ADVANCING HUMANITY in BELIZE

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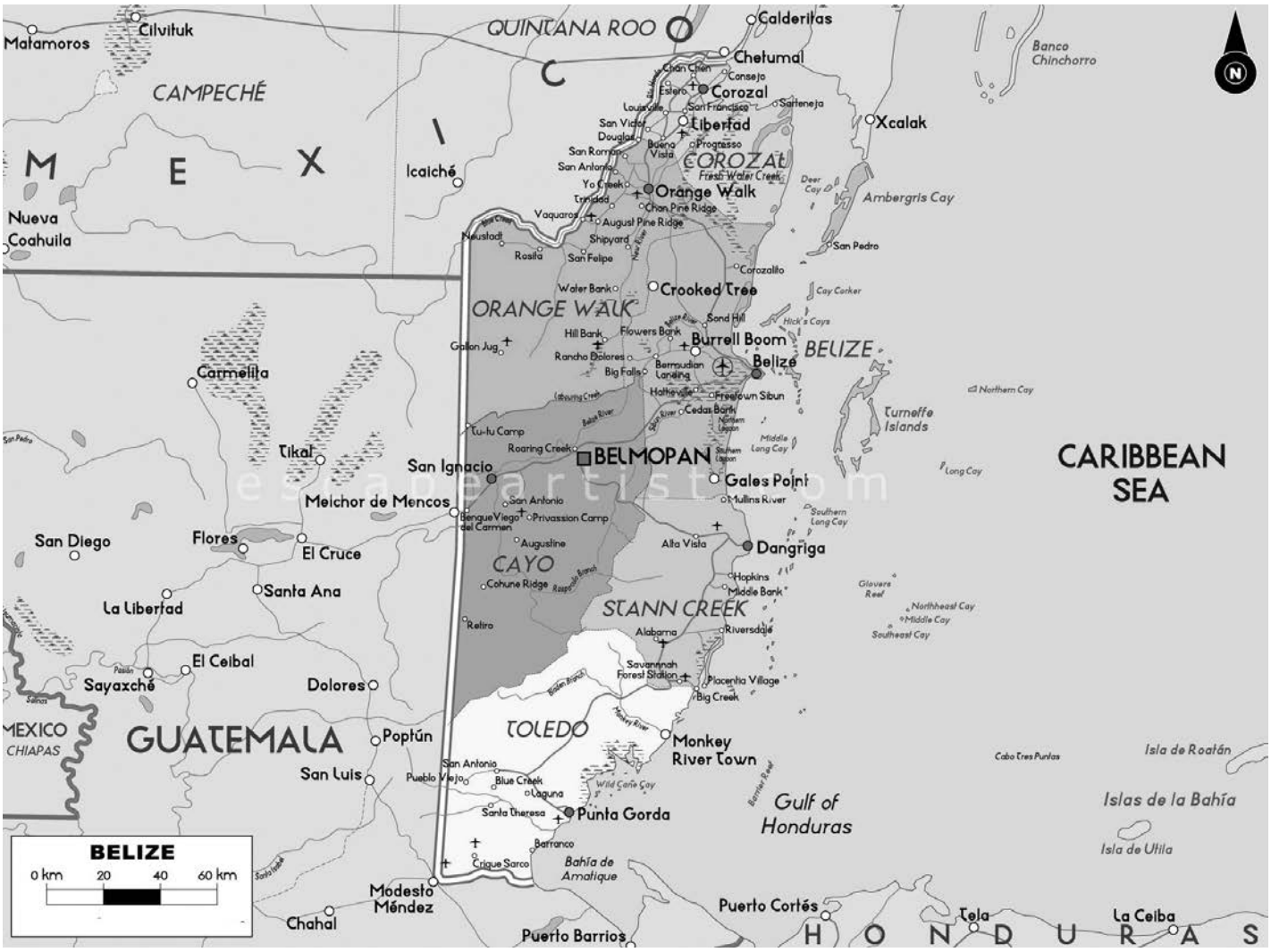


COMMUNITY-BASED RESEARCH IN BELIZE 2010 - 2012

Mary Ann Studer, M.S., McMaster Fellow, Belize 2010 - 2012

What has allowed the McMaster Belize learning communities to make those non-linear connections over the years has been our ability to organize these community-driven research projects within an interdisciplinary framework. We have used a modified version of Integrated Natural Resource Management (Izac & Sanchez, 2001) for the past eight years which has focused our efforts on enhancing ecosystem functions, enhancing human well-being, and enhancing productivity collectively.

It seems that it would be a challenge, year after year, to work with an interdisciplinary learning community of students and faculty to affect change in the context of another culture far removed from the Defiance College campus. While it seems that distances geographically and between disciplines would make our work in Belize more difficult, they, in fact do just the opposite. First of all, repeated presence and collaboration in northern Belize initially facilitated by Programme for Belize has become increasingly direct. Working with Programme for Belize ranger Ivan Gillett and dialoguing within the communities surrounding the Rio Bravo Conservation and Management Area has allowed our work to be explicitly directed by communities on the ground. Bridges of trust have been built which, coupled with a now tangible understanding of the McMaster School's commitment, supports a deeper level of collaboration and impact. The community-based research has also become enhanced, addressing more complex problems. In a real world context the pressing issues or problems most always require interdisciplinary consideration and thus each multidisciplinary group of faculty and students has had to develop mechanisms for working across disciplines to be effective.

What has allowed the McMaster Belize learning communities to make those non-linear connections over the years has been our ability to organize these community-driven research projects within an interdisciplinary framework. We have used a modified version of Integrated Natural Resource Management (Izac & Sanchez, 2001) for the past eight years which has focused our efforts on enhancing ecosystem functions, enhancing human well-being, and enhancing productivity collectively. Over the last two years (2010-2012) we have been able to recognize mechanisms for more effective focus in the remote village of San Carlos Belize in the areas of education and economic development.

Addressing San Carlos Government School's request for pedagogical modeling, suggestions for parental involvement, and their positive reaction to lessons applicable to everyday life has directed our focus, albeit somewhat in hindsight. We are strategically promoting an appreciation for education among the village's adults, so regardless of subject matter or pedagogy, we are committed to modeling lessons with recognizable application. This allows both students and their parents to experience the advantages of education real time instead of having to foresee advantages years from the present. For a subsistence community, this is critically important.

We have also recognized that because of the village's remote location and lack of infrastructure there is an economic cap on the village. Employment for women outside of the village is not feasible in most cases, and the men are working in the fields to provide food and a fixed amount of produce to sell in markets several hours away. Bringing new money into the economic cycle at San Carlos is imperative. In 2011 a women's group was started in the village and by the spring of 2012 this group, working with the McMaster School, opened the San Carlos Sunbreeze restaurant. Sunbreeze serves a

significant Mennonite population that resides in the region and may at some future point be able to attract tourists to the village. It is bringing income and with it opportunity to the village by increasing productivity. In addition, a survey completed by a scholar in December 2011 uncovered artisan talent and capabilities we never knew existed in this agricultural village. Art production is a luxury not afforded in a subsistence community with so little resources; however, art that can be sold through Defiance College's emerging fair trade initiative becomes valuable and an additional way to improve the area's economic condition. This was eye-opening.

I would be remiss if I didn't address the ongoing impactful work that our fellows and scholars are doing to improve the village's access to clean water. In the last two years of testing water, in both the village of San Carlos and the New River Lagoon, results have moved from routine baseline compilation to identification of major contaminants – biological and chemical. Our efforts to remediate these contaminants, identify the sources of contaminants, and secure a viable water source for the village will continue to be a focus of our work until solutions are reached.

Above are just a few of the projects from the last two years of this initiative. We have every reason to believe that our ongoing work with these communities will significantly empower people to develop from the margins toward viable sustainability. The abstracts that follow clearly reveal that a significant amount of work remains. Often results pose more questions than answers, and so we continue to utilize our expertise collaboratively with our community partners for positive impact.

Artisan at San Carlos with Cord Speelman, scholar

Reference

Izac, A. M., & Sanchez, P. A. (2001). Towards a natural resource management paradigm for international agriculture: the example of agroforestry research. *Agricultural Systems*, 69, 5-25.

Village meeting to discuss water contamination

Teaching first aid, CPR, Allie Beck, scholar, and Mark Gordon

Teaching CPR, First Aid, the Heimlich, and Water Safety to Rural Belizean Villages

Allie Beck, McMaster Scholar, Belize 2010 - 2011

The purpose of my project was to teach CPR, First Aid, the Heimlich, and water safety to isolated schools on the periphery of the Rio Bravo Conservation and Management Area in northern Belize. Specifically I worked within the schools and villages of San Carlos and St. Paul's Bank to enhance their knowledge of and skills in emergency response. Accidents happen every day and injuries that could be treated by a local emergency room in the United States could be deadly to someone who is not within close proximity of a hospital, as is the case in rural Belizean villages. Therefore, it is of utmost importance that these isolated communities that are two to three hours away from emergency healthcare learn mechanisms that can save a life or buy enough time to reach a hospital.

The CPR, First Aid, and Heimlich demonstration in San Carlos was attended by all the children and teachers in the school as well as a large number of community members. This group then followed the McMaster team to the edge of the Lagoon bordering the village for a brief demonstration of water safety and rescue. Because of President Mark Gordon's ability to translate my English into Spanish, the majority of attendees were able to easily understand what was being taught. The involvement of the crowd evidenced what they remembered from past years and reinforced the importance of this training to these communities.

Bringing Solar Power Education to San Carlos Government School, Belize

Angela Burklo, McMaster Scholar, Belize 2010 - 2011

One goal of my McMaster project was to better educate the students at San Carlos Government School in Belize about solar power and how this alternative type of energy is used to provide light for their school via a solar panel system that was installed as a result of another McMaster initiative in 2009. The village of San Carlos is isolated from the power grid that provides electricity to other areas of Belize; therefore, it is important for them to understand how solar power is harnessed, as well as how this type of energy could be used to provide power to other areas within their village. My second goal was to obtain solar lanterns for the students. By having lightweight, portable lanterns, students not only gained a better understanding of solar cells but also have the opportunity to read and study in their homes at night. This increases literacy and the overall livelihood of San Carlos. Having knowledge of solar energy and its rewards can now provide advancement in future educational and occupational opportunities for students in the innovative field of alternative energy. This project has enhanced my academic experience by having the chance to both educate and be educated by citizens of another culture, strengthening my breadth of skills as a teacher.

The remote location of San Carlos puts the community and their children a step behind other areas of Belize that have access to electricity. Considering the geographic and climatic conditions of San Carlos, solar power is possibly the most effective and affordable means of providing power to their village. By educating the next generation of community leaders about solar energy and how solar cells work, the chances of advancement and opportunity in their village become greater. Through consideration of the culture, roles, and developmental levels of the students, I was able to provide them with a strong foundation in the future of alternative energy in their village. Having the opportunity to spend time in San Carlos Government School allowed the students and me to learn from one another. Together we generated new ideas and solutions to use alternative energy for advancement in their village and, in the process, using natural resources to effectively care for and preserve the Earth's environment.

The students and teachers at San Carlos Government School were very receptive to learning about solar energy and how solar cells work. The students enjoyed doing hands-on activities that took them outside of the classroom, helping them connect the lesson material with real-world opportunities for the future. Following the lessons, I distributed solar lanterns to the students' families providing students access to light for studying and reading in the evenings. During a meeting with the village members of San Carlos the following day, all families had positive feedback about the lanterns, the amount of light they provided, and the length of time they stay charged. I had several requests for more lanterns that could be addressed and/or met with future projects.

The teachers at San Carlos Government School showed a sincere appreciation and interest for what I could offer as a science and language arts teacher. Not only did we share ideas and learn from each other, but we also forged lasting relationships that reflect mutual respect, friendship, and, most importantly, a genuine and heartfelt concern for the students at their school. It is apparent that no matter the country you are in, the top priorities of all teachers is providing a challenging and engaging educational experience while holding students to high standards and expectations of learning. These criteria provide students with the most relevant and meaningful educational experience possible, and it is apparent that the students in San Carlos are successful as learners.

Escherichia coli Assessment in the Waters of Northern Belize

Brittany Heaton, McMaster Scholar, Belize 2010 – 2011

Water quality is an important issue to consider when it comes to ensuring the health and safety of people around the world, including Belize. Residents of northern Belize rely on the water they collect in wells and cisterns, as well as water from the New River Lagoon and its tributaries. Biological contaminants, specifically *Escherichia coli*, have not been previously tested for in these sources and can cause major health problems. To help provide assurance of safe water, this project tested the waters in close proximity to residential areas for *E. coli*. A total of twelve samples were collected and tested for coliform bacteria including *E. coli* from locations including the New River Lagoon and multiple wells in the villages of San Carlos and St. Paul's Bank. Of six wells tested in the village of San Carlos, five showed positive results for *E. coli*. Despite the seemingly easy remedy to eliminate *E. coli* in the water, a major problem was faced. In fellow scholar Thomas Studer's project, which tested for chemical contaminants in the waters in Northern Belize, high levels of nitrates were also found in the same wells in which I found *E. coli*. This created a problem because the remediation steps for the *E. coli* conflicted with remediation steps for the nitrates.

In order to relay the *E. coli* and nitrate issues, Mary Ann Studer, Thomas Studer, Ivan Gillett and I held a village meeting at the school in San Carlos. With the help of the village Chairman, Mr. Perez, we explained to attending villagers the results of our testing in terms that they would understand without any foreknowledge of the contaminants and their consequences. The presence of *E. coli* in the vast majority of the village was slightly alarming due to the known health effects. However, when we asked villagers if they knew of anyone with the symptoms of being infected with *E. coli*, no one gave a definitive answer. Since rural areas of Belize have no way of reporting illnesses and cause of death is not confirmed by medical professionals, we were unable to examine death statistics for possible *E. coli* causes. While it is also possible that people were not reporting illnesses due to *E. coli* because the *E. coli* strain present in the wells is not a toxic strain, the only way to know for certain is to carry out further studies, then grow and analyze the colonies of *E. coli* present in the wells. The data I collected was sent to Programme for Belize to contribute to baseline data of the New River Lagoon and surrounding waters. Subsequently the data was forwarded the Government of Belize through Programme for Belize. In response, the government of Belize drilled and cased a new well for the village of San Carlos.

Mapping the Roads and Potential Nesting Sites of Yellow-headed Parrots in Northern Belize

Greg McNutt, McMaster Scholar, Belize 2010 - 2011

This project involved collecting and recording the Global Positioning System (GPS) coordinates throughout the Rio Bravo Conservation and Management Area and its periphery in northern Belize to determine specific geographic locations for two different objectives. The first objective was to use GPS technology to map the roads throughout the periphery of the Rio Bravo Conservation and Management Area in order to create an organized map of the roads surrounding this conservation area. An accurate map of the area roads will allow future McMaster Belize teams to split up if necessary in order to be more effective and perhaps engage in multiple projects simultaneously in different locations. In addition, the resulting map will be provided to emergency personnel that have to travel as long as 2-3 hours away as they respond to a critical situation.

The second objective was to provide Programme for Belize an accurate map of the potential nesting sites of Yellow-headed

Parrot (*Amazona oratrix*) using GPS within the savanna area of the Rio Bravo Conservation and Management Area. The popularity of the Yellow-headed Parrot as a pet continues to fuel poaching efforts which have nearly driven the species to extinction in the wild. Their population in the wild has declined from 70,000 to 7,000 in the past twenty years (*Amazona oratrix*, 2008). This map will be used by Programme for Belize rangers working to preserve this endangered species, thus allowing the rangers to chronicle and monitor Yellow-headed Parrot nesting sites and also determine the population of these birds in the area.

The data (GPS coordinates collected while on site) for both aspects of the project was then transferred to ArcGIS (geographic information system software) and two specific maps were created. Both maps were delivered to Programme for Belize, the non-governmental organization that manages the Rio Bravo Conservation and Management Area. The road map was also sent to the nearest hospital with emergency response capabilities in Orange Walk, Belize. In addition, the map of the roads is currently being used by subsequent McMaster teams to Belize.

Reference

BirdLife International (2008). *Amazona oratrix*. *IUCN 2010. IUCN red list of threatened species* (Version 2010.4). Retrieved from http://www.iucnredlist.org

Campaign Plan Targeted at Improving Access to Education in Rural Belize

Richard Sherrer, McMaster Scholar, Belize 2010 – 2011

The purpose of this project was to formulate a fundraising plan and then fundraise for teacher housing for the village of San Carlos. The project began when the teachers of San Carlos Government School requested teacher housing that would enable them to overnight in the village instead of making a 2-3 hour one-way commute home each evening. Having the teachers in residence would allow for evening tutoring sessions and access to the sole source of electricity in the village–the school solar powered system installed through a McMaster initiative in 2009.

I created a fundraising plan and strategy to reach my goal of $4,500 to build housing for the teachers. This fundraising plan started prior to my being on the ground in Belize to ensure that I had a template to present to the community leaders and the teachers of the school. This was important because we needed to keep the goal in mind of constructing a plan that worked in partnership with the community of San Carlos. This project was the number one request from both community leaders and teachers. My project continued to progress while I was on the ground in Belize. I found ways to gather the demographics that I needed for my fundraising plan. I mapped out the site for the teacher house, priced materials, and documented the results of the trip through pictures and writing. Through a series of public speaking engagements, bake sales, and an innovative attempt to bolster Defiance College spirit through DC flag sales, the goal was met in March 2011.

Teachers' House in San Carlos

In late April 2011 I traveled back to Belize with Mary Ann Studer and three community members to construct the house in just five days. In temperatures reaching 100 degrees each day, we secured the materials and with the help of the community, completed the house late in the evening just before we flew home. It has been reported that the teachers utilize the house on a regular basis and as a result the students have access to both light and academic support in the evenings.

Water Quality Analysis Belize 2010-2011

Thomas Studer, McMaster Scholar, Belize 2010 – 2011

The purpose of this project was to conduct water quality tests to gain baseline information for pH, nitrates, ammonia, free chlorine, phosphates, and dissolved oxygen in the New River Lagoon and surrounding tributaries, local wells, and cisterns as requested by community partners in local towns and villages to contribute to the 6-year watershed quality monitoring project. I also worked to determine more accurate methods for nitrate testing when in the field. The data was to be distributed to the community partners in local towns and villages as well as Programme for Belize to inform them about the quality of their drinking water, environmental waterways, as well as any contaminants that could pose a health risk.

One of the targets set forth by the UN Millennium Goals is to "reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation" by 2015 (Prüss-Üstün, Bos, Gore, & Bartram, 2008). Accessible drinking water is critical for overall human health and wellbeing (Prüss-Üstün, Bos, Gore, & Bartram, 2008). The lack of clean drinking water is a major issue, and I hope my work helped to improve access to clean water in these areas in Belize.

At 1,355 hectares in size, the New River Lagoon is the largest freshwater source in Belize (Meerman, 2006). Much of the water flow into the New River Lagoon is contributed by Irish Creek and Ram Goat Creek (Meerman, 2006). Without the Lagoon, much of the natural habitat and local human population would suffer greatly. It is for this reason that the waters of the New River Lagoon must be tested and maintained.

In doing this project I contributed to the existing water project by continuing to test sites from previous McMaster expeditions to Belize. I had familiarized myself with the Hach water test kits used in past Belize trips and used the Hach Surface Water Test Kits to test for pH, ammonia, free chlorine, phosphates, and dissolved oxygen. The only exception was the use of the Hach digital colorimeter for nitrate testing. All testing was conducted on site at the Hillbank Research Station; the results of testing were compiled and given to community partners while still in Belize. Once I returned to campus the results were analyzed for comparisons with the water quality results from past years.

The quality of the surface waters in the New River Lagoon and its tributaries all tested parameters were within safe limits. In San Carlos all tested parameters were within safe limits as prescribed by the Environmental Protection Agency except high readings of nitrate nitrogen were found in all but one well. This information was brought to the attention of the people of San Carlos in a town meeting shortly after the results were compiled on the ground. As a result of the meeting, a short term solution was developed and initiated by the village of San Carlos to build a rain catch above the village school in order to collect and store drinkable water for use during the dry season. The exact cause of the high nitrate readings is unknown at this time although it is critical that nitrate remediation practices be researched and established in the near future. This information was also presented to Programme for Belize which alerted the Belizean government of these potentially critical results. The government trucked water to the village of San Carlos until a new well could be dug to provide the village with safe water. By the spring of 2011 the Belizean government had dug and cased a new well for the village.

References

Hach. (2010). Hach Knowledge Base. Retrieved March 18, 2010 from http://www.hach.com/hc/view.knowledge.base.detail.invoker/PackagingCode=CHLORINE-GEN_1/NewLinkLabel=Free+vs.+Total+Chlorine

Meerman, J. (2006, May 30). Ecological characterization of the New River Lagoon Orange Walk District, Belize. Retrieved March 18, 2010 from http://mcmaster-belize.wikispaces.com/file/view/New_River_Lagoon_Characterization.pdf

Prüss-Üstün, A., Bos, R., Gore, F., & Bartram, J. (2008). Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health. World Health Organization.

U.S. Environmental Protection Agency. (2010). 2009 edition of the drinking water standards and health advisories. Retrieved March 18, 2010 from http://www.epa.gov/waterscience/criteria/drinking/dwstandards2009.pdf

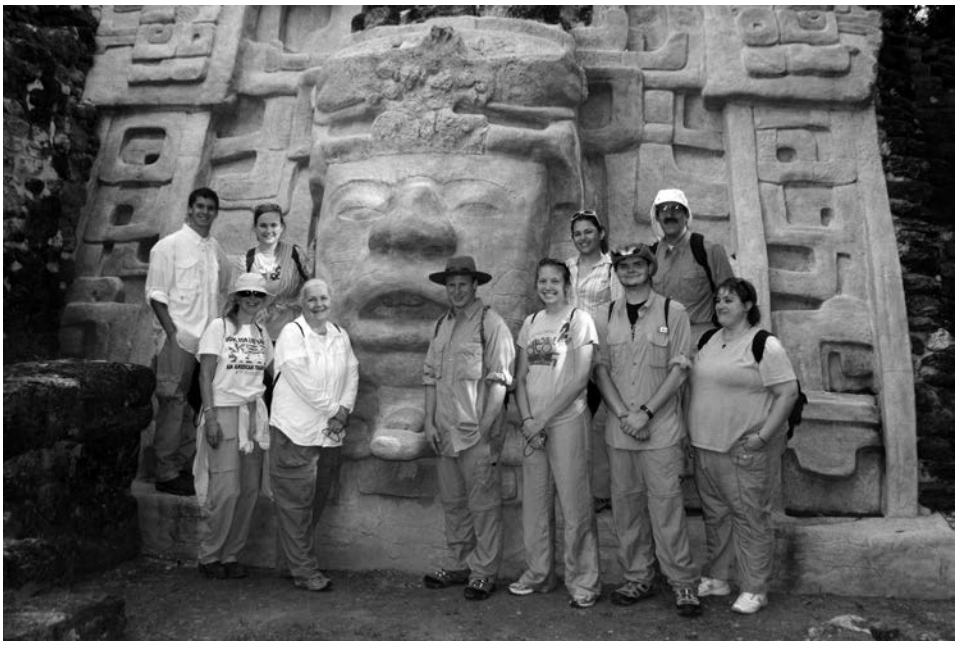
Education in Belize: Helping to Meet Government Standards

Courtney Swabb, McMaster Scholar, Belize 2010 – 2011

In its National Syllabus, the Belize Ministry of Education states, "The ultimate goal is to have all students successfully complete their primary school education, perceive themselves as successful learners, and demonstrate a desire to obtain further education" (Ministry of Education, 2006). The Ministry hopes to successfully educate students by providing minimum standards within their divisions of education in relation to the areas of study. This project focused on the third area of study: social studies and personal development.

Previous McMaster Scholars have focused on advancing the functional literacy of the students in San Carlos Government School. This emphasis, coupled with the McMaster Belize initiative's educational focus on developing explicit links between education and application in the rural communities in Belize, directed my lesson design and implementation.

Although English is the primary language within the Belizean school system, many families still speak Spanish at home. As a result, it becomes the schools' partial responsibility to make sure the students speak English as the primary language. By assisting the teachers of San Carlos and St. Paul's Bank with new lesson plans that include the families at home, we began the process of implementing English at home within Belizean communities.



Belize team 2010-2011 at Lamanai Maya ruins

Lesson plans based on the learning objectives put in place by the Belize Ministry of Education were designed to help teachers meet the requirements laid out within the National Syllabus under the social studies section including history of Belize, major events in world history, and world geography. The lesson plans were developed for each of the grade levels within the Belizean school system with content specific to the learning objective associated in that particular age group.

I was responsible for teaching three lessons while in Belize; each one targeted for each of the three divisions of education in Belize. These lessons modeled for the teachers of San Carlos and St. Paul's Bank the integration into everyday curriculum the maps and manipulatives I provided. My lesson plan for the lower division focused on cultural differences as they relate to geography. The lesson for the middle division focused mainly on the physical environment of Belize, specifically natural causes in relation to adaptation. For the upper division, the lesson was designed to be much more interactive, focusing on how major landforms around the world evolved.

I ended my project by surveying the teachers to gather ideas that could perhaps inspire future McMaster projects to help build up the schools of the Belizean community, which is part of my ultimate goal.

References

Belize Ministry of Education, Culture, Youth & Sports (2006). National syllabus. *World data on education.* 6th edition. Retrieved 14 September 2010 from http://ddp-ext.worldbank.org/EdStats/BLZwde07.pdf

Community-Based Research in Northern Belize

Mary Ann Studer, McMaster Fellow, Belize 2010 – 2012

Soil Analysis in Agricultural Subtropics

Northern Belize is an area struggling to develop sustainably, balancing indigenous farmers' exploitation of their 'natural capital' in order to feed their families against the vision of preservation of rainforest and savanna and desperately trying to put in place an infrastructure that supports an improved quality of life for each individual and each community. This project partnered with remote indigenous agricultural populations to: (1) provide farmers with soil nutrient analysis that has the potential to increase profitability while simultaneously preserving the soil; and (2) offer protocols for remediation of soil degradation.

A field sheet was prepared for each field tested that included an analyses of soil color using the Munsell scale, texture, pH, and the results of a physical assessment of soil quality I conducted while onsite using a modified version of the schema Observational Approach to Soil Health (Romig, Garlynd, & McSweeney, 1995). Criteria for the modification were synthesized using information provided by Assessment of Soil Quality by Maurice J. Mausbach and Cathy A. Seybold (Lal, 1998). All macro and micro soil nutrient analyses were completed using LaMotte Smart2 Electronic Soil analysis apparatus. The following chemical reactions were completed to allow for digital analysis of the soil extract to quantify nutrient levels to hundredths of parts per million or pounds per acre.

Macronutrients (LaMotte, 2004)

Nutrient	**Protocol**
Nitrate-Nitrogen	Cadmium Reduction Method
Nitrite-Nitrogen	Diazotization Method
Phosphorus	Ascorbic Acid Reduction Method
Potassium	Tetraphenylboron Method
Calcium	Schwarzenbach EDTA Method
Magnesium	Schwarzenbach EDTA Method

Micronutrients (LaMotte, 2004)

Nutrient	**Protocol**
Manganese	Periodate Method
Iron	Bipyridyl Method
Chloride	Direct Reading Titrator Method
Copper	Diethyzdithiocarbamate Method
Ammonia-N	Nesslerization Method

In addition to providing soil nutrient analysis to individual farmers along with recommended mechanisms for more sustainable soil utilization, comparisons were also made between the nutrient levels in the fields of farmers with whom I have been partnering since 2005 and farmers with whom new partnerships developed in December 2010. Macronutrient levels were lower and more stable in the fields where I had previously tested and advised. Nitrogen levels were 58% higher in new fields tested. Potassium levels were 7% higher in new fields tested. Phosphorus levels were 31% higher in the new fields tested. It should be noted that the fields that have been repeatedly monitored for the past seven years showed nutrient levels evidencing the effective use of this project's information; none of these fields showed signs of over fertilization and all exhibited improved soil health.

Soil nutrient analysis continued in December 2011. This project has evolved in several directions based on the work over the last eight years. Past studies of cleared rainforest soil evidence the rapid depletion of nutrients (Ayoub, 1999). This concept has been supported over the course of this project through data gathered from fields that have not been fertilized and have been allowed to remain fallow. While fallow periods are generally short, one year, in these subsistence communities in northern Belize nutrient levels rapidly diminish. In addition, as dialogue has increased between myself and the farmers I work with, I have been able to see the correlation between the amounts and types of fertilizer used with the results of nutrient testing. Therefore this project offers an annual monitoring of nutrient levels for those farmers' fields that we worked with repeatedly. Thus rather than its initial purpose to reduce the use of inorganic inputs, this project now provides the necessary information to maintain minimal levels of input for optimal yield and supports continuing rather than increasing levels of profitability. The results from soil analyses conducted during the December 2011 trip showed near optimal levels of nutrients (crop specific) for all the fields tested. No field tested showed high levels of any macronutrient. These results are exciting because they indicate that the farmers that I have been working are now utilizing appropriate fertilizer inputs not only relative to soil types but also to the crops they are planting.

Secondly it has become increasingly important to monitor agricultural fields that border the Rio Bravo Conservation and Management Area for Programme for Belize. I have monitored fields adjacent to the Rio Bravo's carbon sequestration plot at the northern end of the conservation area owned by mechanized Mennonite farmers for the past eight years. This information is provided to Programme for Belize as a way to monitor the level of inorganic fertilizers used and the potential threat this could pose to their large carbon sequestration plot. These farmers have become increasingly profitable and as a

result have significantly increased their ability to utilize sprayers to apply copious amounts of chemicals to the fields. Having a baseline of soil nutrient levels over the years provides a gauge by which to monitor the potential impact of this increase mechanization. While none of these field samples indicated over fertilization, this testing needs to continue to monitor those fields in close proximity to the Rio Bravo.

Nitrate Assay of Water at Depth

The results of testing conducted in December 2010 by McMaster Scholars Thomas Studer and Brittany Heaton showed high levels of nitrates (Studer) and *E. coli* (Heaton) in the majority of water sources in the village of San Carlos Belize. Elevated levels of nitrates first appeared in two locations in the village in December 2009, prior to which all the levels had been within the safe range based on the United States Environmental Protection Agency (EPA) standards. While the scholars in partnership with the village contemplated building a rain catch as an additional source of freshwater, I looked to the New River Lagoon right off shore from the village. The New River Lagoon is the largest freshwater body in Belize and while surface water in the Lagoon also indicated high nitrate levels (Studer), we hadn't tested below the surface more than we could reach with our hands out of the boat. Finding a nearly limitless water supply with low levels of nitrates would be critical to securing a potable water source for the village. So I decided to begin to look at the nitrate levels of the water in the New River Lagoon at various depths.

While biological contaminants such as *E. coli* can be relatively easily remediated, removing nitrates from water is much more complex. If the water in the Lagoon below the surface showed low nitrate levels (within EPA safe standards) then dealing with the inherent biological contaminants may be feasible. Thus preliminary testing was done bracketing the village of San Carlos's access to the Lagoon. Using a Van Dorn tube, testing was conducted at the following locations:

- upstream from San Carlos at 45.72m (50 yds.) from shore at a depth of 2m, and at 91.44m (100 yds.) from shore at a depth of 10m;
- downstream from San Carlos at 45.72m (50 yds.) from shore at a depth of 2m, and at 91.44m (100 yds.) from shore at a depth of 10m;
- aligned with San Carlos at 45.72m (50 yds.) from shore at a depth of 2m; and at 91.44m (100 yds.) from shore at a depth of 10m, 137.16m (300 yds.) from shore at a depth of 15m.

All sites were marked using GPS (Global Positioning System). A Hach Pocket Colorimeter II device and nitrate testing protocol (cadmium reduction method) were used to digitally determine nitrate levels.

The levels of nitrates at the above sites ranged from 3.98mg/L – 6.16mg/L, well under the EPA cap of 10mg/L for safe levels. In some cases the results showed nitrate levels at a minimum depth of 2 meters to be 10mg/L less than at the surface in the same location. These results provided more questions than answers about the sources contributing to high levels of nitrates in surface waters and significantly lower levels at depth. The other factor at play here is the timing of this assay. In December the group is conducting water testing at the very end of the rainy season in Belize. This too could have a significant impact on the results obtained if the nitrate contamination is due to runoff from an onshore source, caused by a change in rainwater composition, flow of water deposited inland by tropical storms, or most probably a combination of sources. Testing nitrate levels of depth will be a continuing project as the McMaster team moves toward better understanding of the threats to clean water for the village of San Carlos and the New River Lagoon.

References

Ayoub, A. T. (1999). Fertilizers and the environment. *Nutrient Cycling in Agrosystems, 55*, 117-121.

Lal, R. (Ed.). (1998). *Soil Quality and Agricultrual Sustainability.* Chelsea, Michigan: Ann Arbor Press.

LaMotte. (2004). Smart 2 Electronic Soil Manual and Test Instructions.

Romig, D. E., Garlynd, M. J., & McSweeney, K. (1995). How farmers assess soil health and quality. *Journal of Soil and Water Conservation, 50*, 229-236.

Testing water in New River Lagoon, Mary Ann Studer, fellow

Installing nitrate filter on rain catch, Ken Adair, fellow

Remediation of Elevated Nitrate Levels in the Village of San Carlos Belize

Ken Adair, McMaster Fellow, Belize 2011 - 2012

Introduction

Defiance College's McMaster Belize initiative was originally designed with a narrow goal of providing basic water quality assessment of the New River Lagoon within the Rio Bravo Conservation and Management Area in service to Programme for Belize (Mavroidis, Schurter, Johnson, Putman, & Sattler, 2006). Over the past seven years this initiative has expanded both geographically as DC students and staff have forged relationships with communities on the periphery of the Rio Bravo and also in scope to simultaneously focus on other efforts that seek to improve the quality of life in these communities (Studer, et al., 2007; Mavroidis, et al., 2008; Studer, et al., 2009). Doing so has enriched the cross-cultural experience as it allows our students the opportunity to share a broader range of expertise and allows them to work with a more diverse cross section of Belizean culture. The downside of this growth is that we have not always had the expertise or capacity to respond to issues discovered through this work.

During the past two years McMaster scholars testing the potability of drinking water in the village of San Carlos have discovered concentrations of nitrate ion that are approximately 50% higher than those recommended by the World Health Organization (WHO) and the U.S. Environmental Protection Agency (EPA), and in some cases even greater than that (T. Studer, personal communication, February 11, 2012). Additionally during the 2010-2011 academic year, biological testing on these water sources discovered that the problem is compounded by the presence of a significant *E. coli* outbreak (T. Studer, personal communication, February 11, 2012). While the bacterial problem can be treated by boiling water prior to consumption, doing so will only serve to concentrate the nitrate ion further. Comprehensive water quality remediation will require chemical methods to deal with the elevated nitrate levels, biological methods to deal with the *E. coli*, and geological assessment to reduce the levels of bacteria and nitrates leeching into these wells. Unfortunately since the original water quality project was envisioned to provide baseline data and not respond to that data, we have never provided these services to our community partners in San Carlos.

This project sought to establish a source of healthy drinking water within the village of San Carlos and investigate potential methods for long-term nitrate remediation throughout the village. The strategy employed involved installing a commercial nitrate filter on the rain catch at the San Carlos Government School. With a source of low nitrate drinking water secure, our efforts can now shift towards understanding the underlying issues leading to the observed nitrate levels.

Water quality analysis in the village of San Carlos

The availability of affordable clean drinking water has been recognized by organizations such as the United Nations, World Health Organization, and the National Academy of Sciences as a basic human right. It is, however, a reality that too few citizens of this world possess. Our community partners in the village of San Carlos Belize in particular have plentiful access to water but do not have the means to adequately sanitize it, nor the financial resources to access clean water from outside the village. As such, they regularly consume water with elevated levels of nitrates and bacteria (T. Studer, personal communication, February 11, 2012).

Health consequences of elevated nitrate levels
Long term exposure to elevated nitrate levels has been related to many adverse health effects, most notably methemoglobinemia. Methemoglobinemia occurs when the iron(II) ion contained within heme group of hemoglobin is oxidized to form iron(III). Unlike hemoglobin which is responsible for transportation of oxygen throughout the body, the resulting methemoglobin is incapable of binding oxygen and as a result the availability of oxygen throughout the body is reduced. This condition is particularly serious in infants where it is a primary cause of blue baby syndrome, often resulting in death. Any reduction in nitrate levels will benefit our community partners by improving their chances of avoiding such fate.

Materials and methods
Two filters were delivered to the village of San Carlos Belize as a result of this research. The first filter system consisted of Crystal Quest CQE-RC-04007 nitrate filter cartridge housed in a standard 10" filter housing purchased locally in Belize. This filter was installed on a communal rain catch located adjacent to the San Carlos Government School. The second filter system contained the same CQE-RC-04007 nitrate filter along with a Crystal Quest CQE-RC-04000 carbon filter and a CQE-RC-04002 Multi Stage filter cartridge Crystal Quest Mega Triple Countertop Water Filtration System. This system was donated to the San Carlos women's group to be installed at the Sunbreeze restaurant which in turn is the result of work by McMaster Scholar Bryant Green and the 2011 McMaster Belize Learning Community. All water testing was performed using a Hach Surface Water Test Kit. Results of this testing as well as select historical data can be found in appendix 1.

Results and discussion
A variety of means can be used to correct high nitrate concentrations with most of them focusing on catalysing the reduction of nitrates to volatile nitrogen and dinitrogen monoxide species (Lin, Chang, & Chuang, 2008) or by passing water through an ion selective resin as was performed here. The choice to install a comercially available ion selective system over developing a reductive system was made based on the reasonable cost, ease of installation, adaptability to a variety of installation environments, and the time required for the system to reach sustained performance. This decision proved fortunate as the installation environment was far different from expected.

The 2009 McMaster Belize Learning Community assisted in installing two cisterns on top of the San Carlos Government School to be fed by water pumped from the adjacent well. This water was then used to gravity feed several faucets in and around the school. Testing of this source during the 2009 and 2010 McMaster Belize Learning Communities revealed nitrate concentrations above the recommended 10mg/L consumption limit (13.2 and 16.3mg/L respectively) but free of bacterial contamination (T. Studer, personal communication, February 11, 2012). Due to the low bacterial contamination and communal access, this source was the anticipated installation site. During the 2011 McMaster Belize Learning Community, it was observed these cisterns were no longer in use and had been replaced by two cisterns at ground level fed by a rain catch. When the Mega Triple water treatment system was connected to these cisterns, the water pressure proved unsuitable due to the lower elevation of the water source. As a result the Mega Triple system was replaced by a single nitrate filter cartridge installed in a locally available 10" housing. Removing the non-nitrate filters from the treatment system proved sufficient to reduce the water pressure requirements of the system to what could be provided by the cisterns. Using this system the nitrate concentration was reduced from 12.1mg/L to 4.4mg/L, well within the WHO and EPA recommended maximum of 10mg/L for potable water.

Testing of rainwater collected in these cisterns revealed the surprising result that the rainwater itself is the source of elevated nitrate ion concentrations. It was anticipated the source of nitrate ion in the water supply was runoff from agricultural activity within the community. Nitrates from fertilizers and other additives could be expected to leach into the water supply as rainwater passes through the soil. The water collected in the cisterns at the San Carlos Government School revealed nitrate concentrations of 12.1mg/L (measured as nitrate-nitrogen), above the WHO and EPA recommendation. This result was in line with the nitrate ion concentrations observed in a rain catch constructed at the Hillbank Research Station, those observed in other cisterns (11.88mg/L to 12.32mg/L), and with surface water measurements of the New River Lagoon (17.16mg/L) and its tributaries including Ramgoat Creek (12.76mg/L), Harry Jones Creek (18.04mg/L) and multiple locations along Irish Creek (15.40mg/L, 7.92mg/L, 6.60mg/L). Surprisingly this nitrate concentration is also higher than that observed in some of the wells in San Carlos suggesting not only is the nitrate ion concentration not increasing as water passes through the soil, but in some cases it is decreasing. Along these lines it is worth noting that the newest and what is believed to be the deepest well in San Carlos (the well most recently dug by the government) also has the lowest nitrate ion concentration.

Though little historical data of the nitrate ion concentration in rainwater in this region exists, what data we do have is illustrative. Additionally the nitrate concentration of surface water sources provides further guidance. During the 2009 McMaster Belize Learning Community, nine rainwater-fed cisterns were tested. Of these nine, five did not contain measurable nitrate concentrations, two had nitrate levels of 4.4mg/L, and the highest concentration measured 15.4mg/L (Hegemier,

2010). During the 2010 McMaster Belize Learning Community, six cisterns were tested with nitrate concentrations ranging from 3.52mg/L to 10.12mg/L (T. Studer, personal communication, February 11, 2012). Though these nitrate concentrations can also be affected by how the cisterns have been maintained, these values along with those from this year suggest that the concentration of nitrate ion in rainwater throughout this region is increasing.

Surface water nitrate concentrations are also indicative of those in rainwater as these sources are fed by rainwater with little opportunity for environmental remediation. Data collected from the same sites on the New River Lagoon and its tributaries during the 2009 McMaster Belize Learning Community ranged from 0mg/L to 7.7mg/L (Hegemier, 2010), and the corresponding data in 2010 ranged from 1.32mg/L to 8.80mg/L. This data also suggests that elevated nitrate levels observed in the rainwater in this region is a new and developing phenomenon. It is worth noting, however, that Belize has significant seasonal variation in rainfall, and thus these seasonal variations may account for some of the differences observed here.

Summary

It is clear from these results that the water quality in San Carlos, Belize, and the surrounding area is rapidly changing. Through this project we were able to reduce the concentration of nitrate ion from 12.1mg/L to 4.4mg/L in a significant community water source and do so in a way that is flexible to changing water needs and conditions. Furthermore, as a result of this work, the women of the San Carlos women's group should be able to secure clean drinking water to utilize in the San Carlos Sunbreeze restaurant which provides a significant platform to build the village economy. Further work will be necessary to understand the causes of the observed nitrate levels as well as the cause for their increase.

References

Assembly of Life Sciences Committee on Nitrate and Alternative Curing Agents in Food. (1981). *The Health Effects of Nitrate, Nitrite and N-Nitroso Compounds.* Washington, D.C.: National Academy Press.

Hegemier, J. (2010). Baseline Water Quality Analysis of the New River Lagoon 2005-2009. *McMaster Journal.*

Lin, K., Chang, N., & Chuang, T. (2008). Decontamination of Nitrates and Nitrites in Wastewater by Zero-Valent Iron Nanoparticles. *NANO: Brief Reports and Reviews* , 291-295.

Mavroidis, S., Schurter, E., Johnson, S., Putman, B., & Sattler, S. (2006). The WATER Project. *McMaster Journal*.

Mavroidis, S., Studer, M. A., Baum, T., Hammersmith, D., Kurtz, J., Perkins, D., et al. (2008). Advancing Humanity in Belize. *McMaster Journal*, 27-30.

Studer, M. A., Kratzer, R., Smith, S., Diers, R., Gibson, P., King, M., et al. (2009). Advancing Humanity in Belize. *McMaster Journal*, 17-21.

Studer, M. A., Schultz, M., Dix, E., Kurtz, J., Perkins, D., Plant, J., et al. (2007). Environmental Sustainability in Belize. *McMaster Journal*, 161-202.

United States Environmental Protection Agency. (2009, May). *Drinking Water Contaminants*. Retrieved Febuary 13, 2011, from US EPA: http://water.epa.gov/drink/contaminants/index.cfm

World Health Organization. (2011). *Guidelines for drinking-water quality - 4th ed.* Malta: Gutenberg.

World Health Organization. (2007). *Nitrate and nitrite in drinking-water.* Geneva: WHO Press.

Teaching Pedagogical Skills to Educators in Belize

Dennis Clemens, McMaster Scholar, Belize 2011 – 2012

Many teachers in Belize do not have the opportunity of attending a school for teacher education before being placed in front of a classroom and are given only a set of standards for their students to grasp in a set time frame. Pedagogy, or the art and science of teaching, is critical to maximizing student learning. However, a strong sense of pedagogy comes from experience and the study of theory, which many Belizean teachers do not receive. Relaying a sense of pedagogy and teaching techniques to these teachers would in turn give students the strategies to learn on their own and better understand the content they are given.

I traveled to Belize to demonstrate to the educators in San Carlos Government School a variety of teaching methods and approaches. These approaches centered on two main goals, to engage students and to use little to no resources. I taught lessons at each of the student levels in the school and assessed their retention and understanding of the material post-learning.

In San Carlos I taught in the Lower, Middle, and Upper divisions. In the Lower Division, I taught students the cardinal directions which would normally be a dull subject for young children, but my integration of a field trip around the village turned their learning into something more meaningful. On the field trip, the students beautifully mapped their village using cardinal directions and a legend. The momentum did not stop as I utilized a balloon pop and chalkboard race to engage the Upper and Middle Division students in learning about the pre-classic Mayan and the ethnic groups of Belize.

The results demonstrated a strong sense of self-efficacy among the students and an interest in their own personal learning. In other words, the students were engaged in not only the material but also the act of learning and building upon what they already knew with confidence. Before leaving, I gave each of the educators a manual on different teaching strategies that can be used at any level and across any discipline.

Future work remains to be done in the San Carlos Government School. As the government promises computers and internet for the classrooms, teachers will need to be trained on how to properly integrate technology into their lessons and make technology-aided lessons serve the students and be meaningful learning. While it would be ideal to have engaging lessons be enough inspiration for students, it is not. Work remains to be done in the school when it comes to developing a realization of the importance of education and its connection to future possibilities.

Assessment of Water Sources for Intestinal Parasites in North Central Belize

Brittany Coats, McMaster Scholar, Belize 2011 – 2012

While parts of Belize prosper, other less fortunate areas struggle through poverty (Studer, 2007). Such an environment may create conditions that make people more susceptible to intestinal parasitic diseases, as the Pan American Health Organization (PAHO) states that intestinal diseases have been a problem in the past (PAHO, 2011). One study in Belize by Aimpun and Hshieh (2004) showed that about 75% of a tested population was infected with a variety of intestinal parasites (Aimpun & Hshieh, 2004); another study by Dix (2007) showed that hookworm was found in water sources neighboring the Rio Bravo Conservation and Management Area (RBCMA) (Dix, 2007). Hookworm can result in iron-deficient anemia and is indirectly responsible for the deaths of many children due to causation of decreased tolerance for other infections or diseases (Dix, 2007; Hookworm, 2009). To address this problem, I tested various drinking water sources for the most commonly found intestinal parasites in Belize to determine the current water quality. If necessary, prevention information was provided to the villages of the periphery of the Rio Bravo Conservation and Management area, as well as for the Programme for Belize, so that the people in these communities could take precautions in order to avoid illness and possible death.

Once on the ground, water samples were taken at six different sites and filtered through a membrane using the Nalgene filtration device to collect any intestinal parasites that might be present. Some of these sites were previously tested by Dix and Gibson, former McMaster Scholars, and data collected this time around contributed to the baseline data for those particular sites. The membrane with the collected sample from each site was fixed in formalin. Approximately one week after arriving back in the United States, the formalin solution from each site was then centrifuged into a pellet. The membrane was rinsed with a Tween20/PBS elution buffer to collect any remaining residue on the membrane, which was also centrifuged into a pellet. The pellets collected from both the formalin and buffer were combined for each individual sample, mixed together, and spread onto four slides. Slides were then created using the TriChrome staining method. Each slide was analyzed to determine if and what intestinal parasites were present using the diagnostic manual created beforehand. The presence or absence of any intestinal parasites was documented for each test site.

One well tested in the village of San Carlos evidenced the presence of hookworm in the form of rhabditiform larvae. The falariform larvae of Strongyloides stercoralis, a parasite less commonly found in Belize was found to be present in both the New Hope Village irrigation site and the New River Lagoon off of San Carlos. The rhabditiform larvae of hookworm were also detected in the New River Lagoon. Remediation information was returned to the village of San Carlos and the data was also disseminated to Programme for Belize.

References

Aimpun, P., & Hshieh, P. (2004). Survey for intestinal parasites in Belize, Central America. *Southeast Asian Journal of Tropical Medicine and Public Health*, *35*(3), 506-511.

Dix, E. (2007). A survey of human intestinal parasites in the waters of the Rio Bravo Conservation and Management Area. *McMaster School for Advancing Humanity Journal, 2*(Spring 2007), 186-188.

Hookworm. (2009). In *Medline Plus.* Retrieved from http://www.nlm.nih.gov/medlineplus/ency/article/000629.htm

PAHO. (2011). Health situation analysis and trends summary. Retrieved from http://www.paho.org/english/dd/ais/cp_084.htm

Studer, M.A. (2007). Project framework. *McMaster School for Advancing Humanity Journal, 2*(Spring 2007), 161-163.

Nutrition and Healthy Living in Belize

Kirsten Frissora, McMaster Scholar, Belize 2011 – 2012

The World Health Organization found that in Belize of the children who are under the age of five, 4.9% were underweight, 22.2% were stunted in growth and 13.7% were considered overweight for their age (World Health Statistics, 2009). My project taught the students of San Carlos the importance of nutrition and healthy habits, emphasizing how these practices can lead to healthier lifestyles and longer lives. The lessons I used were effective based on the information that "student learning is promoted most effectively in courses. . . [with] active learning and knowledge construction" (Lo, 2010). In each of the three multi-grade classroooms, I emphasized the importance of the six food groups and eating a healthy variety of foods from each category. I also demonstrated the proper way to wash hands and provided information about the transmission of germs that may improve their overall health. Finally, I reviewed the correct way to brush their teeth and discussed how this contributed not only to a pretty smile but also a healthier mouth. This triple approach to nutritional and hygiene education will help create some changes in the community that will support healthier living.

References

Lo, C. C. (2010). Student learning and student satisfaction in an interactive classroom. *JGE: The Journal of General Education, 59(4),* 238-263.

World Health Organization (2009). *World Health Statistics 2009*. 13-120. Retrieved April 7, 2011 from http://www.who.int/whosis/whostat/EN_WHS09_Full.pdf

Strategic Planning in San Carlos, Belize

Bryant Green, McMaster Scholar, Belize 2011 – 2012

Currently the McMaster School for Advancing Humanity has completed more than seventy community based research projects to promote sustainable development in San Carlos, Belize. In each case these projects have been the result of a community based need expressed by community partners in the areas in which we work. This project first and foremost benefited the community of San Carlos by providing a direction for sustainable community development and educated the community about effective ways to address community issues. This project also provided the McMaster School with further guidance as to what research avenues to pursue that will best represent the interests and needs of the entire community of San Carlos, Belize. A quality of life/wellbeing assessment coupled with a community SWOT (strengths, weaknesses, opportunities, and threats) analysis was also conducted via the use of interview and observational research. The data collected was used in a strategic planning workshop with the community that developed goals and means to achieve these goals for the community. Based on the results of this research, San Carlos is now better able understand and articulate their needs in a way that allows the community, in cooperation with the McMaster School and other institutions, to address them.

The concrete and immediate outcome of this strategic planning initiative was that it became evident that the community's highest priority was to organize a women's group with the intention of opening a restaurant. In addition, the citizens also expressed how they would like the restaurant venture to expand into other businesses such as lodging.

I continued to meet with members of the women's group both as a whole and individually to discuss how we would work cooperatively to make these goals a reality. We also toured an old abandoned school that the women intended to use to start

up the restaurant. The building was in poor condition; however, they were confident that they could renovate and make it a suitable restaurant. The women also articulated their desire to open this restaurant in order to serve our group from Defiance College and the teachers from the local school. This meal was a pilot program to demonstrate and test the manner in which this establishment would operate.

The day following the strategic planning workshop the San Carlos women's group worked to transform the destitute building into a restaurant. They cleared the building of rubbish, removed dilapidated ceiling tiles, and swept then power washed the entire building. By the time the women were through preparing the building, it looked as though it had undergone a complete transformation. The women had prepared the building for their soft opening of the Sunbreeze restaurant scheduled for the next day.

The San Carlos women's group prepared enough food and table settings in their recently renovated restaurant for seventeen guests. The profit that they made from this endeavor provided the group the income to open a group bank account and provided the resources to secure the future of Sunbreeze at least temporarily. The women's group also planned how the profits generated from this venture would be distributed, with one portion going to the family operating the restaurant (rotating through various families in the village), another to grow the business, and yet another into a scholarship fund developed by the group to help the children of San Carlos attend high school.

The village had reached their financial earning potential and it was not enough to afford any more opportunity. Establishing a restaurant would create a fruitful means to generate income for the village, in particular by providing village women a way to earn money. By tapping into a current community talent, cooking and agriculture, this restaurant has the potential to serve as a catalyst for further economic development. Income generated by this restaurant would bring outside monies into San Carlos for circulation within the village, literally developing an economy.

I returned home and began fundraising to support the construction of an actual restaurant in San Carlos. While the Belize learning community and I worked to secure funds to construct and furnish the restaurant, the women's group continued to serve customers in the makeshift building, without refrigeration and simply cooking over a wood fire. I returned to Belize with Mary Ann Studer and one community member in April, 2012 with $4000 that we had raised for the project. The women's group had secured the property for the building, poured a foundation, and ordered all the materials necessary to complete the construction. We purchased the materials for the building itself as well as a freezer and a stove for the Sunbreeze restaurant with the funds raised. This is a wonderful example of an effective partnership, and this project has successfully broken the economic barriers that had restrained the village in the past.

San Carlos Women's Group with Bryant Green, scholar, construction of SunBreeze restaurant

Scholars Josh Hegemier and Alec Pribulsky teaching snake bite remediation

Teaching Emergency Snake Bite Treatment, Basic First Aid, CPR, and Water Safety in Belize

Joshua Hegemier, McMaster Scholar, Belize 2011 – 2012

The purpose of my project was to demonstrate ways to delay snake bite venom absorption and to continue teaching cardiopulmonary resuscitation, first aid, and water safety in the local Belizean schools. I worked within the community of San Carlos to improve their knowledge of basic techniques to use in emergency situations. The key element of the project focused on the rapid treatment of snake bites and the treatment for poisoning from various household products. In addition to teaching members of these communities, I also instructed the foresters and rangers at the Programme for Belize's Hillbank Research Station on a new technique in snake bite envenomation management known as the pressure-immobilization bandage.

A Fer-de-Lance, also commonly known as a Yellow Jaw Tommygoff, is of great significance to community partners due to the fact that this type of venomous snake bit our guide Ivan Gillett in December 2009 and another ranger in 2010. Since remote areas such as the Hillbank Research Station in Belize are not located in close proximity to a hospital and rangers work deep in the jungle, important measures should be taken to delay the absorption of the venom. Snake venom is circulated through the body via the lymphatic system, and the pressure-immobilization bandage is effective in reducing systemic envenomation (Stewart, 2003). The goal of this technique is to delay absorption of venom after a snake bite has occurred and to increase the time a victim has to travel to a medical facility for anti-venom administration. The training was a significant step in effective risk management for the rangers at the Rio Bravo and the villagers who reside near the jungles on its periphery.

Reference

Stewart, C. (2003). Snake bite in Australia: First aid and envenomation management. *Accident and Emergency Nursing*, *11*(2), 106-111.

Defiance College First-Aid and CPR/Wellness for Belize

Alec Pribulsky, McMaster Scholar, Belize 2011 – 2012

The main focus of this project was to review the basics of first-aid, CPR, and water safety with the people of San Carlos, Belize. For the first-aid portion, Josh Hegemier, McMaster Scholar, and I focused on machete injuries; due to the extensive use of this tool, it can be a significant threat in day to day activities. The demonstration covered how to clean, dress, and wrap wounds and how to deal with the panic associated with injury. We also reviewed CPR in realistic contexts. In addition, I taught proper stretching and warm-up techniques to the local soccer team. Overall, the purpose of both projects was to ensure a healthy lifestyle for the citizens of San Carlos, Belize.

The response from the people of San Carlos was unbelievably positive with about 50 people, including children and a lot of men, taking time away from their busy lives to attend the training and learn important skills. Machete wound care was of particular interest to the community, and it was evident throughout that they did remember the skills from training sessions held in previous years.

Literacy in Belize: Teaching Literacy Lessons and Developing an English as a Second Language (ESL) Night School Program

Jordan Heiliger, McMaster Scholar, Belize 2011 – 2012

Many Belizeans lack functional literacy skills and struggle to communicate in English, the official language of the country. According to the Cornerstone Foundation, it was estimated that the functional literacy rate in Belize was 40% in 1996 (Defour, 1999). While that number has risen over the years, many of the citizens in rural villages do not have access to materials that would allow them to improve their literacy skills, skills beneficial to entering the work force. This project

focused on teaching English literacy in San Carlos Government School and explored the potential for an English as a Second Language (ESL) night school program for interested adults in the community.

While in Belize I taught the following lessons: Infant 1, Infant 2, and Standard 1-Rhyming Words; Standard 2 and Standard 3-Adjective I-Spy; Standard 4, Standard 5, and Standard 6-Adjective Game. I discussed the possibilities of an ESL Program with Mr. Noel Carrillo, the principal of San Carlos Government School to gain an understanding of what type of materials would be most effective. Upon returning to the U.S., I continued researching ESL materials and selected a packet of materials that were returned to the school in April, 2012. The results of this project will not be seen right away, but I am providing San Carlos with the materials to continue their growth as a village.

Reference

Defour, R. (1999) Literacy in Belize. *The Cornerstone Foundation*. Retrieved from http://www.cornerstonefoundationbelize.org/programs/literacy

Scholars Kirsten Frissora, Jordan Heiliger, and Alec Pribulsky with students of San Carlos School

Catie Savage, scholar, teaching water quality monitoring in San Carlos

Water Education that Matters

Catherine Savage, McMaster Scholar, Belize 2011 – 2012

Previous McMaster learning communities have observed that nitrate levels in the drinking sources in and around the village of San Carlos were elevated to the point of being unsafe for consumption. When nitrates enter the body, they change hemoglobin in red blood cells to methemoglobin which is a problem because this does not allow for oxygen to be carried throughout the body. For this reason, I wanted to run tests year-round to provide information that would chronicle the seasonal changes in water quality, if in fact they exist.

I went to Belize to work with the community members and the San Carlos school in order to teach the students how to run simple tests for nitrates, phosphates, pH, temperature, water level, and rainfall, all things that will help to determine the water quality parameters throughout the seasons. For testing, the following materials were used: Nasco Scientific phosphate test strips that had a detection range of 10-100 ppm; highly accurate pH Strips from Ben Meadows that had a pH range of 1 to 14 and showed matches at every 1.0 interval; nitrate test strips from Ben Meadows and nitrate/nitrite nitrogen test strips which provided detection of nitrates within a range of 0.0, 0.5, 5, 10, 20 ppm (mg/L); and nitrite detection within a range of 0.15, 0.3, 1.0, 3.0, 10.0 ppm (mg/L).

A pipe, purchased in Belize, was installed off shore of the village of San Carlos for monitoring the water level in the New River Lagoon. Gempler's Basic 12-1/2" Indoor/Outdoor Thermometer and Gempler's, Clear-Vu Professional Rain Gauge – 11" were mounted on a pole in the school yard for close monitoring. I created logs for the students and community members to keep track of the information they were collecting weekly starting in December 2011 and ending in December 2012. By having the village members test their water for an entire year, the McMaster School and the village of San Carlos will be receiving

data that would report potential seasonal variations in nitrate levels, information that would otherwise be unavailable to us. This information also allows them to gauge for themselves possible times when it would be safe for them to use the wells for drinking and cooking. The lessons I prepared are aligned with the Belizean curriculum and provide students and their teachers with hands-on science activities that have direct relevance to their community.

Artisans of Belize

Cord Speelman, McMaster Scholar, Belize 2011 – 2012

In Belize many artisans lack essentials to become successful and well-marketed. Some of these essentials include a lack of infrastructure, capital, and access to credits and markets. The goal of this project was to create a bridge between artisans in Belize and the United States' market. Working with Project 701, Defiance College's student-run non-profit organization, to establish a fair-trade store on the Defiance College campus would allow us to display the artisans' work and create the needed connection to markets in the U.S. This would, in turn, bring money to households of artisans who are lacking financial stability in Belize.

While in Belize I was able to solicit and interview residents who possessed artistic talent yet lacked access to markets. It is interesting to note that the agricultural community of San Carlos has the potential to provide various indigenous crafts for resale in U.S. markets including stitchery and wood carving, a potential that only became visible once I expressed interest in purchasing goods from this subsistence community.

Through face-to-face communication this project sought to facilitate building a viable base of goods for the fair trade store and contributed to the effective marketing of these artisans' products. As a result of my project, we have short biographies of each of the artists with their art work that we would like to attach as a way to market the product. The result of this project is the improvement of the economic potential of these artisans and their families in Belize through fair trade market commerce in the United States. Our goal is to import their art work and sell it in a fair trade store on the Defiance College campus.

Water Quality Analysis Belize 2011-2012

Thomas Studer, McMaster Scholar, Belize 2011 – 2012

This project was designed to carry out an assessment of biological and chemical water parameters in environmental and potable water sources in and around the New River Lagoon and the associated tributaries. Collection and analysis was performed for sites that were sampled during the 2010-2011 McMaster initiative as well as new sites requested by community partners. This analysis is part of a continuation and expansion of the water project that has been ongoing for the past six years. Chemical testing was performed using the Hach surface water testing kits, and parameter concentrations were obtained for pH, nitrates, ammonia, free chlorine, and orthophosphates in environmental waterways. A focus of the project, however, was determining nitrate levels in potable water sources. The results from my testing during the 2010-2011 McMaster water project showed dangerous levels of nitrates for all of the wells tested in the village of San Carlos. In addition, it was determined by fellow McMaster Scholar Brittany Heaton that *Escherichia coli* was also present in the wells (Heaton, 2011). The 2010-2011 water project combined the testing for *E. coli* and the fore mentioned chemical testing from potable water sources tested during the 2010-2011 Belize project as well as any additional sites as requested by community partners.

For biological parameters, with the exception of the school well and the newly established government well, all wells tested in San Carlos tested positive for *E. coli*. It is important to note that the school well and the newly drilled government well are the only two cased wells in the village. In addition, the New River Lagoon test site at San Carlos also showed presence of *E. coli*. As to the cause of the contamination, it is hypothesized that a lack of efficient sewage disposal is a possibility, though there is no direct evidence supporting this and so the cause remains unknown. The chemical parameters tested for were well within the safety limits as prescribed by the United States EPA with the exception of nitrate nitrogen. The levels of nitrates in the village of San Carlos, as well as several of the environmental sources, were well above the 10mg/L safety limit established by the EPA. In addition to high levels of nitrates in wells and local tributaries, excessive nitrates were noted

in rain water samples while on the ground. It is unknown why these levels were present without excessive local industry of note. It will be critical for future initiatives to focus on examining possible causes of nitrate and *E. coli* contamination both of potable water sources and more importantly the presence of nitrates in rain water.

References

Hach. (2010). Hach Knowlwdge Base. Retrieved March 18, 2010, from Hach: http://www.hach.com/hc/view.knowledge.base.detail.invoker/PackagingCode=CHLORINE-GEN_1/NewLinkLabel=Free+vs.+Total+Chlorine

Heaton, B. (2011). Belize Ecoli Results. Defiance: Defiance College.

U.S. Environmental Protection Agency. (2010). 2009 Edition of the Drinking Water Standards and Health Advisories. Retrieved March 18, 2010, from U.S. Environmental Protection Agency: http://www.epa.gov/waterscience/criteria/drinking/dwstandards2009.pdf

U.S. Environmental Protection Agency. (2009, September 11). Drinking Water Contaminants. Retrieved March 18, 2010, from U.S. Environmental Protection Agency: http://www.epa.gov/safewater/contaminants/index.html

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