps in sandals, I ended up with soaked boots, and we both ended up soaked up to the knees – BUT WE SAW MONKEYS! Curious ones too, they bared their teeth at Ethan and then tried unsuccessfully to throw sticks at us – we didn't retaliate.



The next day, we had our first day trip to Porto Jofre, and spent an afternoon fishing with locals and discussing the registration and opening of the school. We returned to the lodge for dinner with tourists from Holland, Milton made Brazilian version of chicken pot pie and for dessert we had something I didn't even know existed - cashew fruit – poached in syrup, muito muito bom. Afterwards, we went to the nearby Puma Lodge to discuss the school and adult night classes with staff members.



And today, we studied a current construction project in the Pantanal near the lodge, looked at different water pump systems, and then hitched a ride to Hotel/Fazenda Sta. Tereza, where we are now, updating and coordinating transportation for the arrival of our team. We optimistically planned on uploading photos, but the internet wasn't up for it. Look forward to an album hopefully in the middle of June, when we are in Cuiaba again with hearty internet.

Two of our three architects as I mentioned before, arrive tomorrow night at the lodge. And over the next week we will be plotting out our lot, finalizing designs with our construction contractor in Pocone, and preparing to lay the foundation.

Until our next update (or series of updates), tudo bom!

Design/Build Brazil Blog!

posted Jun 8, 2010 9:27 AM by Julie Bateman [updated Jun 8, 2010 10:05 AM]

Check out our architects' blog at <http://designbuildbrazil.blogspot.com/>! They'll be updating on aspects of their design and the progress of construction.



Here's a pic of James and Nisha, two of our three architects (the third, John, arrives in about two weeks) surveying our lot and laying down the boundaries for foundation.

6/02 - 6/03

posted Jun 8, 2010 10:08 AM by Julie Bateman [updated Jun 8, 2010 10:38 AM]

Wonderful news, today is 6/08, we had an unexpected layover in Pocone (the closest city at three-hour drive away), and were shocked to discover this morning that we have American-speed WIFI at our pousada! So pictures are now uploaded below, and maybe it'll hold until we reach updates to the current day.

So, 6/02 we hitched a ride with tourists to Hotel/Fazenda Sta. Tereza (about an hour and a half from our lodge) where we were able to touch base during our last blog batch. Eduardo and a Thai crew that makes World Heritage documentaries met us there for dinner, and then we took a night tour back to the lodge. The group is led by Pongpol Adireksarn, and you can see their work at <http://www.adirexphotogallery.com/>. We then took a late night tour back to the lodge.

On 6/03, we were on the lookout for big cats and monkeys for Eduardo and Mr. Adireksarn, and in the late evening Tito, Eduardo's cousin, arrived with James Chesnut and Nisha Patel. Tomorrow, our architects have their first test - swamp bridge building.



Look closely, and you'll see the current underwater bridge. Tourists aren't fond of wet boots, or possible lurking yellow anacondas (which according to Ethan are harmless and your friends).

6/04 - 6/05

posted Jun 8, 2010 7:38 AM by Julie Bateman

On the 4th, we had a peaceful morning of breakfast and birding, and then set out for bridge building. The bridge takes you from the cattle yard of Eduardo's lodge to the forest, where monkeys live. The center is about knee-deep, making it inaccessible to tourists. Ethan's bridge was swamped, but fortunately most of the wood was still good, and after a wheelbarrow of bricks and trial and error,



And even better, it's crossable!



And we were rewarded with great monkey spotting - the elusive male black Howler monkey.

On the 5th - James, Nisha and Eduardo discussed building logistics - specifically a few obstacles on the lot including palm trees, curious cattle, and Eduardo's house. Our current design will surround Eduardo's house, with the school facing the road and the field station accommodations wrapping around the back of the house. For more on the building design, check out their blog at <http://designbuildbrazil.blogspot.com/>.

6/06 - 6/08

posted Jun 8, 2010 8:07 AM by Julie Bateman [updated Jun 8, 2010 8:35 AM]

On the 6th, we joined a French tourist who works in Chilean observatory for a trip down to Porto Jofre, either a forty minute or hour and a half drive depending on who is driving. Porto Jofre is on the Cuiaba River, and two previous groups had spotted a distinctive jaguar couple. Nisha, Ethan, and our friend set out for the river cruise, and in the meantime James and I wandered Porto Jofre, speaking rough Portuguese with lots of facial expression and hand movement, and then had about two hours of time to spare with puppies and fishing. Unfortunately, no jaguars were sunning, which for today was alright because Ethan and his friend had spotted three on an early morning walk that I had neglected to join. Lesson learned, do not skip early morning walk.



The 7th (yesterday as of now), we had a delicious lunch at Fabricio's in-laws ranch of Pantanal beef, manioc (a starchier potato), delicious delicious squash, and rice and beans. His mother-in-law then ordered siestas for all. Well-fed and well-rested, we met with Carlos and hashed-out the design for two hours. There seems to be a code that contractors do not give money estimates unless you ask the question three different ways.

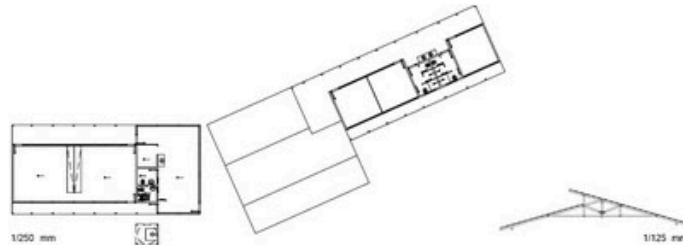


Today, 6/08, Eduardo is coming with the truck that will be our's for the summer, and at 4:00 pm we will finalize plans with Carlos! Then back to the Pantanal!

Rest of 6/08, then 6/09

posted Jun 9, 2010 9:24 AM by Ethan Shirley [updated Jun 9, 2010 10:18 AM by Julie Bateman]

This afternoon, we finalized our design with the construction contractor. Below is the basic sketch, moving from left to right there is the classroom, research room, bathrooms, kitchen, screened breeze-way then in the middle there is Mariana's (Eduardo's mother) home, and following there is this the teacher's and researchers' lodging quarters. We wish we could upload the architects' 3-D model (it's a lot lot cooler than this diagram) but that would require at least two days worth of internet. Tonight, we will have a sunset drive back to Eduardo's lodge.



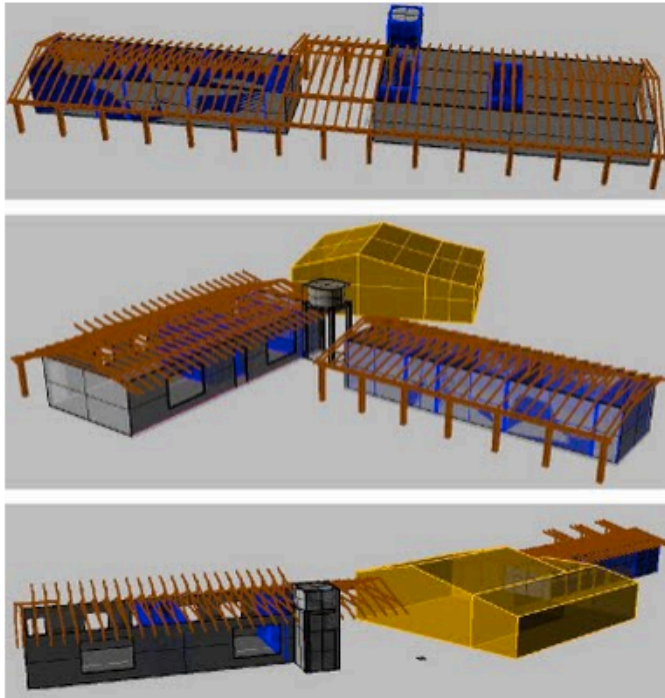
Quick side-story, Ethan told me on one of our first days in the Pantanal that *o pôr do sol* is the word for sunset, literally the "putting of the sun". About a week and a half later I was explaining this to the architects who had just arrived, and the three of us could not for the lives of us figure out why Brazilians think the sunset looks like pudding.

Now it's 6/09 and turns out we have returned to Pocone on a paid journey to pick up tourists, and are using this opportunity to make arrangements for laying the foundation – specifically picking up the materials list from the contractor, and then hiring a *pedreiro* (overseer) and arranging delivery of sand, gravel, and cement (ratio respectively 6-3-1 if you're curious). This afternoon we will return to the Pantanal, and tomorrow morning, we break ground! James has told us we need to know only two words for the first phase of laying foundation: Shovel, Dig.

Good news, screenshots of 3-D model!

posted Jun 9, 2010 10:25 AM by Julie Bateman [updated Jun 9, 2010 10:33 AM]

Here's a bit of an idea of what we've put our architects through. From top to bottom, is the evolution of the design:



The first design was before arrival and discovery that we were building alongside a home, the second design was challenged by grazing cattle & palm trees, and voila the third design is view from the back of what PCER should look like in August!

6/09 continued

posted Jun 14, 2010 5:23 AM by Julie Bateman

We took advantage of Wi-Fi at our favorite Churrascaria (Brazilian steakhouse) in Pocone to check in with family and friends, and keep up with business. Eduardo met us after lunch with visitors from Britain, who would be driving to the Pantanal with us with Ethan as their guide, and James as their driver. Our truck, a 1998 Mitsubishi, was handed over to us two days ago after repairs in Cuiaba.

Driving in, we had a relaxing chorus of the Pantanal's birds, and just at the beginning of pôr do sol (sunset), our truck added its own verse as the engine sputtered out its last breath. Fortunately, our visitors, Paul and Sue, had been stranded on a ship for half a day on a previous vacation, so this was all part of the adventure. We were only a few kilometers from Mato Grosso Hotel, and once we secured cell phone reception, they kindly sent a truck to retrieve us and prepared dinner while we waited for Tito, Pantaneiro guide and a friend of Ethan's, to make the hour-and-a-half drive from the Lodge.

James and Ethan checked out the car, and good news is it looks like an easy fix - a new hose for the oil - it could be ready tomorrow - or in Brazil tomorrow's tomorrow.

6/10 disappeared, now 6/11

posted Jun 14, 2010 5:25 AM by Julie Bateman [updated Jun 14, 2010 5:49 AM]

The dictionary failed us today. The word listed for shovel – *escavador* - actually means a R\$200,000 piece of excavating equipment, which Ethan casually asked Tito to borrow from his father Fione, who has a cattle ranch a twenty-minute walk from the Lodge. After a short game of charades, Tito understood, and Fião has kindly agreed to lend us site-clearing tools. A tractor was lent to us from Eduardo's other friend, but we seem to be S.O.L. with motored vehicles because this one proceeded to die when it arrived on-site, hence the search for hoes, shovels, rakes, and a wheelbarrow.



This photo is post-6/13, we had to show off our sweet clean technology.

In kitchen news, Miltom made a delicious dessert, *arroz doce*, the Brazilian version of rice pudding – this one is with white rice, condensed milk, regular milk, cinnamon, and coconut flakes – served chilled. *Gostoso*. Tasty.

6/12 and 6/13: SITE PREPARATION

posted Jun 14, 2010 5:28 AM by Julie Bateman [updated Jun 14, 2010 5:48 AM]

Saturday (6/12) and Sunday (6/13) were site-clearing days. We hoed, then we raked. Then we whacked a bush or two. Then Miltom and Tito joined us, and we all hoed, and we all raked. Then we woke up and did it again. First column is the front lot where the classroom and common area will be, and second column is the back lot where we will have teacher and researcher lodging.



Disclaimer: No animals were harmed in this operation; two ant colonies will need to relocate. Even better, our site clearing had a nearly non-existent carbon footprint, as it was fueled with sweat – our boots and clothes prove it from a few feet's radius.

On Saturday afternoon, we went to Fião's fazenda for the World Cup – USA vs. England with Tito, Paul, and Sue. There we met the rest of Tito's family, and had beers and delicious fried banana chips. Oh, and in exciting news, on a night drive with Paul and Sue, I saw the rump of a jaguar just before sunset, with enough light to see the spots. Gorgeous animal. Sunday afternoon, everyone was fairly exhausted and so we succumbed to customary Brazilian siesta.

6/15

posted Jun 19, 2010 3:36 AM by Julie Bateman [updated Jun 19, 2010 3:38 AM]

The site is looking like the real deal. Today, James and Nisha strung out the site in neon green and hot pink, and most importantly decided with blue chalking where we would be digging the footings – in our minds big, big holes. Meanwhile, Ethan and I scavenged the surrounding area to keep up with the wooden stake depletion.

Today is World Cup Brazil vs. N. Korea, and needless to say a holiday – even the schools are closed. We cut out after a half day of work, and went to Fiao's fazenda to watch the soccer game. The game was pretty easy to follow in Portuguese, GOL = GOAL, and after two GOOOOOOL's, N. Korea got one in, we had a house of very happy Brazilians.

We came back at sunset to check out our site and were shocked to find most of the architects' carefully distanced stakes out of the ground, and as every Brazilian was occupied for the afternoon, only cows were left to blame. Tomorrow, we are on defense – fence-building!

6/16

posted Jun 19, 2010 3:38 AM by Julie Bateman [updated Jun 19, 2010 3:53 AM]

Everyone was an animal today. James and Nisha re-measured, re-staked stakes, and re-strung the site. Meanwhile, Tito gave Ethan and me a lesson in fence-building. Good news is that all materials were in close vicinity, and best of all free. We are both now fairly good at not getting stabbed by barbed wire, and we think the fence looks pretty fantastic, the real test will be tonight when the cows return to the pen (which is conveniently right next to our site).



Another task in the miscellaneous category filled the afternoon, re-routing the electric lines, which intercepts our south wall

I. We are first reasoned that it'd just be a matter of moving the one pole, then lack of slack demanded shifting of the line and moving of a second pole. And then the real fun came when we went to re-lay the line, and after many wishful heave's and ho's, it became clear that a third pole had to be shifted. James and Ethan are now expert pole diggers/layers and hireable in September.

A bit of hole-digging happened between all of this, and then Ethan and I remembered that we were in charge of part of dinner and all of dessert for the lodge – spaghetti marinara and garlic bread accompanied of course by rice and beans, followed with crème-filled carrot cake. Once the GIEU team arrives, Miltom and I will be do Brazilian-American fusion lunches for our hungry workers.

At this time of the night, we had exactly enough energy to eat dinner and get ourselves into bed. Ethan leaves at 5:00 am for Cuiaba, and the day after that (6/18) our faculty leader, Mindy Matice, and our fourteen GIEU students arrive in Brazil!



6/17

posted Jun 19, 2010 3:41 AM by Julie Bateman [updated Jun 26, 2010 5:59 AM]

Today we dug holes. A bittersweet condition is that we have firm ground – good for architecture, bad for the diggers. Tito and Joam joined us, what took me ten swings was accomplished in about one by them, needless to say they were wonderful to have on site. We pretty much just pick-axed and shoveled until lunch.



This afternoon, I went to visit Fatchima (wife of Fiao), who will be hosting five GIEU students, to make a grocery list, set breakfast and dinner times, and discuss other things that got lost in translation – which is alright because people are incredibly good hosts in the Pantanal.

6/18 and 6/19

posted Jun 25, 2010 8:09 AM by Julie Bateman [updated Jun 26, 2010 5:58 AM]

We have Mindy Matice and her fourteen GIEU students! All arrived relatively on-time (give or take a day) and are now safe and happy in Cuiaba. This evening (no time scheduled for jet-lag) we are on our way to Pocone for *Disposição*, a rodeo and concert festival.

Ethan, Tito, and I were up much earlier than we would have liked the following morning for construction bargain shopping in Pocone. After visiting four stores, Tito has saved us nearly R\$2000 (about \$1120). Surprisingly, the real price difference came down to the transportation not the materials cost – trucking over a dirt road with 83 wood bridges for a little over 110 km is not a good bargaining chip. Construmax is now our new best friend in Brazil, and the first of three loads will arrive at our site Tuesday 6/22!

We returned for a delicious Churrascaria lunch, a first for many of the GIEU crew – hot, grilled meat delivered to your table and speared off the slab by your fork and the waiters knife, and the best of all, spit-roasted pineapple caramelized in its own sugar.

6/20 and 6/21

posted Jun 25, 2010 8:13 AM by Julie Bateman [updated Jun 26, 2010 5:58 AM]

Today is another national holiday – Brazil vs. Ivory Coast. The twenty-some of us watched the game at Fião's fazenda, and it was too easy of a victory for Brazil. Earlier that day, GIEU students continued their eco-tour down the Transpantaneira to Porto Jofre, the scattered fishing village that the school will primarily serve. We continued our trench/hole digging, and tomorrow GIEU joins us on site!

The more the merrier definitely applies to trench and hole digging. GIEU crew were powerhouses with our shovels, post-hole diggers, and pick-axes. We also assembled the fence for the back lot (teacher/researchers' lodging rooms), cows are officially banned from the work site.



Meanwhile, Ethan, Cory and Tito traveled to Cuiaba to pick up our last architect, Johnathon Puff (who just graduated, congratulations!). While there, Cory picked out his water pump to begin tests back in the Pantanal. They should be testing their biosand filter late next week. More on their project here: www.pcerwatersystems.wordpress.com

John Puff & Co. arrived late in the evening at the lodge, which translated to normal architecture hours so James and Nisha filled him in on the multitude of changes – most notably a house splitting the design in two.

6/22 and 6/23

posted Jun 25, 2010 8:15 AM by Julie Bateman [updated Jun 25, 2010 8:53 AM]

Our first load of construction materials arrived! We have cement sacks, lime sacks, sand, gravel, and lots and lots of bricks. Our architects are overjoyed – until now there only material had been dirt.



Unfortunately, we still have to perfect our trenches/holes before brick is laid for foundation. In the afternoon, ConstruMax made an early delivery with the second of our three loads.

And now 6/23, We are yet still anxiously waiting to mix concrete and lay bricks but trenches/holes are not yet to the architects' demanding standards.

Meanwhile, the GIEU students and their home-stay families have been feasting and drinking in Brazilian style – sangrias twice and thrice around.

6/24

posted Jun 25, 2010 8:16 AM by Julie Bateman [updated Jun 26, 2010 6:01 AM by Ethan Shirley]

At last, our first concrete batch!

Ingredients:

3 wheel barrows sand
2 wheel barrows gravel
1 sack concrete
Few buckets of water

Equipment:

3-4 shovels
3-4 shovel-holders
Ground

Pour all dry ingredients on ground into mound. Position shovels and shovel-holders around the mound, directing them in circular motion to combine the dry. Make a well so the mound looks like a volcano. Add water a half bucket at a time. Continue until the architects say so.



We now all know why people invest in concrete mixers for construction – we almost didn't need to add water after our shovel-holders started sweating. And that's just one pile, from my best estimates we have about a million to go. Renting a concrete mixer is a reasonable proposition – only about R\$200 / 4 weeks, but then it also takes about R\$90 / week in diesel – and our project has been almost entirely manpowered up to this point.

And what's more, we started our foundation. After a demonstration by the architects, the trenches were loaded with novice brick-layers, trowels, plumb-bobs, and something called a story board – a fool proof wood stake that measuring from the string showed us where the concrete bed should be, the first brick and onwards through the seventh brick.



And ConstruMax arrived with the final load for this first phase. So now our site is fully stocked, and we have a crew of semi-expert brick-layers.

GIEU crew has been working in pairs with Milton for lunch, and today Robert and Liz swayed the kitchen to make mac & cheese – mmmm.

6/25 and 6/26

posted Jun 28, 2010 4:37 PM by Julie Bateman [updated Jul 4, 2010 8:44 AM]

Ethan and I left for Cuiaba at sunrise, the closest "major" city about three hours away, to visit the Brazilian version of Sam's Club - Atacadon. It's as intimidating here as it is there. Restocking the pantry for twenty-two was an experience, we came away with among other things many kilograms of rice and beans, a tub of doce de leite, some delicious squash, and most importantly jam and nutella.

We made it to Pocone just as the sun was setting, and tomorrow will be visiting the construction store to pick up more tools and make another materials order, and afterward visiting another shop to pick up our concrete mixer (Portuguese wins best word for concrete mixer - *bitoneira*).

And we have a piece of very exciting news! So we were in this mega dilemma trying to find good quality, cheap wood for our roof, and talking over our budget with Eduardo and suddenly our price for the wood for the roof went from about R\$20,000 for to just R\$7,040. Don't worry. It's legal.

There's an environmental police, SEMA, that patrols the Pantanal and also grants rights for trees that have recently died and have good lumber. So back about a week ago, Eduardo called SEMA and told them that he had seen three trees and that we needed good, hard lumber for the school for the kids of Porto Jofre. There's been a lot of history for building a school for Porto Jofre, serious talk of it for about five years, and SEMA agreed to stop by the next day to see the trees and talk legalities.

Next day, SEMA arrived, Eduardo took them to see the trees, and poof two hours later we had R\$12,960 more in our budget! It still seems like magic to us.

So now to 6/26, Eduardo arranged for us to pick up the lumberjacks that live in Pocone. The trees are at least ten meters high and two feet in diameter, and our two lumberjacks are armed with a chainsaw, two saws, and a pick axe.

Our GIEU crew has been very hard at work, to the right is Davicho, Robert, and Gercione, collectively our manual cement mixer. And to the left, are many hard at work digging in the back lot, a never-ending job.



6/27 and 6/28

posted Jun 28, 2010 5:14 PM by Julie Bateman [updated Jul 4, 2010 8:43 AM]

So we were a bit curious about how these trees were going to come down, but we had no need to wonder because morning of the 27th, we walked into the forest with Eduardo's driver, Gercione, and there was our giant tree already felled to the ground. Quite a sight, pictures to come.



Five Americans traveling in a van through South American showed up the night before, and on Sunday they helped us trench and dig. Their crew, [Verdant Collective](#), has a diesel/vegetable oil-powered van and is documenting the open road and conservation. The night before too, Miltom decided that with 27 Americans around and a couple of Brazilians, it was time for *feira*. We taught the Brazilians how to dance in exchange for *cachaca*.

And onwards to today 6/28.

A master builder, *pedreiro*, named Alain, who is working on a nearby lodge kindly stopped by our site to check that the foundation was sound, and also to give us tips for the next stage - walls. We think after the 13th, Alain will be hired to the team to help James in roof construction for the school while we move on to laying brick for the field station. So we had dug another new septic hole because the current one is where we want one of our researcher's rooms to be, and it appears that we under estimated. So today was new septic hole digging, actually not septic hole, on site it is strictly called the "honey pit". So I started hacking away, and suddenly felt something I hadn't felt in three days - a shower. Fortunately, we are now experts at fixing ruptured water pipes - rubber from a used tire is far superior to duct tape and string. Very excitingly, we also poured cement in the original honey pit to eliminate that delightful odor seeping through. We also laid another layer of bricks for the foundation, and very exciting set up a temporary hand-pump for the well behind the site.



Verdant Collective was also kind enough to take some video footage of construction and a bit about the project, they are nearing the close of their five-month trip, and are on to Amazon next. This afternoon, another holiday, was Brazil vs. Chile, 3-0 so still very happy Brazilians in the Pantanal, let's hope they keep winning until they play the U.S. Wow, just realized, U.S. vs. Brazil will be a very dangerous game for us.

6/29 to 7/04

posted Jul 4, 2010 8:02 AM by Julie Bateman [updated Jul 4, 2010 9:12 AM]

So the past week has really flown by. On-site there's been more brick-laying - the seventh and final layer of bricks for the foundation of the school is now complete - and we have been constructing column supports with re-bar and wire. Our concrete mixer (like every mechanical item we touch) is currently broken so pouring the footings is temporarily stalled - our friend and Eduardo's driver Gercione is on top of getting it fixed. Which brings us to an important part of our project that I have ignored so far in the blog - local support, which has evolved entirely different than we expected. Local support has been so crucial that we have taken it for granted. Over the next two blogs or so, I'll do my best to describe some of what our Brazilian friends have helped us with.

Tito (Eduardo's nephew) and his parents Fatchima and Fiao:

Ethan's long-time friend and Portuguese-teacher has kept our spirits high and our costs low. As our truck that we had "repaired" remains in the shop in Cuiaba (a long uninteresting story), Tito has been clutch in transporting us in the Pantanal, and between Eduardo's lodge and Pocone (two hours with Tito driving), along with in and around Pocone for our many errands. We come to Pocone to arrange construction materials deliveries, pick up more tools, visit our civil engineer, take out cash, and re-stock the pantry among other things. For overnight trips to Pocone, we stay at Tito's for the night and for world cup days we have been hosted by many family and friends, and fed like kings.

Crucial for our budget, Tito took care of bargaining for us in Pocone - visiting construction houses and finding the best estimate. For our first building, the school, this saved us well over US\$1,000. And by the time we order all the materials and transport them to site, this bargaining will be what has made construction costs of both the school and field station within budget.

And onwards to his gracious parents, Fatchima and Fiao who own a fazenda near Eduardo's lodge in the Pantanal. Fatchima and Fiao are hosting five of our GIEU students for their twenty days in the Pantanal, and have also hosted the whole group for all of the Brazil football games, and two accompanying bonfires (one celebratory, the other lamenting).

And most important in my mind, Tito & Co. solved one of our biggest challenges - supplying clean water daily for our thirsty crew of 22. Our options previous to their help was slow charcoal-filtering that couldn't keep up with the demand, boiling water (a slow tedious task that also ran the kitchen propane tank low), and trying to arrange water pick-up in Pocone (two hours away) with tourist trips. This headache disappeared overnight, and we now receive fresh, clean, and often cold water daily from Fiao and Fatchima.



Tito is in the right corner with the water tube whip to keep students in line.

He is our master of miscellaneous tasks including fence building, stake collecting and sharpening (he insists that they are for vampires still), repairing water pipes that we rupture, fixing the generator/cars/anything else we can break.

Most recently, he has been helping us in conducting the census for the region between Eduardo's lodge and Porto Jofre (an hour drive), and on the Cuiaba River. The greatest challenge of this school is that families are scattered, and transportation for most of the students will involve a daily boat and bus journey. More to come later on how PCER, Eduardo's Jaguar Ecological Reserve, and Pocone's Secretary of Education will share the responsibilities of running the school. Tito took Ethan and a crew of GIEU students down river to collect census data including names, ages, level of education, parents' literacy. Along with the census, we are starting the hiring process for a boat driver, bus driver, and cook from Porto Jofre.



Tito is the one not-steering the boat in the photo above.

Currently, Tito is back in Cuiaba (three and a half hours from Eduardo's lodge) awaiting the arrival of his first child, who is due any day now. We are anxiously awaiting news, and will be sure to keep you updated.

7/05

posted Jul 5, 2010 6:40 AM by Julie Bateman [updated Jul 5, 2010 7:28 AM]

We have been in Pocone with our GIEU crew for the weekend for everyone to catch up with friends/family, do some shopping, and enjoy the parties and barbecues of the gateway city to the Pantanal. Now that its at last Monday, business can start up again. This morning, GIEU is visiting a primary school in Pocone to get a feel for the public education system in rural Brazil. After lunch, Ethan and I are visiting the Secretary of Education, Neca, with Eduardo and his wife Jucinete to outline the operation of the school, and most pressingly to discuss bus and boat transportation. Which leads well into the countless ways that Eduardo and Jucinete have made this project possible.

Eduardo & Jucinete Falcão de Arruda



Ethan first met Eduardo about seven years ago when his mother took him on a trip to the [Jaguar Ecological Reserve](#) (JER). For many summers following, Ethan volunteered at the lodge carving wood, guiding tours, making faulty bridges, and discussing with all the success of eco-tourism in the region why it was not possible to fund a school for the children in Porto Jofre and along the Transpantaneira (the road between the Jaguar Ecological Reserve and Porto Jofre). Flash forward to this past fall, after forming a dedicated team of students and optimistically planning on support for the university, Eduardo agreed to set up logistics and host us for the summer for the construction of PCER.

Now, the on-ground support - Eduardo in my mind is the *mandachuva* (commander of the rain and all else in Pocone and his region of the Pantanal). He is the provider of transportation, and of food and lodging for Ethan and me, our architects, and our engineers (we eat whatever Milton makes for the tourists, needless it will be a tough transition back to college life in the fall). The land we are building on is owned by Eduardo's mother, Mariana (who now lives for the most part in Cuiaba). The electricity we use for our computers at night (modify night to early morning for the architects), the coffee we drink all day long, all comes back to Eduardo. He is also in charge of the well-being of the GIEU students - arranging the kick-off eco-tour, home-stays in the Pantanal, night spot-lighting, boat-trips, all bus transportation, and hotels in Pocone and Cuiaba.

Beyond the basic living needs covered, Eduardo has advised us on ordering construction materials, setting up the water system, and miraculously finding three recently decayed trees for our entire roof at a third of the original price.



And onwards to the education forefront, Eduardo and Jucinete have already introduced us to the former Secretary of Education of Pocone, and today the four of us will meet with the current Secretary of Education to discuss how responsibilities will be shared for the operation of the school. Rural schools are often stalled by "*politica*" because they are seen as a money-pit, and our goal is to present how on-going contributions from JER and PCER will keep school operation costs reasonable for the Pocone Secretary of Education.

Eduardo this afternoon has also arranged for us to return to the Pantanal with a *pedreiro* (construction contractor) and small crew so that James and John do not have to assemble the roof all by themselves.

7/05 continued

posted Jul 10, 2010 5:24 AM by Julie Bateman [updated Jul 14, 2010 8:19 PM by Ethan Shirley]

This afternoon, we went to the Municipal Secretary of Education in Pocone with Eduardo and Jucineide, but in true Brazilian style - she only works afternoons and we were directed by her assistant to go to the State Secretary of Education. It was only about two blocks away (as are most things in Pocone), but continuing our luck all the doors were locked. We ran a quick errand at the solar power store to kill time, and then returned to find the State Secretary of Education office open and three already waiting in line. Eduardo, our *mandachuva*, abruptly explained to the assistant our objectives and demanded immediate attention - which lucky for the assistant, the State Secretary of Education herself appeared in the doorway behind us.

At last, we got behind closed doors with the Secretary of Education, Maria, and launched into the explanation of PCER and how we planned to share responsibilities in the operation of the school. Not five minutes into this discussion, Maria sat back and decided the press had to be contacted - immediately, its always impressive when something happens instantly here. Within ten minutes, the Pocone news crew appeared on site and ready to interview and shoot film. Our GIEU crew had been patiently waiting in the bus while we had our meeting with Maria, and joined us for the filming. Our enthusiastic Secretary of Education repeatedly turned over our palms to the news crew, the proof for work done, Ethan fortunately had a soccer wound for extra credos.

So if you get Pocone news, be on the look out. On a more serious note, while happy with the energetic response and getting word out to the community, we look forward to talking serious details (like buying us a bus and paying the teacher's salary) around July 16th.

Continuing our tradition of breaking anything we touch, the bus' axle was nearly destroyed - everyone safe and unharmed - on the way home, fortunately only two kilometers from the home-stays and Eduardo's lodge. We all had a nice night walking tour, and left the bus near the bridge as a courtesy warning to other motorists.

7/06 to 7/10

posted Jul 10, 2010 5:45 AM by Julie Bateman [updated Jul 10, 2010 6:40 AM]

Back to the site! We at last have more than just bricks in the ground! The architects surprised us with tee-pee-like-structures mounted all over the site supporting the re-bar for our soon to be columns!



It's starting to be easier to believe that there'll be a building there within the month. The lumberjacks have been busy at work in the forest, and we are about ready to take the crew to retrieve our locally-sourced beams. We also have some very fine scrap wood to make tables, desks, and animal carvings.

The engineers have been hard at work to finish their biosand water filter, and we at last had to give back their giant water container and find a new one. The abandoned field station (read - materials lot) provided a lopsided oil drum fit for the purpose, but it proved to be quite the task to get back to the site - about two miles away. We had been laboriously rolling it down the road when a bull-dozer roared past. Seconds later

with our heads down from the dust, we heard that wonderful beeps of a giant machine reversing and a friendly face motioning for us to put the oil drum in the bin and then to our surprise motioning for us to also hop inside. Belief it or not, that's how we now have a new water basin for concrete mixing (the concrete mixer continues to be three shovel-holders).

Continuing the ridiculousness, Joam (the groundskeeper) decided to capture a caiman (small crocodile) that was wondering around Eduardo's lodge and drag it over to the site with one of the GIEU students, Robert. That not being enough, Joam proceeded to unleash the caiman, tell us all "Tudo bom (All good)", give us a thumbs up, and then walk to the other side of the street, leaving us with a not-so-happy caiman to deal with.

Jo, a GIEU student, played crocodile-hunter and after a bit of playing lassoed the caiman and delivered him to the nearby swamp, with Liz, a GIEU student, and Greg, one of our water systems engineers, holding the tail. We hope he/she made it through the night.



Now some not as exciting news on construction, we have decided where to locate our two septic holes, a gray water hole (for shower and sink wastewater), and our artisan well (that will go thirty meters down). We still have a bit more digging to do, and then some brick-laying within the holes, and then all (waste) systems are a go!



Last night (7/9), two very exciting pieces of news. We poured our first column, with our friend Alino (construction contractor working down the road at another lodge) fortunately on-site. And second, Melanie, a GIEU student, has commandeered the kitchen and took over dessert responsibilities, and cooked a delicious unnameable bread pudding with chocolate, bananas, raisins, and I think some cinnamon and coconut. Yum.

The GIEU crew is with us on site until the 13th, after which they will return Cuiaba and visit the gorgeous Chapada waterfalls.

We also currently have an English Language Institute with three students (Gercione's daughters and a niece), along with the kitchen staff. Mindy is in full force, and Gercione demands that they learn English in three days.

7/10

posted Jul 20, 2010 5:25 AM by Julie Bateman [updated Jul 20, 2010 5:42 AM]

Don't worry we weren't eaten by jaguars...just out of transportation and communication for a bit.

Onwards, back to 7/10:

We've been joined on-site by a *pedreiro* (master brick-layer, translated best as construction contractor), Joam. Nisha and Joam have been hard at work on the verandah columns, constructed with a special brick not seen in the US – *oito furos* (eight holes).



Meanwhile, the inner concrete columns have also been on the move. We've peeled away our wood planks from the first column, and it's standing! It even has delicate markings from the imprint of the wood where the water was sucked out of the concrete. John already has a solution for the next column – pouring cheap vegetable oil down the insides of the planks to seal the wood.

And more exciting site-news, we have been mapping out plumbing! Our facility will have two toilets, and its plumbing will also serve the existing house with one toilet. Our GIEU students poured their sweat into two giant 6-foot deep septic holes that we are currently lining with brick. Tasks left for the septic system include digging a sloped trench over about 50 ft. and laying the pipe. There is currently an old water well about five feet away from the lodge's diesel generator, and this water will be pumped to flush our toilet bowls. Hope this wasn't your breakfast read.

We are considering installing an artisan well. The well consists of a 40-mm pipe sunk 20-m into the ground and outfitted with a built-in pump.

This technology is widely used in Pocone (the closest city, two and a half hours away), and is increasingly being installed in rural areas of the Pantanal. This pristine water would be used for everything except filling toilet bowls – showers, sinks, and the biosand filter for drinking water. It would first be pumped to our 5000-L gravity-feed water tank (located in between the house and the field station), and then pumped to all its desired locations. It would also feed the architects' most ingenious design of PCER – an outdoor shower directly underneath the water tank.

At night, we had a spot lighting of a different sort – the lumber search. Our lumberjacks had finished sawing many of our larger beams and with the help of GIEU dragged them to the edge of the forest and the road, and the environmental police had directed us to remove them as promptly as possible. The architects, Ethan, and I had an amusing evening of cramming 6-m hardwood planks into Eduardo's giant tourist mobile.

7/11

posted Jul 20, 2010 5:42 AM by Julie Bateman

Sunday started off very early for Ethan and some of the GIEU crew – 5 am boat trips, apparently one of the best times to see jaguars. On-site, inner and verandah columns continue to move along, and the septic hole wall is almost reaching the height where you can't climb out of it.



This afternoon, work paused for the final game of World Cup, most had their hearts on Spain. And for tonight, the GIEU crew is throwing a dinner and dance party for their home-stay families and friends – led by Melanie, Kim, and Ally the kitchen turned out delicious lasagna, which the resident Brazilians accompanied with caipirinhas (cachaca, lime, sugar, and lots of ice). And we of course had American brownies, except made with corn flour as the pantry is facing some clutch ingredient shortages.

7/12

posted Jul 20, 2010 5:43 AM by Julie Bateman

This morning was GIEU's last work shift, and fortunately our lumberjacks, Jico and his nephew, had the perfect task for all of us – beam retrieval from deep in the forest. We were led a good two kilometers from site to our



fresh lumber, and were very happy once there to have as many hands did. As of now, we have approximately enough lumber for the school, but Jico has caught Ethan and my disease and consequently his chainsaw is broken. This afternoon, they will return with Ethan to Poconoc to fix the motor, and then they will be back to find the rest of our lumber and also to help us construct the trusses for the roof.

Very sadly for all of us, Nisha departs this afternoon to return to Ann Arbor. It's hard to know whether we or Joam will miss her more. Joam will especially miss her as they have been hard at work together on the verandah columns. I was personally hoping that we

would infect the truck into not working and she'd stay here through end of July or maybe end of August.

This afternoon, we tapped bricks for a few more verandah columns, and James prepared for a big day of concrete column pouring tomorrow.

Having our *pedreiro*, Joam, on-site has been a good shake. He speaks light-speed Portuguese and I need him to repeat whatever he says about five times, which doesn't matter a whole lot as we have many hours to kill. What's been a good shake though is all the time focusing on construction logistics took me away from what it is that we are really working on. As we were talking about the census in Porto Jofre, and an eight-year old named Lara that has never attended school, Joam repeated again and again, "*Cade Lula?*" – Where is Lula, Where is the President? And in Brazil as it's been explained to us, whenever there is a problem, the President is to blame – similar enough to the US. I hadn't really focused on it, but where exactly is the government in rural regions? There's rarely a census out here, there isn't a school quite yet, and the government knows that families live here. Fortunately, that doesn't change why we are here – there needs to be a school in this specific region, and we have a sustainable solution to try – but it does demand us to consider the larger problem at hand. The lack of access to education in Porto Jofre is not unique in the Pantanal, and with good chance not unique in the many rural regions of Brazil, and for that matter not unique in the many rural regions of emerging and developing countries. Being here with amiable and generous people in a pristine wetland with gorgeous sunsets, it's difficult to put a price on providing education to a sparse, scattered population with transportation challenges.

7/13

posted Jul 20, 2010 5:46 AM by Julie Bateman [updated Jul 20, 2010 5:49 AM]

GIEU departed the Lodge today after breakfast for Cuiaba. Tomorrow, they'll be visiting Chapada, and after one more night in Cuiaba, half the group will continue on to Bolivia and Peru, and the rest return to the States.



On site, it's pretty quiet with just James and John working on the inner concrete columns, and Joam and me working on the verandah brick columns. We are having a competition to see who can finish first, Joam and I have the advantage as ours require about the tenth of the precision of the architects' columns.

The concrete columns demand first that either James or John construct formwork – a long wooden crate placed over the rebar and into which the concrete is poured. And as we have not yet invested in an electric handsaw, James and John have excellent workouts putting the formwork together. The formwork is then placed around the rebar, measured and balanced and plumbed into the correct position, tightened with wire.

At this point, we mix concrete in our electric mixer, James climbs up on his A-frame (ladder-like contraption) and then we hand up b

uckets of concrete to him until he calls stop.

The formwork groans and bends a bit under the weight of the concrete, and sometimes becomes "pregnant" with part of formwork arching out under the pressure. Today, one of our corner columns could no longer take the pressure, and gushed out into a puddle of concrete*.

Fortunately, James' fiancée Mercedes (who is joining us on this Sunday) had found Brazilian construction manuals long, long ago so James and John consulted the documents and now have a brand new method to try. And we are even investing in a small handsaw, called a Makita here regardless of the brand name. We've placed our order through Eduardo for more formwork and a Makita through Eduardo, and hope we will have the materials tomorrow.

* Leave some foundation holes empty for times like these. More out of being occupied with other things than out of foresight, we had quite a few foundation holes to toss our spilled concrete into – cleaning up our mess and keeping materials costs down.



7/14, 7/15

posted Jul 20, 2010 5:49 AM by Julie Bateman [updated Jul 20, 2010 5:53 AM]

This morning, we continued on the verandah brick columns and the architects started on their new formwork method. Our 14 pieces of formwork and brand new Makita (actually a Bosch handsaw) arrived in the early afternoon, making the architects' work go about 10,000 times faster.



Construction here has given us all a new appreciation for energy and technology. As we have switched from manual to electric concrete/mortar mixing, from manual to electric water pumping, and now from manual sawing to electrical sawing, it is always shocking how much more in such a shorter time frame can be accomplished with our diesel generator on. We are working on some general comparison numbers, and will hopefully have those in a later blog. It is a curious position to be in as this project is focused on sustainability, and we are now proclaiming the virtues of Eduardo's diesel generator.

This may also be a good time to explain why in the world we aren't generating electricity with our own solar power system. Solar panels and their components (inverter(s), batteries, and charge controllers) are much more expensive in Brazil than in the US, which is why we planned on buying everything except the batteries (airlines wouldn't be pleased) in the US and bringing it all with us to Brazil. Life seemed especially good when TUV Rhineland, a solar panel testing company in Arizona, generously donated twelve 200W solar panels. And then we tried to ship them. And then we thought about taking them on the airplane (each 4 ft x 5 ft, 40-lb which fit within oversized luggage limits), and then we went back to shipping them. Long story short, transporting technology between borders is difficult – in case you were thinking of selling technology on the black market in Brazil. So currently we have three

smaller solar panels on the way with Ethan's mother, Bonnie Shirley – story to be continued.



Oh, and don't worry the curse continued – our Makita saw broke after one day of use. Fortunately, it worked just long enough for the architects to finish their four incredible new formwork boxes.

7/16

posted Jul 20, 2010 5:54 AM by Julie Bateman

Today using the architects' incredible new boxes, we successfully poured two concrete columns - neither pregnant nor exploding!

We were also visited on site by an eclectic group of Europeans – two French, a Norwegian, and a Dane – that had stayed at the same hostel as GIEU in Cuiaba., and heard that there was some school being constructed a hundred kilometers (112 km to be exact) down the *Transpantaneira*. So word to all, we are easy to find – just keep driving (there are no crossroads) and look for a bunch of columns (pretty soon look for a roof in progress).

And late at night, Ethan, Mindy, and her son Max returned to the Lodge bringing Giorie Mahn with them, a recently graduated mechanical engineering student.



7/17

posted Jul 20, 2010 6:00 AM by Julie Bateman [updated Jul 20, 2010 6:11 AM]



It's been end-of-Michigan-football-season weather in the Pantanal for a few days now. We've doubled up on whatever sweatshirts (Dad, we still have your green hammer!) and long-sleeve shirts we could find, and are afraid that we might be losing a bit of our tans. Not that it's a great concern to us, but the Lodge is also out of hot water as the sun hasn't appeared for just over three days.

Saturday the 17th was a big construction day - we finished laying brick for the septic hole, poured three cement columns, finished the brick verandah columns. And Gercione took our broken Makita to be returned in Pocone, and a local expert consulted on site for an artisan well - the biggest concern is high iron content when you dig a few meters down.

Tomorrow is CENSUS DAY! We will be cruising down the Cuiaba River (with five layers of sweaters and our sleeping bags) to gather the final data (names, birthdays, levels of education, and literacy of parents) to deliver to the Secretary of Education on the 20th.

7/18 CENSUS

posted Jul 20, 2010 6:12 AM by Julie Bateman [updated Jul 20, 2010 9:52 AM]



We had the Cuiabá River almost entirely to ourselves this morning and early afternoon, Michigan weather has trained us well. We left Porto Jofre from Boré's dock with Ethan, Mindy and her son Max, John, and Giorie. Boré and his wife have four children (age range from 4 to 13) that are all two to three grades below their age level due to the cost and logistics of educating their children three and half hours away in Pocone. Additionally, Boré has a 15-year-old niece who is only slightly behind grade level. The census was recorded with Ethan's GPS to mark the locations on the river, a notebook for the names, birthdays, education levels, and literacy of parents (the data required by the Secretary of Education). Additionally, John and Mindy with the permission of the families photographed the census. Permission is required for use of any photo in today's blog.

We first traveled upstream (left from the dock) to a *fazenda* (ranch) fifteen minutes away called São Bento. Upon arriving, we were greeted by the Thelura and Joaquim, the owners of the *fazenda*, after which Thelura (in the gray coat) introduced us to the four families working on the *fazenda* and kindly aided us with the census. The ten children among the four families range in ages from 2 to 8 years old, all have 0 years of education, and the aside from Thelura and Joaquim all of the adults are illiterate.



We departed from São Bento to travel downstream to the three next locations. Five minutes downstream we pulled up to a relatively abandoned *fazenda* with three young men (ages 17 to mid-twenties), on a previous trip Ethan had discussed school with the 17-year-old's mother who remained convinced that it was too late for him to start his education. This visit unfortunately went just as poorly, with the 17-year-old backed by his two friends, confirming that he was not interested.

We set off for the next location - ten minutes downstream - to Lara, an 8-year-old with 0 years of education, who lives with her grandparents. While collecting the data, Lara's grandfather told us about "mountains of children" referring to one's of all different sizes that live an hour downstream, and who will be coming upstream on August 6th to celebrate a cousin's first birthday at our next location, the Gós family (ten minutes farther upstream). Already worried about boat logistics, Lara's grandparents offered to provide room and board during the school year for the children an hour downstream.



The Gós family with four children (age range from 10 to 16) was our final stop. The parents are in a challenging position as they can only afford to send two of their four children at a time to school in Pocone. Three of the four children are just slightly behind grade level, but the oldest girl at 16-years-old has never attended school. The very kind Gós' invited us all back for the party on the 6th, and told us to bring our notebook, pen, and camera for the rest of their cousins upstream. We definitely won't forget as our send off was "Até Dia Seis!, Até Dia Seis!, Até Dia Seis!"

On this Tuesday, we are visiting the Secretary of Education in Pocone to give her the census data for the children living in Porto Jofre (tallying at 20 currently). After which, we will have more details on transportation, lodging, lunches, and curriculum for our variety of students. It is still up for debate whether the children will be transported each day on boat and bus, or if it will be better for the families and the Secretary of Education to build lodging for the students and transport on the weekends.

7/19

posted Jul 20, 2010 9:54 AM by Julie Bateman [updated Jul 29, 2010 9:19 PM]

On-site, columns continue to be unveiled, each one a different color than the one before – Joao does the concrete mixing proportions by eye. Today is Mindy and Max's last day, and looks like the cold spell is here to stay. Mindy successfully finished bricking the septic hole today, and it looks gorgeous. Tonight, Mindy, Max, Ethan, and I have a ride out of the Pantanal, we'll be jumping out at Pocone to meet with the Secretary of Education tomorrow, and Mindy and Max will continue on their way to Cuiaba, and then back to the States.



Thank you for everything Mindy – joining us on this project with zero details last August, dealing with Ethan and planning GIEU, your whirlwind energy on the construction site and in teaching English lessons, your sleeping bag that you lent to us last minute in your dead-of-night trip back to the airport, we've loved having you with us for all of this, and can't wait to see you back in AA.

7/20

posted Jul 29, 2010 9:19 PM by Julie Bateman

Ethan and I stayed at Tito's house for the night, and his son Maurilo, now just eight days old, is doing very well – he won't be roughing it in the Pantanal though for a couple months still. After breakfast with Tito and family, we headed to the Secretary of Education with our census data. Currently, schools are on holidays in Brazil – and the Secretary of Education, Lucianna, was MIA but fortunately her very meticulous and amiable secretary, Gloria, was there to help us. We went through the different families, their children with names and grade level, and their locations on the river, with Gloria sorting all of this into a much neater chart. We will return in early August with more census data from ranches along the *Transpantaneira* (the road through the Pantanal) and from the families further down the Cuiaba River, and also with a map from Ethan's GPS with all of the families' locations, the path of the river, the *Transpantaneira*, and PCER – coming soon. Shocking to us, Garmin (the GPS company) marked the *Transpantaneira* incorrectly, fortunately we tracked it ourselves.



We also had a chance to visit ConstruMax to order a new wheelbarrow (old one had seen better days), a few more materials for site, and drumroll dun-dun-nah – 7000 roof tiles! Oh and an interesting side-note - screws are rarely used here, so each time we want to order they have to hand count them, and usually only have a stock of one or two hundred of each type.

7/21 to 7/23

posted Jul 29, 2010 10:01 PM by Julie Bateman [updated Jul 29, 2010 10:17 PM]



We've been joined on site by Ethan's dad Dick and Dianne, and in good timing as bucketing up concrete is only exciting the first five or so times. They've also been helping us lay foundation, a task that has a surprisingly variable amount of precision – while we were busy using a level and plumb-bob Joao cruised past us with a line he had set and his trowel flying.

Ethan and I are the now officially the septic and plumbing specialists on site. Frightening, but we've kept it simple and Joao has given our plan the thumbs up.

We've laid the outlet pipes that will be embedded into the floor and also played with the architects' floor plan by placing the toilets where ever was convenient for us to lay the pipe – fortunately that wall is still negotiable. Within our plumbing responsibilities is setting up the pump for our water tank, and Ethan was hard at work today trying to configure a slow-drip pump that can be run at lower energy costs. We are also now the water safety specialists and ran tests today on our well, tap, and bio-sand filter water, results are pending.



Meanwh



ile, James and John have started the roof trusses, and Mercedes and Giorie are hard at work on laying the foundation for our bathroom/pantry walls. I wish there was more of a story, but really watching from afar we see a bunch of wood being cut and a bunch of brick being laid – plenty good for us.

7/24

posted Jul 29, 2010 10:04 PM by Julie Bateman [updated Jul 30, 2010 6:53 AM]

Five a.m. came too early for Ethan who had a date with our three lumberjacks, led by Jico, to find a team of carpenters in Pocone. For a building of our size, Jico expects roofing and tiling to take fifteen days. Ethan's second goal in Pocone is to find an assistant for Joao, as brick laying and keeping the mortar flowing takes more than his two hands.



On-site, business continued as usual with more foundation laying, more concrete and mortar mixing, more walls, a delicious lunch with accompanying siesta, and then some more foundation laying, more concrete and mortar mixing, and more walls. Ethan returned successfully mid-afternoon with Eder, who will assist Joao, and with a team of three

carpenters booked to start this Wednesday 7/28. We've put in rush order to the architects on the bond beam.

The other minor detail is getting the rest of our wood to site – part of it is sitting across from a swamp and the other part is about twenty-five minutes into the forest. On Monday, Jico will have the wood all ready for us and by then we will have a game plan for collecting it – Eduardo understandably has deemed this task unfit for his truck. Fortunately, his uncle Fiao (who owns a ranch a twenty-minute walk away from the Lodge) is up for taking an adventure in his tractor to collect the wood in the forest. As the swamp is about waist-high, trucks and tractors are out, bodies and ropes are in – and as Fiao pointed out wading with wood is always preferable to carrying it.



7/25

posted Jul 29, 2010 10:13 PM by Julie Bateman



Bond beams and trusses are on our minds; it's still a bit of mystery to all of us of how we are going to keep the concrete in place for the bond beam to form properly. Ethan and I have no doubt that the architects will figure it out in due time – Joao does not have as much experience in this aspect of building so he's keeping a step ahead of us and building up walls to support the bond beam.

The bacteria test for our water samples (bio-sand filter, tap, and well) that had been incubating for the past forty-eight hours was ready this afternoon, and word in the booklet was if our little vials turned from purple to any shade of yellow then there was "potentially harmful bacteria" present in the sample. We ended up with three yellow vials, fortunately not worrisome for the effectiveness of our bio-sand filter because it still requires two more weeks to form the proper bio-layer for filtering – more on the Water Systems' website. As soon as we locate a UV light in either Pocone or Cuiaba, we will run our *E.coli* and *Coliform* tests to see if the "potentially harmful bacteria" is something more sinister.

7/26

posted Jul 30, 2010 5:56 AM by Julie Bateman



Today, I again had a chance to appreciate electric vs. manual power – we have been disassembling the column formwork (wood planks made into a box) so we can make formwork for the bond beam (the beam that wraps all around the building). Before Mercedes arrived with James' incredible box of battery-powered tools, James and John were assembling the column formwork with a screwdriver and hammer; now with a quick-charge (20 minutes or so) we can work at light-speed for a good two-hours to place and remove screws. Onwards, so today James taught me how to use the electric drill without drilling through fingers, and I spent the morning on formwork demolition duty, well about two-hours into my work, the battery died out. So I was handed a screwdriver. And what took me on average

fifteen seconds before (first-day novice driller), now was between one and two minutes depending on how deeply the screw was driven into the wood. And with five formwork boxes, and about sixty screws per box, you can imagine how happy I was when the battery was re-charged and I had the drill back in hand.

More excitingly on site, John and Ethan finished connecting the bond beam cord to the column rebar and around the top of the building. Once the bond beam formwork is made, we will be ready to pour concrete inside, wait two days for it to cure, and then let the carpenters fly. Mercedes and Giorie finished off the foundation for the bathroom and pantry walls, and also started setting in 15-cm rebar standoffs all around the bond beam cord to keep the formwork inline.

James has been hard at work (as he has been for over fifty days now) and finished the fourth and final truss today, the cows delicately stepped over them at sunset to reach their corral. Mercedes and he leave this Thursday 7/29 for Iguazu Falls. To the right is James with Jico, the head lumberjack, with his finished trusses.

And just at sunset, the ConstruMax truck arrived with more sand, gravel, cement, sikal, aaand toilets, tiles, and plumbing fixtures! We still have to cover the bricks with a mortar-like coating and do the floor, but Ethan couldn't resist outfitting the bathroom any longer.



7/27

posted Jul 30, 2010 6:02 AM by Julie Bateman [updated Jul 30, 2010 6:52 AM]

With our good fortune with all things mechanical, Fiao's tractor's wheel bit the dust. And tractor wheel replacements are only in Cuiaba (four hours away from his ranch), and so early this morning Fiao was on his way.

Ethan and I commenced the non-tractor phase and headed to the swamp to meet the lumberjacks and collect our wood. Jico and his team are early-risers and so once we hit the swamp area, we exchanged catcalls with them to figure out where to cross, and then ventured into the brush. Everything starts to look a bit like a snake when you are wading in water. We made it across with no problems, and Jico showed us to our lumber, and then with his team kindly helped us drag the lumber to the side of the swamp. On first site of the two lumber locations, Ethan and I estimated that we would be occupied with dragging lumber for two hours, but with the sudden help of the three lumberjacks all of our lumber was out in just twenty minutes. And they didn't stop there, but then jumped in waist-high with us and helped us drag the lumber to the other side of the swamp – surprisingly close to our work-site if there wasn't another giant swamp/wetland patch in between. Jico then led us into the forest to show us the next location for lumber that they would be cutting this afternoon, they had found a very straight, very tall tree that would soon be forty skinny roof beams. Not thinking that they would approve, Ethan asked if we could stay and watch them fell the tree, they not only agreed but then with no hesitation started the chainsaw. As Jico was supervising the felling, he kept us close to him and I prepared for a giant crash and I won't lie was disappointed as I forgot about all the other brush in the forest that acted as a landing pad for our tree – still spectacular though and a loud enough crash to be satisfying.



On-site, bathroom walls and bond beam formwork are steadily progressing. Our carpenters are coming to site tomorrow, and as they are frequently on the move and without reception we have no way of letting them know that there is no bond beam for them to rest the first roof beams on top. Fortunately, this is Brazil. And chances are that they will completely understand that rarely anything goes according to schedule in the Pantanal.

One exception though to scheduling in the Pantanal is Jico and his crew of lumberjacks. We realized late afternoon that it would be better to pour concrete for the bond beam all at once, and therefore realized that we'd need ten more pieces of formwork. So we were fretting and fretting (as a shipment from Pocone is at least four days from when it is placed, and

we need the bond beam poured on Saturday morning latest), and suddenly remembered Jico and his great crew. Fortunately, they were still at the Lodge having dinner and in just two minutes we had an order placed for formwork and a delivery date of tomorrow after lunch.

7/28

posted Jul 30, 2010 6:05 AM by Julie Bateman [updated Jul 30, 2010 6:50 AM]

Our carpenters came on time, now we are the slow ones – as we neither have our bond beam poured nor all of our wood on site, I think we are adopting the culture pretty well. They were thankfully very understanding. James and John took the opportunity to show them their computer model of the roof design, and the carpenters agreed to return on Monday to start work.

Ethan and I commenced Plan B of lumber collection. We have been talking of this swamp and that forest and now we have another forest – we've had Ethan's GPS to visit all of our trees and soon enough they'll be a map. This forest is about a twenty-minute walk from the lodge, and had a well-traveled nature trail called St. Cruz. Anyways, about ten minutes down this trail we have 20 skinny roof beams, and then another five minutes we have 15 medium-size roof beams, and then another five minutes and we have 19 of our giant (5-m to 6-m) thick roof beams. The giant thick roof beams, called *vigas*, are the first ones needed by the carpenters and ideally located at the farthest bit of the trail. Fortunately, we only need to get them to the side of the *Transpantaneira* (the road running through the Pantanal), and Eduardo's truck will then take over. We deemed the 6-m *vigas* too much to handle, and so spent the morning hauling our 5 5-m *vigas*. About halfway with the first *viga* we started to realize why in the world we got such a great price for lumber – half or more of the battle is retrieval. Well worth it though, this wood already looks like it'll make a gorgeously framed roof, and as we have an open ceiling all the better.

On-site, James and John are still hard at work on the bond beam formwork - making sure it is synched and secure for the two days that the concrete needs to cure (dry). And thanks to Joao, Eder, Mercedes, and Giorie, the bathroom walls are nearly complete.



The lumberjacks delivered on their promise, and just before sunset we had ten freshly lumbered pieces of formwork. As this lumber was just across a nearby field with only a bit of scrub, we decided to test the off-roading abilities of Gercione's car. It made it across the field, it steadily held the ten pieces of lumber, it drove for about a minute and a half, and then a giant creaaaak and snap our ten pieces went flying and we luckily realized that the rusty roof rack had given out at one corner. As the sun was setting fast and the mosquitoes congregating to wherever we were, we abandoned our lumber and decided to return in the morning to collect it the old-fashion way.

7/29

posted Aug 3, 2010 6:54 AM by Julie Bateman [updated Aug 3, 2010 7:03 AM]

Our formwork was waiting in the same spot we left it the previous night, and with four sets of hands it was pretty quick work to get it to site so that John could start milling down our non-dimensional lumber and then construct the formwork boxes. As it was James and Mercedes' last day, and neither had yet seen the Cuiaba River we sent them down the *Transpantaneira* after breakfast to hunt for hyacinth macaws, giant river otters, and the elusive jaguars. The rest of us continued synching and screwing together the formwork up top so that the concrete wouldn't surprise us and burst through during the pour. This activity kept us busy until sunset, when James and Mercedes returned victorious with the spotting of many, many birds, riverotters, a tapir and three whole jaguars. After dinner, Ethan and I took off with James and Mercedes to Pocone where they would be catching a cab for Cuiaba the next day.



7/30

posted Aug 3, 2010 7:03 AM by Julie Bateman [updated Aug 3, 2010 7:06 AM]

Our car, now being called Chevrole (its brand on one side), had taken a beating in the Pantanal so we took it to its owner, Gercione, first thing in the morning. His house is faster and cheaper (aka free) than the mechanics, and in no time had fixed the roof rack and taken care of some other rattling sounds. After a stop in ConstruMax for James to pick up his favorite Brazilian tools, and for us to confirm our next order, we said goodbye to James and Mercedes, and then a small thank you to James for his straight eight-week sunrise to sunset shift building the school.

Ethan and I headed back to the Pantanal plotting how to get the wood out of the forest in case Fiao's tractor didn't come through. With fingers crossed we stopped at Fiao's ranch and were dismayed to find the tractor gone. Fatchima met us at the gate, and as we rushed to ask where Fiao and his tractor were, she asked why in the world we weren't with Fiao in the forest.

And what we discovered is that Fiao had left early in the morning, picked up the three lumberjacks, Joao and Eder and collected lumber all morning, taken lunch and a sesta, and was still out (then at 4 pm) collecting lumber. Our jaws dropped.

Ethan had kept telling me that Fiao would come through with the tractor, and I kept fearing the worst after our truck experience (quick update – it was "fixed" and a driver named Wellington drove it all the way from Cuiaba to the Lodge, and then he was so scared it wouldn't start up again that he left the motor running while he had dinner, and his fear was confirmed when he returned that night to Cuiaba and the engine lit on fire halfway down the *Transpantaneira* – fortunately Wellington was completely unharmed). Anyways, I felt incredibly silly about our wasted morning carrying the five *vigas* a few days back, but overwhelmingly I felt relieved on hearing this great surprise from Fatchima.

7/31

posted Aug 3, 2010 7:06 AM by Julie Bateman

So early this morning, the sun was just thinking about coming up, I was surprisingly awakened by Ethan who unknown to me had made a date with Fiao late yesterday afternoon to pick up the little bit of lumber left near the swamp and nearby forest early the next morning – and *Pantaneiros* love their early morning. Ethan rushed out, I threw on my “clean jeans” (the ones I wear after I shower and typically just to dinner so they are never dirty), rushed out to the road and joined Ethan on the ledge over the tractor wheel. And then Fiao was in gear, and groggy-eyed I looked back to find a dead cow being dragged by two of its ankles. Could not dream of a better start to a day – the cow had been sick for a while and reduced to basically skin, and bones. Onwards, Fiao expertly drove the tractor into the field and toward the forest with the our luggage bouncing along behind, and just as we neared the forest, the rope slipped and Fiao decided it was as good as spot as any for the cow to remain as the vultures’ breakfast – one of the more efficient waste management technologies in the region, the alternative is burning the trash (plastic and all) in a trash bonfire). Getting the rest of the lumber with Fiao and his tractor was too easy to even describe, and in under a half hour we had returned to site with the final addition to our lumber stock.

The day rolled on, and it looked like we would have to wait until the next day, Sunday, to pour concrete into our bond beam. John and Ethan were finishing up the synching and screwing our latest formwork boxes (the ones from the forest), and Joao was securing the earlier ones. Then it hit 10 am and Joao decided that John and Ethan could hustle and finish while we poured the first part of the bond beam.

The pressure was on for the next seven or so hours, mainly just on John and Ethan, we just kept handing buckets up to Joao and moving down the beam. Late afternoon, John and Ethan climbed down at last, and by sunset we poured the last buckets of concrete in the bond beam.

8/1

posted Aug 3, 2010 7:07 AM by Julie Bateman [updated Aug 3, 2010 7:09 AM]

We woke up happily on Sunday knowing that the bond beam was now on its own to dry until the next day. Joao was already busy on site when we arrived setting up scaffolding for building the *rake wall* – the triangle wall just under the roof. We soon distracted him from his task by trying unsuccessfully to cover the columns neatly with mortar (called *reboco* in Portuguese), which protects the building from weathering and makes it much, much prettier. The motion of *reboco* is taking the trowel (I called it the triangle-thing to aggravate the architects - it’s a metal triangle with a handle), filling it with mortar, and flicking it sharply with your wrist at the desired surface. Well we got all those steps down except for the desired surface part, and proceeded to fling mortar at the existing house and all over our worksite. Joao laughed and then came quickly to our assistance, and taught us the tricks of the trade. He tutored us



for two columns and then we charged ahead for the next few, the first two were a 10 on a 10 scale, I’d say the rest ranged between rank 6 and 7. The day moved ahead with Joao working on the rake wall, and us on *reboco* and later onto a more skill-appropriate task of wheel-barrowing ground-fill (dirt from the other side of the house) for our floor.

Just before sunset, Bonnie Shirley arrived after quite a journey – a double ankle break two hours outside of Rio de Janeiro in the mountains – and in a hefty cast – and despite all this – with our solar panel, charge controllers, and inverter! We rushed to unwrap the panel from its styrofoam and bubble wrap and we’re happy to find that it had survived its many baggage claims.

Back to work-site news, we are having a slight change of crew. Joao is taking a two-day vacation in Cuiaba, and will return with two of his own assistants, and Eder is returning to Pocone for good. On Tuesday, Joao will return with his assistants and promises that the building will finish *rapidom* – rapidly.

8/2

posted Aug 3, 2010 7:09 AM by Julie Bateman

We woke up excited for our carpenters to arrive, and set off to remove the formwork and find out if our bond beam was permanent. Joao had ripped off the front wall formwork the previous evening, so we knew that at least part of it was permanent. Removal of the rest of the formwork was a bit trickier and consumed the majority of the morning, mixed in with a bit of ground-fill wheel barrowing. After lunch, we started to wonder about our carpenters. Fortunately, Gercione, one of the drivers for the Lodge and a friend of the carpenters, arrived and as he had to drop off supplies here anyway the carpenters had asked if he could check if we were ready or not. We gave him the thumbs up, and tonight he will return to Pocone and send the carpenters on their way tomorrow. The rest of the day disappeared in finishing the removal of formwork and wheel-barrowing dirt – doesn't warrant much description.



Onwards to something very interesting here – eggplant is always served with eggs, typically sunny-side-up-like egg cooked well-done. Delicious with rice and beans.

8/3 and 8/4

posted Aug 7, 2010 7:07 AM by Julie Bateman [updated Aug 7, 2010 7:22 AM]

We have solar power! Yesterday, we picked up our deep-cycle battery from a shop in Pocone (the one component that isn't airlines-friendly) and this morning we set to work connecting our panel, charge controller, battery, and inverter. Other than the panel having some strange connections on its output wires that we had to chop off, all went very smoothly and in no time we were charging a phone, laptop, and jamming to Pantanal country music – without the (loud) hum of the generator that typically provides electricity on site. We have an 85-Watt solar panel, and our battery can store a little over 1600 Watts, so on a good day when we would have about 10 hours of quality sunshine, we can recharge the battery about halfway – in the future we want to hook up two 85-Watt solar panels or alternatively one 200-Watt solar panel to our battery. Over the next few days, Ethan and I will be doing an electricity analysis of the Lodge to figure out if solar power could reasonably replace the diesel generator.



John and Giorie have been hard at work making wood frames for the windows and doors. Our team of carpenters continues to be a no-show, and Joao with his new assistant Jorge (who speaks wonderfully comprehensible Portuguese) are very close to convincing us that even though it is ideal to have three sets of hands for the roof, we should hire them to do the roof. Until the 14th, having a team of two would be no problem as there only needs to be two on the roof, and the third person on the ground (one of us) is just handing up beams. The no-show carpenters estimated that our roof would take about two weeks, so after we leave on the 14th, we would just need to find a third person to help Joao and Jorge finish the roof.

To me, the roof always seemed like the logical last step to construction, but for a few very good reasons it comes before the mortar wall covering (*reboco*) and the concrete floor. Scaffolding used by carpenters typically pokes holes through the walls, which if they are already covered in *reboco* requires patchwork repairs if it's done before the roof. And for the floor, when the roof is being tiled, the clay tiles often (hopefully not too often) slip from the carpenters' hands and would split and crack a beautiful, new concrete floor. After finishing the half-walls, Joao and Jorge are moving ahead on *reboco* in non-scaffolding locations such as the wall facing the *Transpantaneira*, and by tomorrow or the next day we will have a decision on the carpenter situation.

8/5

posted Aug 7, 2010 7:23 AM by Julie Bateman [updated Aug 8, 2010 10:53 AM]

So today, we continued our census in the other direction of the *Transpantaneira*, on the way to Pocone. We had chatted previously with a man on one of the major bends (there are true no cross roads) and he had mentioned that there were some children on his *fazenda*, and that the *fazenda* had just been bought so there would be four or five families working there in the coming year. So with Tito, we headed down to the bend, and fortunately met the same man, Adelinar, who was hacking away some brush on his road. After he and his four dogs greeted us, he led us to his home to "*fala calma com café*" – speak relaxed with coffee. Brazilians have a remarkable ability to shoot the breeze with strangers. On his porch with coffee brewing, Adelinar chatted with us about cattle, the rain, pigs, the wind, diesel, cars, and to our shock solar power! We had seen his diesel generator as we walked in, but turns out it was only for the water pump in the well – everything else (lights and a few appliances) is powered by his one solar panel on the roof, and a battery and charge controller hooked up next to his hammock. Very, very cool. He uses a car battery (R\$400), which we had considered, and replaces it about every year, and says his solar power system has been reliable and fit all his electricity needs besides the water pump.



Hmm, and now his water system...so us being hot-shot college students thought we were introducing new technologies to this remote region, but guess what Adelinar had sitting on his porch – a bio-sand water filter! A layer of rocks, then calcium, then charcoal, topped with a thick layer of sand, and *presto* bio-sand water filter fixed with a tap at the bottom and mounted on a tree stump for ease of use. And talk about ease of use, Adelinar has used this system for nine years with essentially no maintenance. Curious, we tried the water, and found out that with the addition of calcium or maybe it was charcoal (we'll find out), there's no sand taste as there is with our current filter on site. In hindsight, a bit more exploration of the current systems in the region would be worthwhile. I should mention here that Adelinar lives ten months of the year in the Pantanal, and there's a good chance that he has immunity to bacteria that could take a good hit at our stomachs. I've had great health the majority of my time here, but later that night either dinner (which I hadn't yet had problems with) or that half-glass of water took me and my stomach out for the night. Full health was restored by the morning, along with a renewed enthusiasm for filtration and water tests.



At last we got around to census business. Adelinar has a 9-year old son who currently lives with his mother in Pocone, and the two of them and Adelinar would much prefer to all live together on the *fazenda*. In addition to his son, Adelinar told us that he expects there to be between 5 - 10 more children on the ranch as it was just recently bought and will restart operations in the coming year.

8/6

posted Aug 8, 2010 10:53 AM by Julie Bateman [updated Aug 8, 2010 11:53 AM]

Today, we anxiously waited doing this and that on the work site until after lunch to depart for Porto Jofre for a census further down the river and the Gós family party. We arrived at the Cuiaba River around 3 pm and were then taken about a half hour down the river to the Conceição family. There we were greeted by Sr and Sra Conceição and their four children (age range from 10 to 15). Even though school has already restarted and their kids attend school in Pocone, they have not been able to arrange a boat ride and car ride to Pocone (approximately a five-hour trip total) so their children have remained on the river and will be a week late in returning to classes. Sr and Sra Conceição and their children were very excited about the prospect of their children being able to come home more frequently than two weeks in July and a month and half in December.



While there, Sr and Sra Conceição also discussed the medical services offered in the region. Currently, the only services offered is a medical boat that goes down the Cuiaba River in November. The next best option is to figure out transportation to Poconé - very expensive and difficult to arrange. There has been talk for a long while of a medical facility in Porto Jofre to serve the town and families on the river, and hopefully with the increased awareness of the population in the area, there will be an opportunity to improve the current system.

While there, Sr and Sra Conceição also discussed the medical services offered in the region. Currently, the only services offered is a medical boat that goes down the Cuiaba River in November. The next best option is to figure out transportation to Poconé - very expensive and difficult to arrange. There has been talk for a long while of a medical facility in Porto Jofre to serve the town and families on the river, and hopefully with the increased awareness of the population in the area, there will be an opportunity to improve the current system.

Before we left, Sra Conceição came out onto the porch and gave us a giant egg - about 5 or 6 chicken eggs combined and explained that it was a Rhea egg from the property and described how to make an excellent *bolo* - cake - with it. Once on the boat, we realized that there was a bit of conflict over the Rhea egg - I was interested primarily in cracking and cooking with it, while Ethan wanted to return to the States with it as a biological specimen. Fortunately we came to a compromise and will screwdrive a hole to drain it - so we can have our cake and Ethan can have his shell, I am not so sure about how he is planning on packing it.



We returned back on the river and backtracked to the Gos family home, and discovered that the party had actually been moved to this Sunday 8/8. But all was not lost as the Gos family had many questions about the operation of the school - Sr and Sra Gos were particularly concerned about their 15-year old daughter who has had no schooling - and also had the names and ages (range from 5 to 13) of five cousins down the river who also have never attended school.

Time is rapidly coming to a close here, and our next visit to the Secretary of Education is on Friday the 13th. By then we will have finished our census and have a map of the families on the Cuiaba river and the *Transpantaneira* along with their names, ages, and current education levels. After that it is a waiting game until October when the government makes decisions on school registration, funding, and teacher assignments for the coming school year.

The carpenters have disappeared into the vast Pantanal, and it looks like Joao and Jorge will be taking over roofing operations. Joao and Jorge have also promised that long as there is a steady stream of cigarettes and Reals, they are more than happy to finish the construction of the school after we leave. The building is now starting to look livable, and we have briefed Eduardo about logistics for finishing the roof, floor, and *reboco* wall covering so that he can take over operations when Ethan leaves on the 21st. Judging from past construction operations at his Lodge, Eduardo expects that our school will be finished by the beginning of September.



In exciting news to come, we showed Eduardo our small solar power system - and he now cannot contain his enthusiasm for converting the entire Lodge. Turns out his diesel generator has almost reached end of life and converting to solar power (though a massive capital investment) may be financially reasonable or even beneficial. We will leave it there as we don't want to spoil it before we have our analysis of the Lodge's electrical needs, and before Eduardo has his estimates for package deals on solar panels and batteries.

8/7, 8/8, 8/9

posted Aug 15, 2010 6:09 AM by Julie Bateman [updated Aug 15, 2010 6:34 AM]

This past weekend we took care of a bit of business in Pocone, and returned late Sunday night to the Lodge, charged up for our final week of construction as John, Giorie, and I have flights this coming weekend. The most intimidating part of the roof is our four heavy trusses that need to be lifted and centered onto the bond beam.

We thought about making a game plan for the best way to lift them, but once on site Jorge and Joao decided trial and error was as good as method as any. Jorge has been an excellent addition to our team, nicknamed Hercules on site, and is both calm and very, very strong. The trusses were to the say the least awkward to get on top of the bond beam, and ours may not have been the prettiest process, but with the fourth and final truss on top and no one or nothing smashed to pieces, the morning was a success. The trusses look so good we are considering nixing the rest of the roof. The rest of the day was spent installing the central beam along the tops of the trusses spanning the building along with the never-ending fun of ground-fill.



8/10, 8/11

posted Aug 15, 2010 6:17 AM by Julie Bateman [updated Aug 15, 2010 6:23 AM]



Tuesday and Wednesday passed quickly with more, and more of the roof falling into place. Two beams were installed on either side of the long central beam; making echoing crashing noises each time a beam was connected. And in other site business, the door jams were mortared into place, and the bathrooms and closet are nearly prepped for pouring the concrete floor. Ground-fill had been a fairly simple business of wheel barrowing dirt and sand, jumping on it a bit, then more dirt and sand, more jumping, and then a layer of crushed rock, and a bit more jumping. Then Gercione visited the site, and said there was a floor tamper on the side, which turned out to be a metal pipe set into a concrete-filled paint can and worked wonders in compacting the ground – more simple, great technology from remote, rural living.

Once our large beams spanning the length of the building were in place, the next step was nailing the *caibros* into place and spanning the porch with large beams. Jorge and Joao set to work on the side porch beams, and left the *caibros* to amateur turned expert carpenter Ethan while John and Giorie set to work preparing the back porch beams.



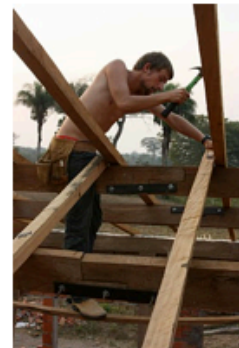
work on the side porch beams, and left the *caibros* to amateur turned expert carpenter Ethan while John and Giorie set to work preparing the back porch beams.



And most exciting for our architects, John started installing the roof monitor! Most roofs in the region have a roof similar to the roof in a grade school drawing of a house. To allow for better ventilation, our roof has a gap along the center for hot air to escape and for light to be let in. There was some concern from Eduardo, Jorge, and Joao that the gap would allow the wind to blow tiles off, and not wanting to lose our ventilation, we will be wiring-in vulnerable tiles.

And speaking of tiles, six thousand of them were desposited on site by ContruMAX today.

More *caibros* need to be nailed in, and the *ripom* need to be laid horizontally across the *caibros* and nailed in to create a grid for the tiles. Nailing in we expected to be a simple task, but Brazilian hard wood proved to be true to its name. Ethan has been hammering fervently away installing the *caibros*, and much to his dismay the nails prefer to bend instead of remaining straight as they go into the wood. As we have wood from a few different types of trees, some of the *caibros* are more receptive to the nails than others, and the others are now clearly marked with seven or eight bent nails before a straight one got through to the central beam.



8/12

posted Aug 15, 2010 9:57 AM by Julie Bateman

Today came suddenly – my, John, and Giorie's last work-day on site. We went out with a (hammer) bang, and nearly completed nailing in all the *caibros* and half of the roof monitor.



As the Secretary of Education, Lucianna, along works weekday mornings, we will be leaving early tomorrow morning for Pocone so that we can visit her with our updated census data and our beautiful new map of the Transpantaneira and Cuiaba River. Then after a night in Pocone, we will be on our way to Cuiaba where Ethan is picking up a biologist from Arizona State University, Bobby, interested in the Pantanal, and possibly in running a field camp or study abroad program at PCER. Ethan will be showing off the Pantanal to Bobby and his girlfriend for most of the next week.

Its



sad to be leaving our team and the work site, but we know it is in good hands with Joao and Jorge and possibly one more as Jorge will also be departing tomorrow to pick up his nephew in Cuiaba who will be joining the construction team.

A delayed 8/12 to 8/21

posted Aug 31, 2010 5:08 AM by Julie Bateman [updated Aug 31, 2010 5:54 AM]

The remaining week I was there without Julie and the rest of the crew I spent guiding and making sure the locals we hired were working on the roof. After a couple panicky moments and screaming matches regarding construction of minute details in the roofing monitor and on top of the cement bond beam, three paid days of hard work and two unpaid days of hard liquor, the roof's entire wood frame was together and structurally sound. The next challenge was getting the tiles on, which turned out to be no challenge at all. Unfortunately, I left after only a corner was done.



The remaining work will be done within the next month; we have been promised photos from Tito's sister (Livia, who lives nearby), and will pay the price already agreed to per square meter after the work is complete and we've seen it in all its glory (in photographs). Essentially what remains are three major things: tiling the roof, cementing the floor, and resurfacing the walls; and a million little things, like plumbing and electricity and other such forgettable details.



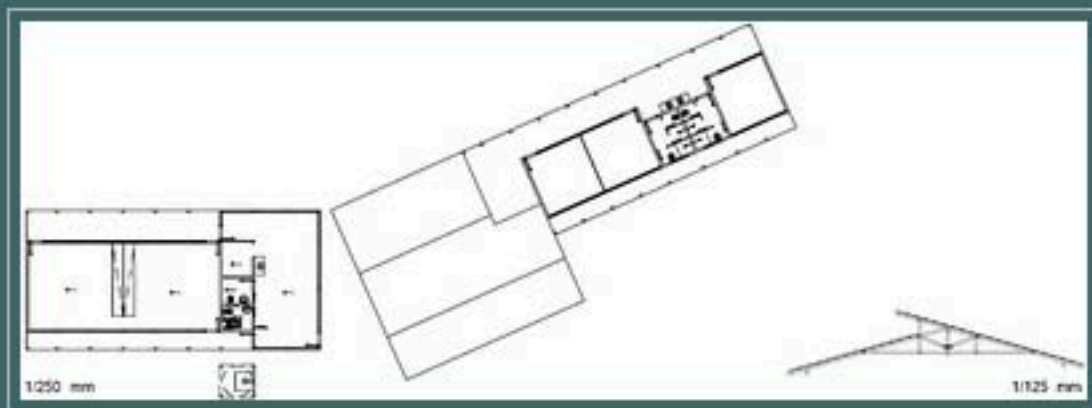
After talking extensively with two of the three major players in the office of the Secretary of Education, I was thoroughly reassured that I would not be needed again until January. I will therefore return in January to finish up the million little things, forgettable details, and to make sure the building is in working condition before the modified school year begins at the start of the dry season in late April. There is one major budget matriculation that I will miss in October, which involves calculating how much money will be needed for the bus and diesel. The map we made and the census we've done should be sufficiently detailed for this mission. Nothing will be done with the education levels of the students and arranging the teacher until I get back in January. The reassurance offered involved the 'simplicity' of the process as a whole – because our school is a sala anexa (a kind of satellite campus of a school already in existence in Pocone), we are guaranteed a teacher and materials which are at the ready in Pocone.

With this said, we have appointed Tito and Fabricio, my two closest friends there, with the task of keeping an eye on everything and making sure things continue to get done without gringos there to yell commands. Additionally, I have obtained the elusive email address of the Pocone office of the Secretary of Education, and have arranged biweekly communications with them for status updates.

It was an amazing summer, folks... Stressful at times, yes, but many of our near-impossible goals were accomplished. The blog will be diminished in frequency from here on out, but we will post updates as we receive them for those who are interested. As a final note, we appreciate greatly all who have kept up on our exploits and all who have contributed in one way or another to the project. We thank U of M and our community for their guidance and generous support that made this project possible. Of course, as it is a continuing project and there was little time dedicated to the field station this year, we are hoping to receive more donations to fund that other important part of the project for next year.

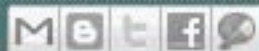
Signing off, for now... Until the next update. Please keep your eye out every couple of weeks.
-Ethan

Week 1-2



We paid a visit to the construction supplies store that will be providing the materials for the project. This gave us a better idea of what would be available to us and the concrete mixture typically used = 6 sand, 3 gravel, 1 cement. We should be connecting with the contractor/construction supervisor very soon to determine an exact start date. We met with the engineer to approve the final drawings and discuss the details of the structural system. Pictured are the final drawings given to us by the engineer. We will post diagrams of exactly how the roof members come together soon. "Soon" is as specific as it gets here. We returned to the Jaguar Reserve to discover the site unexcavated. We are sure it will get done soon though.

Posted by Nisha R. Patel at [9:09 AM](#) [1](#) comments



Labels: [Design](#)

Learning the Language (Construção)

Orçamento Quantitativo
 - Phase 1 (classroom, research station, water handling, WC)
 Total Price = 12696.50 Reals

1: Infra-estrutura (sapatas e pilares, viga baldrame e alvenaria de embasamento)
 - Slab and formwork
 Segment Price = 8927.50 Reals

ITEM	DESCRIÇÃO	UNID	QTD
1.1	Cimento - cimento	kg	75
1.2	Areia - areia	m ³	10.0
1.3	Cascalho - gravel	m ³	10
1.4	Ferro (510) - rebar	barra	23
1.5	Ferro (24)	barra	21
1.6	Ferro (40)	barra	21
1.7	Arame Passado - wire	kg	12
1.7.1	Tipo Meio - cold break	unid	2001
1.7.2	Tipo Adutora	unid	2102
1.8	Sisal - adhesive (like fiber)	kg	7

2: Meio e super estrutura (vigas superior 15 X 25 cm)
 - Structural frame and columns
 Segment Price = 2307.50 Reals

ITEM	DESCRIÇÃO	UNID	QTD
2.1	Cimento	kg	25
2.2	Areia	m ³	3
2.3	Cascalho	m ³	3.0
2.4	Ferro (210)	barra	24
2.5	Ferro (40)	barra	24
2.6	Arame passado	kg	4.8

3: Elemento de vedação
 - Wall mtl
 Segment Price = 1417.50 Reals

ITEM	DESCRIÇÃO	UNID	QTD
3.1	Tipo concreto 2.5/10 - 8 inch block	unid	2001
3.2	Cimento	kg	9
3.3	Sisal	kg	16
3.4	Areia	m ³	1.0

Orçamento Quantitativo
 - Phase 2 (Residences, WC)
 Total Price = 16306 Reals

1: Infra-estrutura (sapatas e pilares, viga baldrame e alvenaria de embasamento)
 - Slab and formwork
 Segment Price = 12489 Reals

ITEM	DESCRIÇÃO	UNID	QTD
1.1	Cimento - cement	kg	77
1.2	Areia - sand	m ³	11.5
1.3	Cascalho - gravel	m ³	9.5
1.4	Ferro (510) - rebar	barra	52
1.5	Ferro (24)	barra	72
1.6	Ferro (40)	barra	52
1.7	Arame Passado - wire	kg	18
1.7.1	Tipo Meio - cold break	unid	3001
1.7.2	Tipo Adutora	unid	4001
1.8	Sisal - adhesive (like fiber)	kg	12

2: Meio e super estrutura (vigas superior 15 X 25 cm)
 - Structural frame and columns
 Segment Price = 1212.50 Reals

ITEM	DESCRIÇÃO	UNID	QTD
2.1	Cimento	kg	25
2.2	Areia	m ³	3
2.3	Cascalho	m ³	3.0
2.4	Ferro (210)	barra	24
2.5	Ferro (40)	barra	24
2.6	Arame passado	kg	4.8

3: Elemento de vedação
 - Wall mtl
 Segment Price = 1504.50 Reals

ITEM	DESCRIÇÃO	UNID	QTD
3.1	Tipo concreto 2.5/10 - 8 inch block	unid	2001
3.2	Cimento	kg	10
3.3	Sisal	kg	14
3.4	Areia	m ³	1.0

A second unexpected trip to Pocone last week yielded another visit to the engineer who provided a list of materials needed for the foundation and concrete structural support. We were also able to return to the construction supplies store to get an exact quote. There are some discrepancies with numbers which we need to clarify with the engineer, but the quotes are pictured here to give an idea of the materials and approximate quantities that will be used. While this information is helpful in understanding local materials used and likely construction processes to ensue, we still have many more questions for the construction supervisor and engineer, both of whom we will be meeting with tomorrow. Eduardo Falcao De Arruda (Owner of Jaguar Eco Lodge and site of project) has also had much input and insight into the local construction and logistic processes and is recommending a construction supervisor (pedreiro) who has recently built two structures at the lodge. While we have been waiting to meet with the construction supervisor, we have been building detailed 3D models of the structure and roof system based on the materials that will be used as well as the local construction methods that we have learned about based on buildings we have seen, our conversations with the engineer, conversations with the construction store manager, and with other local well-informed building owners.

Here are some of the questions we have for the engineer and construction supervisor:

What are the extents of the slab? Building footprint? Breezeways? Roofline? Roofline, and then some?

What is the slab thickness?

Is there rebar or reinforcement of any sort in the slab?

What size rebar goes where? And how many - how many in the columns (1, 2, 4?) and how many in the bond beams?

What is the maximum spread for the columns?

Is there footing under columns? All the columns? What kind of footing?

If the typical dimension for a beam is 10 by 20 by 4m, then why is the beam drawn in the truss elevation 12 cm?

What happens between the bond beam and the door? - Brick? Netting?

What is the height of the bond beam?

What is the approximate space below the netting/window (even though this is flexible, it would be good to know what they were thinking in order to understand the estimates)?

What accounts for the width difference between the column and brick? Even if there is a stucco finish, there is a difference in width.

What is the dimension of the mortar joint?

What is the typical order of building?

What type of formwork is used?

What kind of tools will you (the construction supervisor) bring to the site? What tools do we need to get?

➤ Learning Flexibility



We got impatient with hearing “the site will be cleared tomorrow” and decided to take matters into our own hands. After moving large obstacles (posts, satellite, part of a fence, etc.) out of the way, we began the ground-clearing process. While at first, an excruciatingly slow process with the few tools we had at our disposal - a short-handled axe and a pick axe; eventually, we were able to borrow some long-handled hoes (enchada) and rakes (ancinho) from the neighbor (about 10 km away). We successfully cleared the site and are happy we will no longer have to hear that the site will be cleared “tomorrow, for sure!” The pictures show the tools we used and the site after we finished our work, check out Picasa for some before pictures. Next up, some more digging (we think) for the column footings.

Otherwise, we’ve continued to see new kinds of birds and other wildlife every day and had some near encounters with more jaguars. There was a funny moment when we were clearing the site the other day when we looked up and everyone (as in, the tourists at the lodge, the cook, the housekeeper, the neighbor - who happened to be stopping by, and a couple tour guides) was booking it down the road and frantically calling us over to join them - “Jaguar! Jaguar! Jaguar!”. A jaguar had just crossed the road about 40 feet away, having hopped out from the swamp, swept up a capybara (giant rat - as in, small bear size) and walked off into the swamp on the other side. All we were able to see were the massive wet footprints the big cat left behind. There were also a couple tourists from the UK who we got to know the last few days. We spent an afternoon with them down the road at the neighbor’s (also the Eduardo’s uncle) place where we set up a TV in the semi-enclosed porch, and with cows, chickens, and endless wetlands in the background, enjoyed the USA VS. England World Cup match. Thank goodness for England’s butter-fingered goal-keeper! The tie game allowed us to remain friends afterwards. Chasing jaguars and enjoying futbol: some expected field conditions!!

Lesson One



The engineer was no where to be found so a few of our questions went unanswered, but here are the questions which were answered by the pedreiro (master builder):

Q: What are the extents of the slab? Building footprint? Breezeways? Roofline? Roofline, and then some?

A: Slab extends through veranda, entire footprint

Q: What is the slab thickness?

A: 4 cm. Our follow up question was, "Really, truly?! That thin?!" The answer was an astounding "YES!" We have also asked a handful of other people (including another pedreiro) and paid close attention to other buildings we have seen and that does seem to be standard.

Q: Is there rebar or reinforcement of any sort in the slab?

A: No.

Q: What size rebar goes where? And how many - how many in the columns (1, 2, 4?) and how many in the bond beams?

A: 5/16 rebar everywhere (which is .8cm), 4 go in each column and each bond beam, 2 rebar run in one of the mortar courses of the formwork,

Q: What is the maximum spread for the columns?

A: The pedreiro through out a 4, 5, 6 m answer, but this, of course, also has to do with what the dimensions of the beam between the columns and roof is. With the materials we will be using, we will maintain the 2m spread for interior columns and up the spread to 4m for exterior.

Q: Is there footing under columns? All the columns? What kind of footing?

A: Under all interior columns. Pier footing.

Q: What happens between the bond beam and the door? - Brick? Netting?

A: Courses of brick downwards from the bond beam to the door

Q: What is the height of the bond beam?

A: 20 cm (generally speaking, the pedreiro seemed to use dimensions based on the typical brick with mortar - 10 X 20 X 20)

Q: What is the dimension of the mortar joint?

A: 1.5 cm

Q: What is the typical order of building? - Specifically, what comes first the columns or the brick infill?

A: Brick infill for interior walls is last in terms of construction order.

To give an idea of construction order for the interior:

1. Brick formwork for slab (concrete bed of 6-8cm, 7 courses of 4.5 by 9 by 9 bricks with 1.5cm mortar joints and rebar running all the way through after the 4th course)
2. Footing - including rebar
3. Column formwork, including bracing
4. Pour column
5. Remove column formwork
6. Bond beam rebar
7. Bond beam formwork
8. Pour bond beam
9. Remove bond beam formwork
10. Slab
11. Wall infill
12. Roof

Q: What type of formwork is used?

A: Brick formwork for slab. 10mm thick wood attached with wire for columns (check out PICASA!)

Q: What kind of tools will you (the construction supervisor) bring to the site? What tools do we need to get?

A: None. In fact, the pedreiro has not and will not be joining us on site. We are the pedreiros for this project.

The pedreiro also demonstrated exactly how a typical veranda column comes together (pictured above). A couple interesting facts we discovered during this trip to town included that the standard footwear for construction workers seems to be flip flops and there are 83 bridges from Pocone to the Jaguar lodge!

Week 2-3



Between the visit to the construction site in Pocone and the arrival of more helping hands, we re-mason lined and water-leveled the entire site with respect to the finished floor elevation (FFE) of the existing house. This means we will need a lot of fill to get 4 cm (slab thickness) below the FFE but we cannot move the FFE because of the rising water levels during the wet season. While we were doing this, Ethan and Julie built a barbed wire fence around the entire site to keep the cows out, for once and for all (this is both to save our time of having to restring our lines but also for the safety of the cows as we begin to dig massive holes for the column footings). We also dug all 60 cm deep pier footings for all interior columns and began the trenches needed for the slab form work and moved a few electric poles out of our way (please note the OSHA-approved ladder in the picture).

➔ Week 4



The water and waste management team joined us on site including Cory VonAchen and Greg Ewing (check out their blog which is linked on the left side of the page). Their first major project was to brave the intense stench of the septic tank to move it from the back of the house (where we will be building Phase 2 and therefore need to fill with concrete) to the north side of the house and new building. They have also been running tests on water flow rates and scoping out materials needed for their sand filter. The GIEU study abroad group, including 14 undergraduate students (from all different departments) and 1 instructor, Mindy Matice, has also joined us on site. The extra hands have made the work progress much more quickly. We finally reached a completion point with interior trench digging for Phase 1 and began slab formwork. We have reached the rebar level and will soon be pouring column footings. We got our first electrically operated tool - a concrete mixer! Unfortunately, the primary generator is down and the smaller, temporary one, may not be able to take it. That will be fixed "soon" though. In the meantime, we will continue to mix concrete by

hand.

We were recently visited on site by another pedreiro who is currently working on a project down the street at another lodge. He approved of our work thus far but recommended that we dig shallow footings for the veranda columns and confirmed that the veranda columns should be full of concrete as well (regardless of whether they are constructed with brick + rebar or if constructed with PVC pipe - an option we are currently looking into. We have also had mixed responses to what concrete and mortar mixes are typically used and finally received a confirmation that our mixes were good - 4 sand, 1 sikal (equivalent to lime), 1 cement for mortar, and 3 sand, 2 aggregate, and 1 cement for concrete.

Our days of manual labor and nights of computer and drawing-related labor have been getting longer as we have been working out more construction details but we have managed to enjoy a few more world cup games - happily seeing Brazil and the USA continue onto the round of 16. We were also joined by a group of five enthusiastic writers, photographers, and videographers. They are making an epic journey through South America in an orange 1982 Volkwagon Westfalia and happened to get wind of the project we are working on. They stopped and worked with us for a day - helping finish up the trenches for the veranda columns (check out their website - inverdant.com). Milton (the cook) and Maria (the housekeeper) also hosted a little festa at their house (they live in the house on the building site) this week - there was loud music from car speakers, dancing, and cachaça. Saúde (pronounced "saw-oo-gee")!

Pictured here are Cory and Greg with the gear they used to remove all the waste - buckets and masks; material arriving and being unloaded (it seems that material delivery is the one and only thing in here which happens as scheduled, we have been very impressed); mixing mortar using the "volcano" method (basically, piling materials, mixing materials into a mountainous heap, creating a crater in the middle, pouring water in the crater, shovel and mix materials, then repeat; the group enjoying a brick laying demonstration; an expert mason, in the making

➔ Local Knowledge



There have been various locals who have played key roles in advising us towards a more efficient way of construction as well as operating in the local field condition. Tito who has left for Cuiaba in anticipation of a newborn has been integral in a wide range from proper fence construction to plumbing repair to fashioning stakes. Gerstioni is the Jack-of-all-trades and one of our go to guys. He keys us into some of the other field conditions such as operating the generator and maintaining some of the equipment around. Elano is a pedreiro who is working at a lodge (posada) that is up the transpantaniara highway about 3km. He has lent us and fabricated some tools that have proven to be more efficient and fast (rapido) in the construction process. For example: We were using some found pipe to bend .42 cm steel for the retention ring assembly that is part of the rebar infrastructural column. Elano provided us with a bender that is made up of one piece of angle iron, three nails, and a board of wood. It works great. Images: From the left: Gerstioni (Driver and guide for Jaguar Ecological Lodge) with the water systems team, Gerstioni working on the concrete mixer, Tito (Very talented guide for the Jaguar Ecological Lodge) cutting stakes, Elano (local pedreiro) setting up and showing us how to use a local small gauge rebar bender, The wood milling crew.



We have had a good push on the excavation of both phase I and II with the helping hands of the GIEU crew. Large septic pits have been dug and the trenches and footings are near completion. All the while, the in-ground brick work that acts as both a structural footing for the infill wall system (tijolos) and a form edge for the interior slab has been completed on Phase I. Excavation cut from the septic and structural systems digs has been reused as fill in order to reach an FFE (finished floor elevation) that is consistent with the existing house. Infrastructural columns of rebar (ferro) have been built and installed. They are set in concrete footings (40x40x60 cm) and braced to establish an accurate stub out at the footing. Rebar above the footing will be manipulated at a later date in preparation of column formwork. The production and process of building and setting columns has been one of invention, correction, and common sense. Local knowledge and advice has been graciously availed to the crew and employed in most cases. It is sometimes the case that we utilize different tools or techniques than suggested as our own experience prevails in the decision making process. It is also common that suggestions vary from pedreiro to pedreiro (construction managers) and the locals. As it stands now we are moving vertically out of the ground with the main structure of the interior structural frame and setting up for the veranda brick work to begin. Nights are often spent drawing details that have evolved, discussing strategies for organizing a large unskilled labor force, and deriving cut lists for materials and a lumber package. We met with our local lumber supplier/millwork and discussed the derived cut list for the roof system (four structural trusses in the north/south direction that carry three beams (vigas) in the east/west direction, that carry all the rafters (caibro) in the n/s direction that carry all batons (ripom) in the e/w direction, on which sit the dry stack roof tiles). We were able to get a look at some of the vigas that have been cut for our job and so far the cuts look good and straight (reta). The vigas are being milled at 6m lengths and are coming from a local tree species called Piuva, which is a dense hardwood. The rafters will be of the same species at varying lengths and the batons will be of a softer species due to the amount of nailing involved to secure it to the rafters. All other materials are being

delivered at a steady pace at one to two deliveries a week. We expect the deliveries to slow due to the fact that much of the necessary materials are currently on site. Occasional trips to Pocone are used to blog and pick up some needed tools and materials and this trip we will swap out the motor for the concrete mixer that had never operated properly.

Plumbing stub outs for in ground wastewater are being dimensioned and two options for water delivery are being weighed. As for the luxury of a concrete mixer, the primary generator is now up and running but the motor on the mixer is and has been in no shape for operation since it arrived on site. All of the concrete mixing remains on ground. Our current water supply for mixing concrete and mortar is coming from an existing well that was at one time the source of water for the existing house. Initially we lowered buckets into the well but have since moved up to a new manual hand pump that operates as if it were as old as the well. The water systems team is currently working on a bio filter that is made up of varying sizes of aggregate and sand that is sifted through a series of meshes that they brought with them.

General Notes:

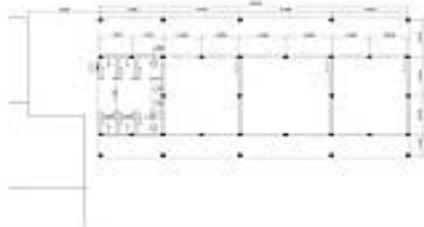
_It is this week that Brasil was knocked out of the World Cup by Holland. It is a disappointment to say the least.

_The daily schedule for the design team (John, Nisha, and James) is now 6am-12pm 1pm-6pm

_Laundry gets done rarely and often only when it is absolutely necessary. We have all squeezed it in this week.

MONDAY, JULY 5, 2010

Week 5



Be sure to check out the photo link on the right to see the rest of the images of Week 5

Working It



We have finally been joined on site by a *pedreiro* (or building master) named Joam from the city. He has been working in the field of construction for 30 years but never with a woman or with Americans, both circumstances he seems to welcome. The communication was very difficult at first as he didn't speak the clearest Portuguese (Ethan went so far as to claim that he was speaking another language, altogether) and our Portuguese is relatively slow but soon enough we were able to understand each other and communicate by showing/doing as much as possible. One of our biggest challenges is to keep up with the *pedreiro's* very fast pace of working. This requires that we adapt quickly to his work methods while foreseeing the next step in the process. Once finishing all of the bond beam rebar towers and remaining column rebar towers, the next logical step for Joam was the exterior veranda columns (pier footing, rebar, retention brackets, mortar, oito furo bricks). In the meantime, we poured all footings for interior columns, constructed formwork, and began to pour the columns (composed of wood formwork greased with expired soy bean oil, vertical rebar, rebar retention brackets, rebar braces (15 X 20) to hold the formwork in place, and concrete). Another major task on site concerns the water team. They have been working away (with the helping hands of GIEU students) on the construction of the septic tank/leeching facility which is made from oito furos with the occasional brick turned sideways in order to let materials seep through. They have also been cleaning materials for their water filtration system. Both of these tasks are near completion. We also fetched the wood from deep in the forest where it had been cut and moved it to the roadside. This required a lot of bug spray and some night time adventures to move the wood from the side of the road to the building site.

Week 6



Gersione returned for an extended stay meaning the large generator has finally been fixed. After blowing 3 outlets and one cord, we (really, Gersione) finally figured out a way to get the bitornera (concrete mixer) going. He also happened to bring an electric water pump with him. With these developments, concrete for the interior columns and mortar for the exterior have been at our disposal without too much extra work. On site, the columns are going up quickly as they have been the primary building focus for the three architects and Joam. This has allowed a couple of us to focus on interior columns and a couple of us on exterior columns.

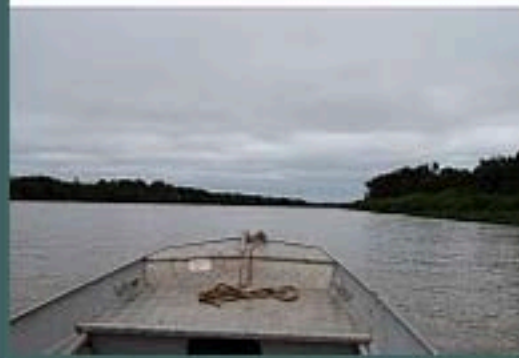
Other major events:

_While James was performing the job of eco-tour driver (for the second time since we've been here) during a night ride, we saw a taper

_We managed to stop working for a bit and catch the second half of overtime of the final match to see Spain win the world cup for the first time ever

_The GIEU has departed and in 3 weeks time, another pedreiro (Elano, who, we mentioned before, is working on a project up the road and has provided a lot of helpful tips and tools to us) and his two men (they call men who work for pedreiros "servants" here) will arrive and focus on constructing Phase 2

Census Data



This week the remaining group excluding myself ventured off to Porto Jofre and various other river villages to collect census data of the potential student population that will be utilizing the school. This included a trip out on the Cuiaba River and the delivery of some soccer balls that Greg (water systems) brought down from the states. The numbers exceeded expectations rounding out to approximately 20 students. Also, registration paperwork (to legitimize the school) has made its way to the secretary of education who is (at this point) offering funding for diesel for the school bus and other necessary components in the operation of a rural school in Brasil.

The Children





This week (unusually cold) began with high expectations and our first real disappointment on the construction site. Although our first and second concrete column pours were a success the third and fourth would prove to reveal the instability of the initial form design. Furthermore, with the departure of architect/pedreiro's apprentice, Nisha Patel, we have lost one of our strongest assets, both on the job and in design, which is a perpetual state in which we operate. The initial form design deviated slightly from that which we have encountered thus far and may be one of the main reasons for its eventual failure. Due to the fact that we were ripping formwork by hand and each cut was taking between 20 and 30 min, we chose to rip only one piece, which gave us two sides of the form, and the other two sides ran long. Typical in the area is to have all pieces ripped to size with no excess, and nails attaching one piece to the next and wire (similar to bailing wire) wrapped around the form at about a 40cm interval. Well the third column became "pregnant" which is not uncommon, but the fourth one blew out which we are told is also not uncommon by Joam. With one form still standing and un-poured John and I aborted the pours for the day and spent some time in the evening re-working the form design.

The new design included all pieces cut to specific lengths, screwed together for reuse, with a series of ribs spaced to resist the greatest outward force of the concrete load, and wrapped in wire. This was made easier with the arrival of an electric "Makita" or small sidewinder/circular saw Bosch GDC 14-40 with a cut depth of 40mm. The new method has worked exceptionally well and is only slowed by the fact that much of the column assembly has to be screwed together by hand. We have an electric drill but lack enough cord for it to reach the slab site, so we are assembling three sides permanently and installing and pulling the "face" of by hand. Thus far concrete and tijolo columns are going well and the system that is in place is working well.

Re-Design



➤ Form Failure



Form Field



The form work construction evolved into a much more strategic and directed endeavor due to previous failures. In this image one can see the new form work. It is set around the rebar infrastructure with one face off. After the face (which is labeled with a circled letter that corresponds to the column letter) is installed, braces are applied (to get close to plumb) and heights are measured from the FFE (finish floor elevation) dry line. note: the dry line has been reestablished to account for the thickness of the form rather than the finish column. In doing so we know that all columns are level and generally plumb. When shimmed to the correct height the bottom is "pinned" with stakes and a variation of materials that land us on specific dimensions. Using a plumb bob the forms are plumbed in perpendicular directions and the braces are wired to stakes that have been set in the ground. We have also been checking diagonals in plan and elevation to make sure that all is square which has been the case being that we checked our dry lines time and again. A triple check has been measuring parallel dimensions at the base and tops of the columns. These forms have been successful and we have been getting three to four uses out of them in the overcast weather. When the wood sees much sun it warps and splits at a rapid pace. We butter them up with old cooking oil two times.

➔ Assembly



Layout



Form Station



John and I set up a work station for laying out and building the form boxes needed for concrete column construction. The delivery of the electric saw and 14 pieces of form work have allowed for a more efficient production process.

THURSDAY, AUGUST 5, 2010

Week 7

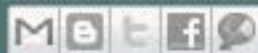


Waste Water



The plumbing infrastructure is installed within the "water bar" of the initial design. Water delivery will come from above and waste water will terminate below ground: all of which exist within the same bay in plan, localizing the water systems. Separate piping is run for sinks/showers and toilets. Black water being 100mm and gray being 40mm.

Posted by James Chesnut at [1:55 PM](#) [0 comments](#)



Labels: [Water Systems](#)

Tijolinha Header



The header system was initially intended to be the bond beam but was revised with the realization that there was going to be too much tela (screen) and it would demand additional un-needed mullion infrastructure to support it. The roof loads will continue to be transferred through the bond beam to the columns and the header height and structure for all openings has dropped to the 215 cm. The tijolinha header will have to support only itself and the small sections of wall above. Its' construction (as pictured above consists of a wood formwork (cut from off cuts of column form), two pieces of 3/8 or .8cm rebar that is buried in the first mortar joint (massa), two courses of tijolinhas (the smaller brick), and tijolos oito furros (8 holes) above with 4/2 rebar in the mortar joint. A plumb bob is used to check for plumb and dry line is set in each course level (nivel) and strait (reta). The initial header height is pulled from the FFE (Finish floor elevation) dry line and snapped across all coloumns.

Wall Preparation



Week 8 brought with it four new people (Mercedes, Giorie, Dick, and Diane. Above - the finishing touches of the tijolinha foundation and the beginnings of the infill wall installations. At every third course of the tijolo (8 hole) wall system is a piece of 4/2 or 42 mm "rebar" (ferro) set in the mortar joint and drilled into the column. It is additional lateral support with the anticipation of childhood energy and futbols acting up against the parede (wall).

Truss Build



Week 8 has included the building of the four main structural trusses that will be exposed to the interior space and carry the weight of the framing and roofing loads. John and I designed the truss to a specific angle specified by our solar systems engineer and began the build. They are currently cut to fit and tacked together with screws and will eventually receive metal strapping and hardware at all planar connections. The wood type is Piuva, a Brazilian hardwood and is rough sawn at best. It is milled to size with a chain saw (plain sawn technique) and the accuracy is excellent given the tools and conditions. Attention is paid to thickness when cutting stock for the king post and intersecting cords and crowning for all sloped and horizontal members is in the upward direction. The king post is left un-cut at the top where it will receive the ridge beam so fine adjustments can be made according to the varying dimensions of material that it will receive.

Bond Beam



The bond beam rebar infrastructure as shown above being installed by Ethan, Julie, and John. Each section is pre built by Joam and contains about twice as many retention rings as the vertical columns. Each vertical column has four rebar stub outs that tie the bond beam to the column and the bond beam will contain rebar stub outs that tie each truss to it.

Column Field



➤ Form Removal



Column form installation and removal was made exponentially easier with the arrival of Mercedes who brought with her a cordless 18v li-ion Makita Drill/Driver set (model: LXT 211A). More small things arrived on site this week, with Ethan having come back from Pocone, such as 30 meters of electrical cord, 300 screws, and drill bits.

Week 8



Week 8 was a big week for a multitude of tasks on site. Waste water infrastructure has been installed for the two bathrooms of the school and research facilities by Ethan and Julie as seen in a following photo spread. The gray and black water have been piped separately for the opportunity to recycle the gray back into the gravity feed system that flushes toilets. The septic style pit has been built up by various workers and completed by Mindy and Max (also shown in the water photo spread).

All columns have been poured and above is a series of close up images of ten different columns. One of which the concrete was mixed on the ground. For the majority of the columns the pedreiro Joam has been mixing and the reddish tone is a product of the procedural steps in mixing in the bitonera (concrete mixer) as opposed to on the ground: Ground Mixture: sand, cement, and aggregate are mixed dry and then water is added. Bitonera Mixture: Aggregate then water then cement then sand then water = red concrete. (the aggregate being red)

Posted by James Chesnut at [2:31 PM](#) [0 comments](#)



Labels: [Columns](#)

Beyond Knowing, or Caring (Ally)

Life in the Pantanal is, in some ways, completely different from life back home. One of the hardest cultural adjustments I've had to make during my time in the Pantanal is accepting the concept of what we call "Brazilian time." Life here happens at a slower pace, and if doesn't suit you, that's just too bad. The Brazilian attitude is very laid back—they're an easygoing, relaxed people who believe that things will happen in their own time, whether or not that time fits into your schedule. It's not to say that the Brazilian people don't do good work—the work manager here mixes up a batch of concrete in the amount of time it takes me to pick up a shovel—but things happen here in a much more flexible manner. Adjusting to this lifestyle after coming from the regimented, scheduled, precise world of a university campus, I've had to learn very quickly how to let go of my notions of how things are done. Whereas before I checked my email and my cell phone neurotically, I keep track of the days here in Brazil by the World Cup schedule and I pretend that I can tell time by the position of the sun. This lifestyle has opened my eyes to a new way of doing things, to the joy of sitting in a hammock and chatting with friends or putting in a hard day's work and then going home when I feel like it, not when the clock tells me to. The concept of not knowing and not caring what time it is, what I'm doing next, where I'm going after this is a liberating feeling, one that I am infinitely grateful for having had the chance to experience.

Sanford Carton

As this month in the Pantanal comes to a close, I reflect on what I will take with me from this experience. While most of our days have been devoted to long hours in the sun, toiling to raise a school in a field which has provided food for free-grazing cattle for years, the hour or so after the sun sets is a time which has given me a greater perspective on what life is like in the Pantanal. Arriving back at my home-stay with four other GIEU students, as the sun is setting and the mosquitoes are coming out, our host family also is finishing up their daily tasks (feeding the pigs usually comes last). We congregate in the dining room of the house and converse about our day. At the beginning of the trip, our dialogue with our host family was difficult and I solely relied on Davicho – a Chilean roommate who basically spoke Spanish with a Portuguese accent – to translate. In the last week we have started to understand more and have asked questions about their lifestyles in the Pantanal. Yesterday, I learned that the husband and wife used just machetes to clear the dense brush and wet lands that had covered the beautiful square-mile field which their house now lies on, making our work to mix cement in the heat of the Pantanal sound like nothing. In the time spent relaxing after work and before dinner, I have gotten to know amazing people and have been exposed to a lifestyle unlike anything I had known before.

Field Notes (Joseph Johnson)

June 17, 2010...

[En route to Sao Paulo, Brazil]

"An intellectual exploration, the chance (if you are patient enough) to enter in some degree into the hearts and minds and feelings of alien peoples with exotic cultures. The final discovery, that **we are all ultimately alike**, is a hard-earned revelation"

- Moritz Thomsen

Living Poor

San Francisco, California

I sit here in my seat, 20A, on flight AA963, waiting for morning to come for it will bring arrival in Brazil. Excitement for what is to come in the next six weeks has given way to futile attempts to fall asleep in hopes of passing the time less torturously. But still, as my team member Sanford reads quietly beside me, excitement and anticipation I cannot escape. It is an incredible thing to be part of another culture, to spend time immersing oneself into the lives and the communities of a new culture. I hope to come to a better understanding, a revelation, of the world and the people that so diversely populate it.

...in the afternoon, Davicho and I prepped for our ESL lesson for Livia and Fatchima. It was one of the most enjoyable experiences I've had teaching here. We reviewed the names of parts of the human body with a memory card game, which to our surprise Fatchima seemed to enjoy much more than Livia. I noticed Livia had retained much of the lesson from yesterday, and very quickly absorbed our lesson on different types of fruits and vegetables. I can see she really has a longing to learn English, so I made her a translation card with common phrases I've learned here. She says she would like to learn numbers next so I will give her something to study tomorrow before heading to work in the morning...

Elisabeth Wilson

Sometime after Breakfast

As I sit here looking out the window of the Jaguar Lodge restaurant, I am overwhelmed by the natural beauty that defines the Pantanal. Two blue macaws are resting atop a tall coconut tree while the light breeze carries the faint chirps of birds in the distance. Back home I am too often swept up in the fast pace of New York to appreciate the unique sounds and sights of city life. It took some time for me to get adjusted to relaxed, easy-going lifestyle of the Pantanal and embrace it in order to appreciate the beauty that defines the area. At first I was a little annoyed to learn that our schedule was centered around the phrase, "some time after breakfast." "What time is that exactly?" I wondered for the first few days but in the past three weeks I have learned that *some time after breakfast* defines the pace and spirit of the Pantanal. This slower, more relaxed pace allows for time to stop every once in a while and take in the beauty of the Pantanal. At home, I usually rush from place to place without taking some time to appreciate the beauty of the city that surrounds me. However, the slower pace of the Pantanal has forced me to look around and watch the sunset, enjoy the breeze, and observe the wildlife frequently. The strenuous work days have also given me a deeper appreciation for everything I have in the US like heavy duty machines and construction workers. Before coming to the Pantanal, I never thought about the significance of either but after a few weeks building a school by hand, I have developed a new found appreciation for both. Here mixing cement is an extremely tiring 4-5 person job while back home it takes a few clicks of a button to mix a batch of cement. My trip to the Pantanal has given me a deeper appreciation for my lifestyle back in the US, allowed me to meet a diverse group of people, make new friends, and above all taught me embrace my surroundings when I have *some time after breakfast*.

On the Transpanteneira: Center of South America

Julie Chau

Wildlife

Sitting atop the worn down truck, our sole means of transportation out of the Jaguar Lodge, I watched the sun rise. An assortment of birds made way for the truck, which barreled down over the dusty roads and bridges, just like an old rollercoaster. Insects smashed into my face as I endured the morning chill, but it didn't matter. The sheer beauty of the scene, exotic birds and reptiles awakening to the light of the sun, masked behind the misty morning, was breathtakingly inspiring. A few of us continued our early morning by going on a boat trip down the Cuiaba River and into some tributaries. Tangled roots and piles of cayman lined the shores as we traveled along, searching for jaguars and other species of interest. Although we were unable to spot a jaguar, the trips down the Transpanteneira Road and the Cuiaba River, with my hair blowing in the wind, will remain as highlights of my time in this part of the world.

*vital sidenote: One of the worst "souvenirs" that I will take from the Pantanal will also be from the wildlife: the literal hundred mosquito bites and scars that I have gotten here! I've tried a combination of Ultrathon, Permanone, Repelex, etc. and I still get eaten alive everyday. So Pantanal travelers beware!

Work

Two main objectives were described as we prepared to come on this Brazilian adventure: building a school and teaching English. Little did we expect the sheer effort it takes in building a school from the ground up, with only a handful of small tools and sheer willpower. Life in the Pantanal has not been easy. There have been days where we've dug holes and pickaxed nearly solid ground in 90-100 degree weather; days where the source of clean water was questioned, and days when there was just no desire to help with the construction of the school. But (nearly) everyone continued to work, and I think it's because everyone knows what an education means. During one of the census days, we met a young girl living in a small house with her grandparents. She had never attended school. During the ESL days, I was able to help teach Milton and Sheila (the two cooks at the Jaguar Lodge), as well as three young girls from Pocone. Their smiles and eagerness to learn English are enough to inspire even the most exhausted bodies. I also think working as a part of a team and as part of a community has also been a prime source of motivation.

Community

Just meeting and living with the people here has been a source of motivation. To give you an idea of the population, here's a diagram of the area:

Fione's house ————— à Alfredo and Nivelda's house ————— à Jaguar Lodge/Milton's house

I spent my first two weeks living with Alfredo and Nivelda; their generosity and kindness will be something that I will remember. Playing Uno and drinking cachaça with Nivelda, while learning the Portuguese translations for colors and "reverse" was great.

Interacting with the people here; Milton, Maria, Vera, Jerceone, Alfredo, Nivelda, Fione, Livia, Fachima, Sheila, Joam, and Roberto (this may be a list that only the people here will understand), reminded me that people and the relationships that you form are often what you take away the most from a trip.

The "GIEU group", Ethan and Julie, Mindy, Nisha and James and John aka "the architects", Corey and Greg aka "the engineers" have also all been part of an interesting community to work with. We've all worked hard, played hard, and contributed sweat and blood to a school that will hopefully change people's lives.

Thanks for reading and caring about this project. Brazil 2010!

Elizabeth Ludwig

Some of my favorite moments

There are many things that I have come to appreciate about Brazil and I want to share a few of them with you. Every morning the people get up an hour before the sun rises to start their daily tasks. I, on the other hand, woke an hour later at 5:45 am right when the sun was peaking over the horizon. For three weeks in a row I have witnessed the same simple event, the rotation of the earth, but it was by no means the same. Each morning the hues were different and the feeling of awe which filled me was slightly different. I know back in the states I would never rise before the sun every day. Somehow it feels natural to rise and sleep in accordance with the sun.

In addition to the natural beauty of the Pantanal, I truly appreciated the wildlife. I love the farming practices here. The cattle are free range and so are all of the other animals. This being said I got to pet a cow, horse, and kitten. One of the coolest animals that I touched was a caiman. Caiman are like small alligators. One of the men that work at the Jaguar lodge brought a caiman by the tail and mouth over to the worksite and left it there. Unfortunately that meant that we had to move it. Joe ended up roping it around the neck and I picked up its tail. Together we walked it to the nearest swamp.

However my all time favorite moment of the trip so far occurred on the worksite. I was on a barrel hunt with Julie which took us a mile and a half away from the worksite. When we finally found one it was heavy and awkward to lift. Our solution was to roll it down the road all the way back to the worksite. Only about .3 miles down the road: tired, sweating and panting a bulldozer passed us on the road. It stopped and turned around to offer us a ride in its bucket. We were thrilled and could not stop laughing until we were back on the ground.

David Cortes-Olivares

After almost a month, the GEIU Pantanal project is almost over. We all came here with many expectations and ideas but out of all I really wanted to see a Jaguar. We would walk every morning and sometimes late at night hoping to see one, to have the chance to see a creature in its original environment, after numberless tries to see one I thought we were going to leave the pantanal without seeing a jaguar, uma onza. Today July 12, hours before our departure from the pantanal, we went on a boat trip and after hours of looking, we finally saw this magnificent animal, right there in front of our little boat. People told us that jaguar were hard to see because they are afraid of people, but this male onza seemed like he wasn't scared of us nor the sound of the boat, this was his place, his river, his pantanal.

I heard Liz saying "we have finally succeeded" and I'm sure that's exactly how we all felt after many tries, we were looking at the onza pantanero. This whole experience has been completely different, I was so wrong about how our four weeks here in the pantanal were going to be, although "Ephan" and Mindy explained the project to us as good as they could, I believe that everything was so unique, the working enviroment, the homestay families, the jaguar lodge, the animals, etc. I can't believe how close we got to be from caimans. Obrigado Pantanal for all the wonderful things you let us see and experience!

The Pantanal: A Food Critique

By self-definition I am a food enthusiast. I love to bake, am majoring in nutrition, write for a food blog and work for a prepared-food CSA. Since I am a pescetarian-the only meat I eat is fish-when I was interviewing for the Brazil site, my first thoughts were, 'What is the food situation?' To my surprise and delight, I would be staying in the Pantanal, an area where two of the major livelihoods are fishing and cattle ranching. I would hopefully have the opportunity to learn more about my passion-food. At the same time, during our pre-trip meetings I was preparing myself for eating rice and beans for every meal.

Upon my arrival I was greeted with a buffet of champions. Fresh tomatoes, roasted beets, sliced watermelon, roasted fish, and a new food I learned to be manioc. My expectations were blown out of the water and after having an ice cream cone that tasted like frozen frosting I was hooked on Brazilian cuisine.

After I got to the Jaguar Lodge, I met Miltao the chef who welcomed me into his kitchen with open arms. From then on I helped cook at least one meal a day, while broadening my Portuguese vocabulary along the way. Though Miltao spoke a few words of English and I about the same of Spanish, we didn't need words to cook.

In the kitchen there is a whole other language. We needed not communicate verbally when we could charade, laugh and learn. We swapped garlic techniques-him smashing cloves with a monstrous pestle and me boiling them for easy skin removal. I became really adept at motioning cooking motions and learned how to make traditional beans. As someone who is a real talker, having to go temporarily mute forced me to forge a deeper bond with Miltao and the others in the kitchen. I had to relate to and work with them without sharing how I was feeling or being able to ask what I could do. I was extremely freeing.

It was refreshing for me to see the community that gathers around food. The monotony of breakfast at seven, lunch at noon and dinner at seven created a common thread for all of us whether it was excitement for a meal or an opportunity to share stories of the day. It seemed as if food was the only thing we could truly count on in the Pantanal.

On one of our last nights, I thanked everyone the best way I knew how-by cooking. After about five hours in the kitchen, I couldn't pour enough of my heart into those dishes to quantify their kindness and hospitality. They kept thanking me for cooking but I just smiled, having learned that wherever I go, food is the universal language.

Visitors in a land of Animals

In my first few weeks here in the Pantanal I have seen more wildlife than I have in probably the last two years at home. The animals here, in this rural, slow paced setting, live alongside the people and are able to roam where they please without fences or barriers, the land here belongs to them, while the people are just visiting. The first day we arrived I was somewhat surprised and a little disturbed by the presence of the cows owned by Eduardo, the owner of the lodge. As I walked across the street, to the home I would be staying in, the long dirt driveway was lined with cows, as I walked past they all stopped grazing, lifted their heads and just stood there and starred at us; it was almost as if they were judging us and as if we were irritating them by disrupting their grazing, it was a look I've never seen on a cow. We quickly learned that the cows, as well as most of the animals and wildlife here are much different than at home. Here the cows, and all animals for that matter, come and go as they please, if you come near a mother with her calf she will charge you, and if you walk under a tree of the Capuchin monkeys they will throw sticks at you, the birds will squawk at you as you pass and will wake you up every morning at just about 5:30am and the bugs will attack at dusk and dawn.

In these three weeks I have also seen more Caiman and Capybara than I ever thought was possible. When Ethan told us how many Capybara – which look kind-of like giant pig sized guinea pigs – and Caiman – a type of alligator – we would see I had no way of comprehending what he meant, there are literally Caiman and Capybara, everywhere, in every little swamp and waterway, of which there are 1000's, there are Caiman covering the banks and even just on our worksite, we have seen three different families of Capybara passing through. In addition to the variety of animals here, the sheer number of each amazes me.

Last week, while I was helping to cook lunch with our wonderful chef Milton, a huge iguana came walking up from behind the kitchen, we fed it three whole raw eggs; Milton rolled the egg toward it and it would swallow it whole. That was the 4th iguana/lizard thing I had seen and after lunch today I saw another.

If you look in any direction at any time of day, you can see birds of all varieties. In the palm trees behind the Jaguar Lodge there is a group of five or six Hyacinth Macaws, which I think, have probably had more pictures taken of them than most celebrities. There are also occasionally brightly colored Toucans and Chestnut-eared Araucarias that eat the Papaya and other fruit from the trees in the front of the lodge. That's another part of the Pantanal I love - all of the homes here have so many fruit trees. They have trees full of oranges, limes, bananas, star fruits, guava and other fruits I've never heard of and all of the people here eat and use the fruit regularly. Each time we are at the Falcao's home to watch the world cup games they offer us fresh oranges which they literally just reach over and take from the tree beside their patio. Growing up and living in a mostly urban and suburban area in Michigan, fruit trees like this are rare if not non-existent, our fruit, comes from a grocery store not a tree in our yard.

I'm sure much of the reason we are able to see so much amazing wildlife is largely due to the sparse population of the Pantanal and the fact that where we are staying is a designated private reserve. What surprises me the most though, is how the animals here seem to run the land, while the people, seem to be the ones, fenced in and temporary. This is one of the only places I have seen where people have not taken over and have instead adapted to and used the wildlife and animals surrounding them as a source of eco tourism to be admired, rather than something to be feared, removed or contained.

Appendix C: Construction

Construction material quantities:

Concrete/Mortar	unit	kg/unit	units	total kg
Sand	cubic meter	1602	28	44856
Aggregate	cubic meter	1746	17.5	30555
Cement	50 kg sack	50	180	9000
Lime	20 kg sack	20	73	1460
Mortar mix	20 kg sack	20	8	160

Bricks/Tiles	unit	kg/unit	units	total kg
Small frogged brick	19x9x5.3cm	1.5	5200	7800
Ceramic brick, 8 holes	19x19x9cm	2.2	4100	9020
Roman tiles	16pc/m2 roof	2.4	7000	16800

Wood	head size	lin.meters	m3
Formwork	3x0.3cm		
Ripom, 4-5 m pcs	5x2.5cm	758	2.592
Caibros, 2-5 m pcs	6x6cm	520	1.872
Vigas, 6 m pcs	6x16cm	270	0.9475

Metal	Unit	Kg/Unit	Quantity	Total Kg
Rebar 3/8"	12-m bar	7500	21	157500
Rebar 4.2 mm	12-m bar	4800	55	264000
Rebar 5/16"	12-m bar	1308	87	113796
Total Rebar				535296
Wire	1 kg		22	
Screws	1 unit		240	
Nails	1 kg / sack		22	
Nuts	1 unit		84	
Washers	1 unit		84	
Plates	1 unit		42	

Infrastructure	unit	kg/unit	units	total kg
small frogged brick	19x9x5.3cm	1.5	5200	7800
Cement	50 kg sack	50	152.5	7625
Lime	20 kg sack	20	18	360
Sand	cubic meter	1602	7	11214
Aggregate	cubic meter	1746	17.5	30555

Walls	unit	kg/unit	units	total kg
Ceramic Brick, 8 holes	19x19x9cm	2.2	4100	9020
Lime (1 sack per batch)		20	55	1100
Cement (1/2 sack per batch)		50	27.5	1375
Sand	cubic meter	1602	21	33642

Rebar			
Nominal size	Diameter (mm)	kg/meter	kg/12-m bar
Ø 3/8"	10.0	0.616	7500
Ø 5/16"	8.0	0.394	4800
Ø 4.2 mm	4.2	0.109	1308

Material estimated versus actual prices:

Material	Unit	Estimate	Actual	Actual - Estimate	Reals/Unit	Price Difference
Sand	m ³	29	28	-1	R\$ 42.50	R\$ (42.50)
Aggregate	m ³	21.5	17.5	-4	R\$ 44.50	R\$ (178.00)
Cement	50-kg sack	163	180	17	R\$ 28.00	R\$ 476.00
Lime	20-kg sack	97	73	-24	R\$ 7.10	R\$ (170.40)
Small brick	1 piece	5200	5200	0	R\$ 0.17	R\$ -
8-holes brick	1 piece	5900	4100	-1800	R\$ 0.39	R\$ (702.00)
Roman tiles	1 piece	7000	7000	0	R\$ 0.94	R\$ -
Rebar 3.8	barra	21	21	0	R\$ 52.00	R\$ -
Rebar 5.16	barra	55	55	0	R\$ 30.00	R\$ -
Rebar 4.2	barra	87	87	0	R\$ 8.00	R\$ -
Wire	kg	16.5	22	5.5	R\$ 9.00	R\$ 49.50
Total						R\$ (567.40)

Appendix D: Estimated school operation costs

OPERATION COSTS	
<i>INITIAL</i>	
bus	R\$ 25,000.00
outfitting	R\$ 2,000.00
textbooks	R\$ 300.00
initial total	R\$ 27,300.00
<i>ON-GOING</i>	
teacher	R\$ 11,000.00
driver	R\$ 5,800.00
cook	R\$ 5,800.00
boat gas	R\$ 725.00
bus maintenance	R\$ 1,500.00
bus gas	R\$ 2,610.00
food	R\$ 3,625.00
food propane	R\$ 290.00
emergency diesel	R\$ 850.00
on-going total	R\$ 32,200.00

Appendix E: Air travel

Flight definitions	# of kilometers	kg CO2/km
Short	<452	0.18
Medium	<1600	0.126
Long	>1600	0.11

Source: http://www.webflyer.com/travel/mileage_calculator/

Airport Code	one-way distance(km)	Flight definition	kg CO2/km	one-way kg CO2	round trip kg CO2	# of trips	Total kg CO2
DTW-CGB 1	9750			1093.78	2187.56		
DTW-MIA	1850	Long	0.11	203.5	407	19	7733
MIA-GRU	6570	Long	0.11	722.7	1445.4		27462.6
GRU-CGB	1330	Medium	0.126	167.58	335.16		6368.04
DTW-CGB 2	8563			971.258	1942.516		
DTW-ATL	959	Medium	0.126	120.834	241.668	2	483.336
ATL-BSB	6730	Long	0.11	740.3	1480.6		2961.2
BSB-CGB	874	Medium	0.126	110.124	220.248		440.496
RIC-CGB	9230			1057.86	2115.72		
RIC-MIA	1330	Medium	0.126	167.58	335.16	2	670.32
MIA-GRU	6570	Long	0.11	722.7	1445.4		2890.8
GRU-CGB	1330	Medium	0.126	167.58	335.16		670.32
RKD-CGB	10170			1139.98	2279.96		
RKD-MIA	2270	Long	0.11	249.7	499.4	1	499.4
MIA-GRU	6570	Long	0.11	722.7	1445.4		1445.4
GRU-CGB	1330	Medium	0.126	167.58	335.16		335.16
Grand total						24	51960.072

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