

ADVANCING HUMANITY IN BELIZE

Learning Community

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CONTINUED SOIL STUDIES: POSITIVELY IMPACTING THE EFFORTS OF SUBSISTENCE FARMERS AND SUSTAINABLE FORESTERS IN NORTHERN BELIZE

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PURPOSE STATEMENT

The purpose of my 2009-2010 Belize project as it relates to the indigenous subsistence farmers of the region surrounding the Rio Bravo Conservation and Management Area in northern Belize is to provide information that will help these farmers to sustainably farm with increased profit potential. This will be accomplished by assessing both macro and micro soil nutrient levels and advising on strategic organic inputs, and by assessing soil compaction followed by information on remediation that would improve yield. A second component of this project is to assess soil compaction at selectively logged sites within the Rio Bravo Conservation and Management Area and to provide this information to Programme for Belize to support their efforts toward sustainable forest management. Finally I will be chronicling the 2009-2010 McMaster Belize learning community in order to provide a resource binder to institutions of higher education in Belize that have expressed interest in this model of interdisciplinary research.

LITERATURE REVIEW

The current global economic crisis has hit developing countries with a greater severity than can possibly be imagined by a citizen of the United States. Because developing countries generally do not have the capital or credit cushion to dampen the impact of such an economic crisis, even slight downturns in the global economy produce significant impacts on poverty and negatively affect economic growth. "By end-2010, 89 million more people are expected to be living in extreme poverty, less than \$1.25 per day, than would have been the case without the crisis" (World Bank Group staff, 2009, p. 1). The ripple effect of the economic downturn in developed countries in the synergistic global economy is significant in and of itself – limiting access to credit, reducing funding for development and aid, limiting access to education, reducing foreign investment, and reducing the prices on goods exported by developing countries. In addition Belize, because it is a country that depends heavily on tourism for foreign exchange and jobs, has been negatively impacted by the reduction in disposable income of the majority of the developed world. "Worldwide tourist arrivals declined by eight percent between January and April 2009, continuing the sharp falloff recorded during the second half of 2008" (World Bank Group staff, 2009, p. 7). Businesses on the cays in Belize that cater to middle income tourists were experiencing a five to fifteen percent decline in revenue as of the end of 2008 (Coward, 2009). Thus the quality of life in Belize that we have been working to positively impact over the last five years proved to be even more fragile as we partnered for positive sustainable development in the northern areas of Belize in 2009-2010.

Assessing the ability of this particular project to positively impact our Belizean partners on a micro level – one person, one school, one village, or one NGO at a time – is possible in the short term. However, I feel compelled to explore aspects of this project on a more macro level to evaluate their long term impact potential, particularly in terms of this project's contributions to poverty reduction. Research has shown that wealth gained from the strategic management of renewable natural resources can more significantly reduce poverty than wealth garnered from other economic sources. This is due to the fact that monies from renewable natural resources tend to provide access to income over a wider geographic area and to provide income that can be dependable when global market sources of income are limited (Department for International Development, 2008, p.9). Going one step further, I would include within the category of renewable natural resources the relative concept of natural capital for agricultural communities, which incorporates both soil/soil fertility and the available labor force. This is a critical inclusion as we consider subsistence agricultural communities on the periphery of the Rio Bravo Conservation and Management Area.

Research shows “that investments made by developing countries in agriculture... are both pro-growth and pro-poor” (Bezemer & Headey, 2008, p. 1342). One can argue that Belize has made strides toward development through exploitation of natural forest reserves, logging first logwood and then mahogany during the years of British colonialism, followed by foreign driven commercial agriculture such as sugar cane intensification in the 1960s, and the most recent 1990s push for a viable ecotourism base. However the subsistence agricultural communities in the interior of northern Belize such as San Carlos, Indian Church and St. Paul’s Bank have engaged only in a peripheral sense with the job opportunities and income associated with any of these waves of development. In short these communities have failed to benefit from this path of development.

As Bezemer and Headey (2008) note in their article “Agriculture, Development, and Urban Bias,” “Numerous cross-country-specific studies conclude that agricultural productivity is a major source of poverty reduction, and almost certainly *the* major source at lower levels of development” (p. 1345). Increased soil quality preservation through more strategic farming techniques (the focus of our efforts since 2005) and the development of local markets in this area will not only increase agricultural profitability, but it also has the potential to lower food prices for those populations that typically spend the majority of their household budgets on food. In fact “a cross country examination of the relationship between growth and poverty by Gallup et al. (1997) establishes that a one percent increase in agricultural GDP leads to a 1.61% increase in income of the poorest quintile, while the corresponding values for the manufacturing and services sectors are on 1.16% and 0.79%” (Thirtle, Irz, McKenzie-Hill, & Wiggins, 2001, p. 9).

Not only is agricultural growth a key factor in reducing poverty and establishing food stability, it is also critical in assuring political stability. Bezemer and Headey (2008) note that one of the manifestations of persistent rural poverty and high-land inequality in Latin America is a relatively weak political voice of the rural poor even when compared to urban poor populations. Therefore in Belize, promoting sustainable agricultural growth in these isolated communities needs to occur despite the government’s focus on other sector development or perhaps in synergy with the government’s focus on environmental conservation and ecotourism. That latter path of hybridized sector development may not only be more feasible, it also has the potential to be sustainable, and offer renewable resource exploitation that will most rapidly result in poverty reduction and subsequently reduce the political marginalization of these populations.

The factors that have made increasing agricultural productivity difficult in Belize are similar to those issues that have challenged agricultural development elsewhere, including limited access to credit, poor access to markets, and a poorly developed infrastructure. It is noted that among least developing countries these “structural disadvantages have typically been compounded by systemic political economy forces...which bias policies against smallholders in particular” (Bezemer & Heady, 2008, p. 1343). Over the past five years working in Belize we have seen foreign control over the livelihoods of small farming communities in the papaya growing scheme which imploded, leaving in its aftermath farmers indebted in some cases as much as tens of thousands of US dollars. We have seen government promises of soybean transportation dissolve and abundant yields rot in Belize’s high humidity because farmers had no access to export markets. What is extremely evident in northern Belize today is that these challenges, many of which are a direct result of adverse colonial influence, have suppressed the ability of indigenous people to move above a subsistence quality of life. The vulnerability of these populations increases with their level of poverty, “destroying assets and reducing productivity, and indirectly by forcing them to invest in less risky but less productive activities” (Department for International Development, 2008, p. 11). This characterization is a reality in rural areas of northern Belize and is precisely what has impeded human progress in these farming communities. The level of subsistence related poverty is literally 150 years old. Under British control the lack of infrastructure and relative isolation, the lack of access to education, the lack of access to viable markets were all intended to maintain and exploit a cheap labor force as foreigners logged Belize. Today the same populations fail to thrive and face challenges to sustainable development because they lack sufficient political voice to change the status quo. The lack of infrastructure, limited access to education and health care, and limited access to markets all remain significant impediments.

The pace of agricultural development in northern Belize is not only stunted by the context of their historical roots and the current low level of governmental support but these factors are compounded by the state of the natural capital – the soil that characterizes these farms. Soil nutrient depletion throughout Latin America and the Caribbean was documented in 1990 as occurring in over 71.4 million hectares (Ayoub, 1999). Because farmers are cultivating soils that are only moderately fertile as a result of the rapid nutrient depletion caused by deforestation, this severity and extent of nutrient depletion for Latin America and the Caribbean was more than double that seen in Africa and nearly five times more severe than that documented in Asia for the same period (Ayoub, 1999, p. 118).

Research on the fragile soils of the tropics has identified management components necessary for preserving potential productivity: (1) maintenance of organic matter and soil cover – already a problem on the farms we work in; (2) minimal surface soil disturbance – this can be monitored through the soil compaction survey of this project study in 2009-2010; (3) appropriate and strategic fertilizer use – the focus of continued soil nutrient analysis conducted since 2005 and continued in this project 2009-2010; (4) intercropping – suggested to farmers after research completed in 2008-2009; (5) effective fallow periods and crop rotation – effective fallow periods are not implemented at this point due to minimal landholdings (Kang, 1997, P. 76). Working to improve these small scale subsistence farmers' understanding of the mechanisms for soil preservation contributes positively to sustainable agricultural development and thus reduces poverty. Since 2005, the focus of the McMaster Belize initiative has been on giving small agricultural stakeholders a voice in the region's move toward sustainable development synergistically with the perspective of Programme for Belize, managing NGO of the 260,000 acre Rio Bravo Conservation and Management Area. The multidisciplinary projects supported by the McMaster School for Advancing Humanity have been organized under the interdisciplinary framework of Integrated Natural Resource Management modified from that of Izac and Sanchez (2001), and Sanchez, Palm and Buol (2003). This framework has focused the aspects of this 2009-2010 project not only on the problem of poverty and the solution of enhancing agricultural



productivity but also on how that collectively happens without degrading the environmental quality of the rainforest surrounding the fields. The 1982 World Parks Congress noted that, “It is a fully observable phenomenon that developing countries do not start to implement environmental programs until standards of living have started to rise” (World Growth, 2009, p. 9), and that “protected areas in developing countries will survive only insofar as they address human concerns” (World Growth, 2009, p. 14). The World Parks Congress went on to advise that conservation and development in which humans could benefit from and utilize natural resources must occur simultaneously in order to be effective and sustainable. Building an understanding among the communities on the periphery of the Rio Bravo that the preservation of the rainforest and its native species has a positive impact on their quality of life is integral.

The converse of this statement is also imperative. Thus it is essential that this project effectively contribute in a research capacity to the efforts of Programme for Belize (PFB) as they sustainably manage the forests of the preserve. Integrated Natural Resource Management (INRM) requires consideration of multiple perspectives and promotes a realization that sustainable development must address the problems of poverty, food insecurity, and ecosystem degradation by promoting practices that enhance human well-being, productivity, and ecosystem functions.

“It is a near universal experience in forest industries that conservation areas need to be managed to ensure they serve their environmental purpose” (World Growth, 2009). Programme for Belize continues to conduct research on the Rio Bravo Conservation and Management Area that supports its efforts to sustainably extract mahogany without degrading the ecosystem in the process. In 2005-2006 I conducted a nutrient analysis survey of selectively logged sites in the Rio Bravo. This 2009-2010 project (the 2005-2006 sites revisited and expanded) surveyed rainforest soil compaction that has resulted from moving downed logs out of the forest for transport and will allow PFB to work on protocols that have the potential to promote rather than reduce the rate of forest regeneration. This project will contribute to PFB’s ongoing exploration of the impact of different treatments on the regeneration of mahogany and other shade-tolerant trees. Beyond Belize there are few examples of sustainable extraction without compromising environmental values. “Integrating timber and conservation management is one of the great challenges for tropical forest protection on a large scale” (Programme For Belize, 2008). In order for this conservation effort to be sustainable, not only does the forest need critical monitoring, conservation education is fundamental. In all of its projects/research PFB has as an element of conservation education and awareness. This recognition of the

importance of educational outreach drove the development of the final aspect of this 2009-2010 project.

After completing research in Belize over the last five years I have seen how the lack of accurate information about appropriate fertilizer use has resulted in damaged soil. Farmers applied gross amounts of fertilizer, in some cases 60% over what would have been recommended for optimal yield, in an attempt to garner yields that would place them above a subsistence level of income (Studer, 2009). Through McMaster initiatives since 2005 we have been able to provide critical information about soil nutrient levels to farmers on the periphery of the Rio Bravo. This information has saved these farmers thousands of dollars, has allowed crops to grow in optimal conditions, and has reduced the negative agricultural footprint on the rainforest and waterways that cradle these agricultural fields. It would be even more advantageous to establish a mechanism for more farmers in Belize to have access to information about soil nutrient levels throughout the year and on a much broader scale than is currently possible. This record of impact coupled with discussions I have had with junior colleges in Belize about how to make their students more marketable post graduation allowed me to see if the McMaster model of community based research through interdisciplinary teams could be implemented by Belizeans for Belizeans. Thus utilizing the McMaster Belize Learning Community as a model I hope to encourage the development of teams of Belizean college students that could conduct soil analysis and establish similar partnerships throughout the region. In addition It is hoped that, by utilizing the McMaster School model, Belizean institutions of higher education with environmental studies majors will be able to offer their students opportunities to engage in applied environmental science, strategically preparing these students to develop expertise in agriculture, forestry, and conservation critical to their own communities.

In "More Productivity with Fewer External Inputs: Central American Case Studies of Agroecological Development and Their Broader Implications," Roland Bunch (1999) assesses two agroecological development programs, one in Guatemala and the other in Honduras, and states that the positive effects of the programs could be seen five and fifteen years from the date of implementation (Bunch, 1999). The methods prescribed by these programs are very similar to those that this McMaster initiative is trying to encourage. Thus it is clearly possible that the long term effects of this McMaster initiative may continue beyond what any of us expect as we repeatedly partner with these indigenous farmers, with Programme for Belize, and with institutions of higher education in Belize being more focused and responsive as they move toward more sustainable futures.

PROJECT DESCRIPTION AND PROJECT GOALS

The 2009-2010 research scope of this project focuses on the following areas:

- (1) Continued work with indigenous and Mennonite subsistence farmers to strategically improve farming methods through soil nutrient testing with a focus on the development and implementation of methodologies that support sustainable agriculture. In addition I determined soil compaction levels in the agricultural fields on the periphery of the Rio Bravo that we are currently working in.
 - The goals of this aspect of the project were (1) to simultaneously improve income levels of indigenous farmers by specifically advising these farmers on soil nutrient levels, effective methods for sustainable agriculture, and on diverse crop production for local markets; and (2) to provide recommendations for remediation of soil compaction that would support improved emergence and yield while reducing the negative impact that agricultural inputs have on the surrounding rainforest and waterways.
- (2) Determine soil compaction levels at logged sites within the Rio Bravo Conservation and Management Area to provide information relative to the emergence of crops and rainforest fauna at these disturbed sites.
 - The intended goal of this aspect of the project was to contribute to the ongoing assessment and improvement of forest extraction protocols that constitute Programme for Belize's research of rainforest regeneration and sustainable forestry in the Rio Bravo Conservation and Management Area.
- (3) Develop guidelines for forming interdisciplinary learning communities using our McMaster Belize Learning Community as a model that would provide junior colleges in Belize with the information they need to establish interdisciplinary student teams that could parallel our work in Belize.
 - The goal of chronicling the interdisciplinary learning community is so that we could offer specific information to Muffles Junior College and perhaps other institutions of higher education in Belize that would allow them to establish interdisciplinary teams of students that could parallel some of the work accomplished by the McMaster Belize teams. Hopefully this will result in the development of ongoing collaborations with Belizean

institutions and greater access to information for our current Belizean partners.

METHODOLOGY

Soil Nutrient Assessment Protocols

A field sheet was prepared for each field tested that included an analysis 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, Harris, & 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 will be completed to allow for digital analysis of the soil extract to quantify nutrient levels to hundredths of parts per million or pounds per acre.

Macro-Nutrients (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

Micro-Nutrients (LaMotte, 2004)

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

Soil Compaction Assessment Protocols

The DICKEY-john Soil Compaction Tester was used to assess soil compaction. Two tips were used both at 30-degree cone one ½ inch for soft soils and the other ¾ inch for hard soils. It is recommended that soil be tested when the moisture content is relatively high. Thus testing the soil in Northern Belize at the end of the rainy season in early December was an optimal time to assess soil compaction. The penetrating rod was pushed into the soil at a constant rate of approximately 1 inch per second. The compaction layer was recorded when the gauge reading indicated a pressure in excess of 300 pounds per square inch and again when the pressure fell below 300 pounds per square inch to determine the depth and thickness of the compaction layer. These protocols align with the standards for hand-held penetrometers set by the American Society of Agricultural Engineers (ASAE). "In agriculture and forestry applications, the most common standards are: ASAE S313.3 February 2004, *Soil Cone Penetrometer*, and ASAE EP542 February 1999, *Procedure for Using and Reporting Data Obtained with the Soil Cone Penetrometer*. ASAE standards require using a steel cylindrical cone

with a 30-degree tip, the diameter of the cone is 20.27 mm (.798 in) for soft soils and 12.83 mm (.505 in) for hard soils. The shaft has a diameter of 15.88 mm for soft soils or 9.53 mm for hard soils. The amount of force exerted over the cone's surface is called the Cone index or CI, typically recorded in units of kilopascals or pounds per square inch. The cone should be inserted into the ground at a steady rate of about 30mm/s" (Kees, 2005). PG5 In addition a densitometer was used to calculate percent canopy cover at all selectively logged sites. Correlations were developed between canopy cover and compaction zone depth.

RESULTS

Soil Nutrient and Soil Compaction in Agricultural Fields Result Summary

Comparisons were possible between the nutrient levels in the fields of farmers with whom I have been partnering since 2005 and those farmers with whom new partnerships developed in December 2009. Macro -nutrient 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 new fields tested. All farmers whose fields were tested received annotated results and recommendations.

Significant compaction layers were found in those fields that had been planted and harvested by steel-wheeled tractors, common in many of the periphery Mennonite communities. Remediation protocol was returned for the farmers' use. Compaction layers were not prohibitive to root growth or yield in the non-Mennonite, non-mechanized communities. "Soil compaction can easily reduce crop yield by 10 percent, and can lead to water and soil quality degradation due to increased runoff and soil structure destruction. There are two forms of compaction surface and subsurface. While surface compaction can be partly alleviated with normal tillage operation, subsurface compaction below the normal tillage depth will remain. Fracturing or cutting subsurface compacted soil has, in some cases, resulted in remarkable yield increases" (Duiker, 2002, p. 1). Farmers whose fields indicated subsurface compaction were given the data acquired by this testing. Knowing the depth of the compaction zone will allow these farmers to till at sufficient levels to break the compaction zone and promote a more effective environment for adequate root growth.

Soil Compaction and Canopy Cover Correlations at Logged Sites within the Rio Bravo Conservation and Management Area Result Summary

The data showed a significant positive correlation between time ago logged and depth of the top of the compaction layer, between time ago logged and the bottom of the compaction layer, and time ago logged and the percent

canopy cover. Percent canopy cover was also positively correlated to the depth of the compaction zone. There was no significant correlation between time ago logged and the thickness of the compaction zone or canopy cover and thickness of the compaction zone. These results align with similar research conducted in other managed forest areas. Selective logging within the preserve is closely monitored to enable certification from the Rainforest Alliance's SmartWood program the leading standard for environmentally and socially responsible forestry throughout the world.

CONCLUSION

The results obtained through nutrient testing have become less dramatic after five years working with farmers on the periphery of the Rio Bravo, which is reflective of the project's effectiveness. Stabilizing appropriate fertilizer application in this area is beginning to happen. The comparison in nutrient levels between farmers, villages, and Mennonite camps I have been working with and new contacts made on this initiative, however, is a stark realization that the work needs to continue. On this initiative I connected with a new Mennonite community and an emerging agricultural cooperative comprised of 27 families. To even see the development of a farming cooperative in this area of Belize is exciting because it indicates that these people are gaining the ability to move produce beyond the local area. Growing for local markets and controlling the movement of agricultural products within the region will reduce the area's dependence on imported food, and provide a more sustainable and resilient market for goods. The soil compaction studies prompted by Programme for Belize will support their efforts to chronicle and maintain sustainable forestry efforts, a model that could have far reaching global impact.

Working in partnership with the Belizean people and a learning community is always a humbling experience. No aspect of this project could have been implemented without significant help from my mentor on the ground Ivan Gillett, Programme for Belize ranger. While no initiative happens without its challenges, the support and collective motivation of the learning community makes good things happen. After two flat tires, rain, cold showers, too many tamales, mud, fire ants, long drives to Shipyard, 'no-see-um' bites that have lasted for months, and Ivan's encounter with a poisonous snake, we will still most remember the laughter, the people, the tears after an entire village gathered for first aid training, the joy of experiencing the first running water in a school, and the good taste of mashed potatoes after a long day in the field. It is remarkable to me the resilience that a team can muster when they experience the efficacy of impacting the human condition.

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BIOFUEL IN BELIZE: A CAUTIONARY TALE

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Securing energy resources is one of the most significant challenges facing developing nations. Scarceness of natural resources, limited infrastructure, and pressures both internal and external towards sustainable development, all exacerbate the problem by pricing developing countries out of the market. In Belize power generated from indigenous sources has been insufficient to supply a growing demand for energy leading to energy shortages and importation of foreign energy at inflated prices. Furthermore, a lack of infrastructure prevents the existing supply from reaching the extent of the nation, masking the true depth of the deficiency between energy supply and demand.

This project examines methods developed in Haiti that convert biomass, the byproducts of agriculture, into charcoal, and the impact these methods could have in the communities of northwestern Belize. Use of charcoal produced from biomass could provide a source of reliable energy to some of the most underserved portions of the country, and potentially offset some of the demand for scarce energy resources. This paper examines the energy situation in Belize, the potential of biomass charcoal, and the reception by our community partners to such methods.

ENERGY RESOURCES IN BELIZE

There is no shortage of statistics that point to the undesirable energy situation in Belize, but perhaps the most stunning is that half of all electricity, and all fossil fuels, must be imported into the country (Azurdia-Bravo, 2003). These problems are compounded by geographical, historical and logistical challenges that further limit the number of trading partners from which this energy may be purchased (Barcott, 2009). In turn, this drives up the cost of importing energy, and undermines national security and quality of life in the process. Belize also has projected growth in energy demand far above that of its peers which is likely to increase this discrepancy in the coming years (Public Utilities Commission Steering Committee, 2003). Clearly any increase in domestic energy supply would improve these problems.

According to the Belizean government's own energy sector survey (Azurdia-Bravo, 2003) the annual demand for energy in Belize is approximately 12.7 petajoules. For comparison this is equal to the amount of energy consumed by Canadians every ten minutes. The per capita rate of 48GJ is approximately equal to that of its neighbors, but significantly higher than

the per capita rate of other developing countries (Public Utilities Commission Steering Committee, 2003). It is estimated that this demand will grow at a rate of eight to ten percent per year over the short term, well above the global average of 2-3% (Barcott, 2009). In short the problems Belize faces meeting current demand will only get worse.

Domestic energy production in Belize comes from three sources: hydroelectric power produced from the country's three run of river dams, burning of bagasse generated during the processing of sugar cane, and the combustion of fuelwood as a heat source (Azurdia-Bravo, 2003). Though valuable sources of energy, all three of these methods are seasonally dependent. Since the power generated in season cannot be stored, it is risky to develop a comprehensive energy plan based solely on these sources. On the other hand, these methods are based on renewable resources, something that is desirable for long term sustainability and to meet international pressures towards renewable energy. Over the course of the year, these three sources produce approximately half of the current demand for electricity in Belize.

Domestic production is supplemented by electricity imported from Mexico, and diesel generators powered by imported fuel (Azurdia-Bravo, 2003). There are two significant problems with this reliance on foreign power. Chief among them is the threat to national security. Any nation that depends on the benevolence of its neighbors to keep the lights on is a nation perpetually beholden to foreign interests. However, that alone is not the most pressing issue for Belize in the short term. The second and bigger problem is that when it comes to energy Belize has exactly one trading partner: Mexico. Mexico in turn has problems meeting their own energy demands, and limits the maximum amount of power they will supply to Belize (Barcott, 2009). Additionally, as the only supplier of energy to Belize, Mexico is free to sell that energy for prices well above market value. Coupled with Belize's total reliance on foreign sources for fuel, this leads Belize to spend what amounts to one third of all export proceeds on importing foreign energy (Barcott, 2009). The lack of trading partners also means that all power entering Belize comes down from the north. Since power transmission lines lose power proportional to the distance the power travels, significant loss can occur when transmitting power from the north to the south. This along with sparse population that prohibits development of transmission lines has made the southern Toledo district of Belize the poorest in the nation (Public Utilities Commission Steering Committee, 2003).

In some regards the path forward for Belize is clear. More energy will be needed, and that energy must, at least in part, be produced domestically.

The real challenge is identifying methods to produce that energy. Exploiting Belize's newly discovered oil reserves is one obvious solution, but this will require developing costly infrastructure in order to refine the fuel. Another option, the one this project investigates, is further expanding the use of biomass in energy production by converting corncobs into charcoal.

CASE STUDIES OF CHARCOAL PRODUCED FROM BIOMASS

Haiti, like Belize, is a nation with scarce natural energy sources. As a result, the nation is highly dependent on foreign sources of energy, and some of the results have been predictable. The primary cooking fuel in Haiti is wood, one of the few locally available resources. As a result Haiti has suffered a staggering 98% deforestation (Smith & Frayne, 2004). As bad as the deforestation is, the heavy use of wood in cooking will only make it more painful when the forests are depleted. Though the situation is more serious than the one that currently exist in Belize, the challenges are similar. In order to address the desperate situation in Haiti, work is underway to develop a means by which locally available agricultural waste, in this case sugarcane bagasse, can be converted to charcoal. Researchers at the Massachusetts Institute of Technology have developed a process by which bagasse is converted to charcoal using little more than an oil drum, a homemade briquetter, and a binder made from the local cassava root (Smith & Frayne,



2004). In addition to reducing the demand on a scarce wood supply, the charcoal produced from this method has several health benefits to the people of Haiti.

The charcoal produced in this manner is both a cleaner and denser fuel than hardwood charcoal. Relative to hardwood charcoal and undensified biomass, biomass charcoal can be burned with significantly less smoke and risk of complications (Smith et. al, 2004). Because it is a more dense fuel it can more easily be transported and stored. Also because the carbonization process removes compounds which subject the biomass to rot it can be stored indefinitely (Smith et. al, 2004). It has also been proposed that the charcoal produced from biomass could be an opportunity for microenterprise which would help alleviate poverty, and do so in a way which keeps the income generated in the local community.

Belize already recognizes the value of biofuels: 5% of the national energy supply is already generated by the burning of bagasse (Public Utilities Commision Steering Committee, 2003). One of the keys to current means of production is that sugar cane is transported to central processing facilities creating a centralized supply of bagasse. Power can then be cogenerated on the site of the processing facility with some used to power the processing plant, and the remainder fed into the national power grid (Public Utilities Commision Steering Committee, 2003). Such a situation does not necessarily exist for other proven sources of biological carbon such as corn cobs.

It was believed that production of charcoal from these sources would provide a valuable means of producing a dense, renewable, energy source from indigenous materials and at minimal cost. This fuel could then be easily stored for use during the rainy season and would provide a measure of security in procuring cooking fuel. However after discussing these methods with the farmers of northwestern Belize it would appear that these methods are of only marginal interest, and provide a cautionary tale for future McMaster Scholars and Fellows.

RECEPTION IN BELIZE

It is clear that Belize, like Haiti, faces many significant challenges in providing energy to meet a rapidly growing demand. Furthermore Belize and Haiti face many of the same struggles to meet this demand. But this alone is only half of the picture. The indifference of Belizeans to the production of biomass charcoal cannot be found in the similarities between these two nations, but rather in the differences. Furthermore the agricultural communities in northwestern Belize with which we partner are skeptical of

foreign assistance not specifically requested from within the community, and for good reason.

The purpose of this Partnership for Environmental Education and Rural Health was to gauge the interest within the communities of northwest Belize for corn cob charcoal. In discussions with Mr. Peres, vice chairman of the village of San Carlos Belize, and Maximillian Hernandez of the New River Farming Cooperative, both men had significant concerns about the necessity of such methods and generally believed that these methods required a significant amount of work to solve a problem they did not have. It would also have been useful to discuss these methods with representatives from northwestern Belize's Mennonite communities, but language and cultural barriers prohibited this.

Fundamental to the success of implementing these methods in Haiti was the relative scarcity of wood, a condition that does not exist in Belize. It is easy to focus on the potential inherent in biomass charcoal, but to a farmer living at a subsistence level potential is less important than being able to put a warm meal on the table, and having the time left in the day to enjoy it. Regardless of any potential benefits relating to health or sustainability, for most subsistence communities implementing change ultimately comes down a simple question: will this be more or less work than what is currently being done? In Haiti it is less labor intensive to produce charcoal from readily available materials than to forage for a scarce wood supply. In rural Belize, however, wood is plentiful and can always be found in close proximity to homes. Furthermore many of Belize's larger farms are more mechanized than those found in Haiti. This mechanization results in more damaged byproducts that are less suitable to the production of charcoal. In order to justify such an investment of time and money there would need to be offsetting gains in health, storability, or decreased energy costs. However even these benefits are muted relative to those found in Haiti.

The communities of northwestern Belize, including the village of San Carlos, are relatively isolated and not connected to the national power grid. Within this community, outside of solar power at San Carlos Government School added as part of a previous McMaster Partnership for Environmental Education and Rural Health, the major sources of energy are wood fires for cooking and light, and diesel generators that are used sporadically to produce electricity. Since this method of charcoal production will only impact the amount of wood needed for cooking, and not costly need of diesel fuel, it is unlikely that San Carlos will see any economic benefit from adopting these methods. Also, unlike Haiti, most cooking fires in Belize are created outside of the home. This allows for greater ventilation that

reduces the concentration of hazardous combustion products in the living quarters. Without significant gains in health or economic conditions the only remaining compelling reason to adopt biomass charcoal is the ease with which it can be stored. It was believed that this would be of great interest to the people of Belize as a fire starter during the rainy season. The charcoal produced from corn cobs and other biomass is more compact and less susceptible to rot than the materials from which it is derived. As such a supply of charcoal could be kept dry within the living quarters and then used as starter material to ignite wet wood during the rainy season. This possibility was what most interested community partners, but was not compelling enough to make the effort worthwhile as these communities already store corncobs to be used as a starter during the rainy season.

In the end the lack of interest for corncob charcoal expressed by our community partners is the result of many factors, but most of all our own assumptions. It is easy for those in developed nations to see the potential in a method, but to those that depend on the outcome of those efforts only the results matter. To our community partners it is not a matter of if it doesn't work try something else, but rather if it doesn't work a lot of time and effort was not applied where it was most needed. These are proud people that live a life of hard work, and periodic exploitation. There is a long history of exploitation for the people of northwestern Belize starting during colonial times and extending to the current day (Studer M. , 2009). As such our community partners are reluctant to give away precious time or resources to indulge the whims of foreigners. This Partnership for Environmental Education and Rural Health should thus serve as a powerful reinforcement of what was already known to be true. Successful McMaster Partnership for Environmental Education and Rural Health can only result from genuine community need. As much as we work to understand the culture and daily life of those that we work with we presume too much when we claim to know better than our community partners how to improve life in these communities.

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PESTICIDE IMPACT ON WATER QUALITY IN BELIZE

Brittany Heaton, McMaster Scholar

In Belize, the New River Lagoon and its tributaries are a major water source for the northern part of the country, making their water quality important to the people who use and live near them. Because several farms are located near tributaries that feed the lagoon, this project monitored and checked the levels of the pesticides atrazine and simazine to ensure safe water quality. Also, in partnership with Programme for Belize, the data collected added to baseline data for the New River Lagoon which will help this NGO monitor levels of pesticides in this waterway.

LITERATURE REVIEW

Water quality is important to public health and safety. The U.S. Geological Survey (2009) defines water quality as the “chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose” (USGS, 2009, par. 1). These purposes include drinking, agriculture, and recreation. Sources of poor water quality include the “runoff and leaks from agricultural fields, city streets, construction and mining sites, and precipitation and deposition from the atmosphere” (Natural Resources Conservation Service, 1997, p. 7).

Pesticide use is a large part of agriculture around the world aiding in better sized and less damaged yields. However, the pesticides used on crops can pose hazards and problems to water quality and human health. Contamination of water occurs when pesticides themselves and the residues from the pesticides are transported by erosion and runoff from the application sites (Papendick, Elliot, & Dahlgren, 1986, p. 4). Precipitation and natural movement of pesticides into the ground cause their movement into the nearby waterways to occur. The largest amount of pesticide transfer occurs from “compacted soil, which leads to quicker, larger runoff, and increased concentration and loss of pesticide from original application” (NRCS 1997, p. 34). Knowing as much as possible about a pesticide helps to ensure safe pesticide levels in water for human health as set by the United States Environmental Protection Agency. These set levels help protect the water being used, and can be applied to countries around the world as an approximate limit for which to test.

The northern part of Belize has large distances between the cities, and citizens in these regions survive by growing crops for food and for profit. In order to yield good crops, farmers frequently use pesticides registered with the Belize Pesticide Control Board (2009). A large portion of agricultural

fields, mainly from San Carlos and Indian Church in northern Belize, surround the New River Lagoon and its tributaries, increasing the chance of pesticide contamination. The New River Lagoon, the largest freshwater body in Belize, is a daily water source for irrigation, recreation, fishing, and other uses (Meerman, 2006, p. 2). Based on the CIA's World Factbook (2009) on Belize, "20% of the freshwater withdrawal from the Lagoon is for agricultural needs – growing crops such as bananas, citrus, sugar, and cacao" (United States Central Intelligence Agency, 2009, par. 2, 5). Since agriculture is a major source of land use surrounding the New River Lagoon, the water quality could be affected due to pesticide runoff.

While considered a pristine waterway, the New River Lagoon has seen signs of contaminants such as pesticides within its waters (Meerman, 2006, p. 26). Because of this, Programme for Belize is working to better sustain the conservation of the New River Lagoon and other watersheds through the Freshwater/Aquatic Programme (PFB, 2008, par. 1). An important insight into the quality of the watershed can be seen from its layout "which is narrow, long, and deep, [and] is created by two major streams, Irish Creek and Ramgoat Creek, as well as a few smaller streams that feed into the Lagoon" (Meerman, 2006, p. 2). While on the Lagoon in December 2009, the tributaries that feed the larger body of water were easily visible, and the farms located in close proximity to the tributaries were also easily seen when travelling by car. Each piece of the Lagoon and its tributaries contribute to the possible input of pesticides and their potential effects on water quality.

Water quality of the New River Lagoon has been central to McMaster initiatives since 2005, and the McMaster School for Advancing Humanity has played an ever-increasing role in helping to maintain and test the waters of the New River Lagoon. Because one aspect of aiding in the quality of the New River Lagoon is checking to ensure that the levels of pesticides found in the water are safe, this project tested for atrazine and simazine, pesticides that Belize's Pesticide Control Act and Pesticide Control Board have authorized for use.

Atrazine, a common pesticide, is used to control "broadleaf and grassy weeds in corn, sorghum, rangeland, sugarcane, macadamia orchards, pineapple, turf grass sod, asparagus, forestry, grasslands, grass crops, and roses" (United States Environmental Protection Agency, n.d., par. 5). In Belize, atrazine is applied in large doses to grow crops in areas where rainforests have recently been cleared in an effort to remove all remnants of the forests. This chemical can have several health effects caused by either inhalation or absorption, and is considered slightly toxic (Extension Toxicology Network, 1996a, par. 6). In its data on the health effects of

atrazine, the EPA lists, "In the short term, heart, lung and kidney congestion, low blood pressure, and weight loss are possible detriments that have been reported. In the long term, problems of weight loss, cardiovascular damage, retinal and muscular degeneration, and cancer have occurred." Due to the various effects of atrazine, its Maximum Contaminant Level Goals (MCLG) and Maximum Contaminant Level (MCL) are both at 3.00 parts per billion (ppb). According the EPA, these numbers are the "lowest level to which water systems can reasonably be required to remove this contaminant" (U.S. EPA, n.d.a, par. 6-9, 12-13).

The other pesticide, simazine, is "used for control of broad-leaved and grassy weeds on a variety of deep-rooted crops such as artichokes, asparagus, berry crops, bread beans, citrus, etc." (Extension Toxicology Network, 1996b, par. 6). Like atrazine, the EPA has also collected data on what health problems have been reported in relation to simazine. For short term, weight loss and changes in blood have occurred. In the long term, "tremors; damage to testes, kidneys, liver and thyroid; gene mutations; cancer." The MCLG and MCL set for simazine are both 4.00 ppb (U. S. EPA, n.d.b, par. 6-8, 10-11).



Integrated Natural Resource Management, which is a way to enhance productivity, human well-being, and ecosystem functions based on the specific project, greatly impacts the areas surrounding the New River Lagoon. Testing the water for pesticides has the potential to enhance ecosystem functions by decreasing the amount of pesticides exposed to the environment, and in turn could help keep the New River Lagoon pristine and healthy. Productivity could be improved by decreasing the cost of production by using fewer pesticides, and in turn producing healthier crops. The well-being of humans then would be enhanced because of increased productivity at a lower cost, resulting in more profits. Overall, the water used both by farmers on crops, and by people near the New River Lagoon for daily use will be safer and healthier.

METHODOLOGY

The pesticides atrazine and simazine were chosen based on usage in Belize and previous testing. The test used to determine the presence of pesticides was an immunoassay (lateral flow) test strip, antibody-based stick test from InspectUSA.com. This test detected the USEPA limits of both pesticides on a single strip. The water samples from agricultural runoff areas were combined with the test kit to produce results of the presence of pesticides. The data and results were compiled, analyzed and sent to Programme for Belize to add to the baseline data on the New River Lagoon, and to allow for future monitoring of the pesticides in the waters encompassing the New River Lagoon watershed.

RESULTS

The results of this project are based upon the testing of agricultural runoff locations surrounding the New River Lagoon in Northern Belize. Ten samples were collected all together: Irish Creek from the bridge, Bergen's Gate, Ramgoat Creek- far, Ramgoat Creek- near, Ramgoat Creek- mouth, Harry Jones Creek, New River Lagoon- San Carlos, Irish Creek- mouth, Irish Creek- inner, and New River Lagoon- Hillbank dock. Each of the locations produced a negative result, indicating levels of the pesticides atrazine and simazine below the US Environmental Protection Agency's set levels of 3 parts per billion (ppb) and 4 ppb, respectively. The Bergen's Gate site with a high level of atrazine from previous testing, has gone down and is now safe. These results were a positive aspect to add to baseline data on the New River Lagoon in partnership with Programme for Belize. In turn, it will allow for continued monitoring of pesticide levels, which will help keep the people who utilize the waters healthy.

CONCLUSION

Pesticide contamination in water systems can lead to many problems. The agricultural based communities of Northern Belize have to lead their lives by using the water from the New River Lagoon and its tributaries. These waterways, due to their proximity to the farms on which pesticides are used, have the potential to have high levels of harmful chemicals. Surveying pesticide levels at agricultural runoff locations surrounding the Lagoon is helping to assure the people who come into daily contact with the water of its safety. Each of the ten locations that I tested produced negative results, indicating that the levels of atrazine and simazine in the waters was below the EPA level. This shows that the water should be free of the harmful effects that the pesticides could cause.

REFLECTION

When traveling to developing countries such as Belize, transitions to the culture and people are important, especially when one is working closely with the people. Being able to slow down, take in everything around me and connect with the community members about a certain goal was beneficial. This transition was made easier by our guide, Ivan Gillett, whose established relationships with the communities in which we worked enabled our communication and connection with farmers and community members. Ivan's connection to the people and land made the success of my project possible because he knew the areas we were to travel to and work in, which ensured the right locations to be tested. I also showed Ivan how to carry out the pesticide test so that he will be able to check the levels of the water if there is a problem noted in the future.

While in 2007, a high level of atrazine was found at the Bergen's Gate location, the level during this project was found to be safe. This finding raised several questions, including whether the farmers were using fewer pesticides, whether the weather affects the flow and transfer of pesticides from fields into water, and whether the depth at which the sample was taken affect the concentrations of pesticides. Answering these questions will provide directions for future projects, as well as continued monitoring of the levels of the pesticides that have leached into the water.

The trip as a whole changed my perspective on life. In learning how to interact with and adjust to different cultures and people, I have become more open and ready for new challenges. Participating in this project has also taught me skills that will be beneficial in my career as a forensic scientist, including collecting and testing samples for various chemicals or problems. Personally and professionally, Belize has changed my life for the better.

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WATER QUALITY ANALYSIS OF THE NEW RIVER LAGOON

Joshua Hegemier, McMaster Scholar

My project contributes to a six year water quality analysis of the New River Lagoon region and assesses the quality of drinking water in the Belizean communities by testing for certain contaminants. Edilberto Romero, Programme for Belize director, specifically requested full range water quality testing as a needed project in 2007. Therefore, printed test results for all sites will be returned to Programme for Belize to help this organization monitor the water quality in the New River Lagoon region and the communities on the periphery of the Rio Bravo Conservation and Management Area.

LITERATURE REVIEW

As stated in a petition to the United Nations to add clean and accessible water as the 31st article to the fundamental human rights, “Everyone has the right to clean and accessible water, adequate for the health and well-being of the individual and family, and no one shall be deprived of such access or quality of water due to individual economic circumstance” (Freeflo). Many people and organizations are making attempts to improve water quality around the world; however, “the present situation of water quality management in the world is far from satisfactory, due to the pressures of increasing population and economic development” (Huang & Xia, 2001, p.1). Ammonia – a chemical added to water to destroy bacteria – can be potentially harmful to the environment, especially when it is broken down to other compounds. “If sufficient dissolved oxygen is present, ammonia can be easily broken down by nitrifying bacteria to form nitrite and nitrate” (FM River, par. 2). Sources of nitrate contamination may also occur “as a result of nitrate-containing fertilizers used in agricultural areas, fecal contamination from feedlots, and leaking onsite wastewater systems contaminating the water source” (Centers for Disease Control and Prevention, 2008, par. 3). Another source of nitrate contamination is from the “airborne nitrogen compounds emitted by industry and automobiles” (Manassaram, Backer, & Moll, 2006, p. 320).

Nitrate penetrates through soil and remains in groundwater for decades, which makes it difficult to remediate highly contaminated spots (Manassaram et al., 2006, p. 320). “Private wells are usually shallower and closer to sources of nitrate contamination, whereas public supply wells are usually in deeper groundwater aquifers where contamination is less likely” (Manassaram et al., 2006, p. 320). Because the Belizean people get water from shallow wells in close proximity to agricultural areas, they are at a higher risk for nitrate contamination. Drinking water with excessive levels of nitrates

has been known to cause short term effects such as shortness of breath and blue baby syndrome (United States Environmental Protection Agency, 2009), “a potentially fatal condition that occurs when the hemoglobin in an infant’s red blood cells is oxidized to methemoglobin” (Knobeloch, Salna, Hogan, Postle, & Anderson, 2000, p. 675).

“Disinfection of drinking water is used in most industrial and developed countries to minimize the risk from hazardous waterborne microorganisms causing diseases, and chlorination is the most commonly used method” (Goebell, Villanueva, Rettenmeier, Rubben, & Kogevinas, 2003, p. 475). Although chlorination minimizes the risk from these waterborne microorganisms, the process leads to harmful by-products such as chloroform (Goebell et al., 2003, p. 475). According to the EPA, the Maximum Residual Disinfectant Level – the highest level of a disinfectant allowed in drinking water sources – for chlorine is set at 4.0 mg/L or parts per million, and anything above this would cause adverse health effects (U.S. EPA, 2009).

“Chlorination of surface and ground water produces a wide range of disinfection by-products” (Xu & Weisel, 2005, p. 6). According to the 1992 meta-analysis conducted by Morris, Audet, Angelillo, Chalmers, and Mostellar, “the results suggest a positive association between consumption of chlorination by-products in drinking water and bladder and colorectal cancer in humans” (Morris et al., 1992, p. 955). Therefore, one might predict that the “epithelial tissues at the bladder and rectum are exposed to higher levels of chlorination by-products and are therefore at increased risk for the development of neoplasia, the process of tumor formation” (Morris et al., 1992, p. 961-962).

Dissolved oxygen is unique among the tests performed in the Belizean communities since the test for dissolved oxygen is actually looking for high levels, whereas the other tests are looking for low levels of the contaminants. The amount of dissolved oxygen needed varies depending on the type of organism. Aquatic organisms can be divided into two types, cold water and warm water organisms. Cold water organisms, such as trout or salmon, require a minimum dissolved oxygen content level of at least 6.0 mg/L (Partnership for Environmental Education and Rural Health, par. 3). However, warm water organisms – such as bass, carp, and catfish – require less dissolved oxygen than cold water organisms. Furthermore, “If dissolved oxygen drops below 1.0-2.0 mg/L, it will result in a fish kill, where large amounts of fish die, and float to the surface” (Partnership for Environmental Education and Rural Health, par. 6).

The pH of each sample was tested using a pocket pal pH tester from the HACH Company. The pH scale measures how acidic or basic a substance is and the scale ranges from 0 to 14 with a pH less than 7 being acidic and a pH greater than 7 being basic. The Environmental Protection Agency's secondary standard – “non-enforceable guidelines regulating contaminants that may cause cosmetic (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) effects in drinking water” – recommends a pH range of 6.5-8.5 (U.S. EPA, 2009). “EPA recommends secondary standards to water systems but does not require systems to comply” (U.S. EPA, 2009).

The water samples were also tested for phosphate and phosphorous levels since previous teams had detected high levels in the southern regions of the New River Lagoon. The United States Geological Survey reports, “Phosphorous is an essential element for plant life, but when there is too much of it in water, it can speed up eutrophication (the reduction in dissolved oxygen in water bodies caused by an increase of mineral and organic nutrients) of rivers and lakes” (USGS, 2008, par.3). Phosphorous stimulates an increase in the growth of aquatic vegetation; however, “The rapid growth of aquatic vegetation and/or increase in the algal population can cause the death and decay of vegetation and aquatic life because of the decrease in dissolved oxygen levels” (Oram, par.12).

While humans contribute to the high levels of contaminants in water, natural processes such as wind and erosion also have an impact on contaminants in water systems. Former McMaster scholar Austin Kleman (2009) suggests that the significant decrease in phosphate levels from 2007 to 2008 may have been attributed to Tropical Storm Arthur (Kleman, 2009). Specifically Kleman's findings in 2008 with regards to phosphate levels are critical to monitor so as to determine the source of previously recorded phosphate levels. If we once again note high levels of phosphate in these previously tested areas we might also be able to determine the impact of tropical storms on the water quality of the Lagoon and the down watershed areas including the sea.

According to this research, the Belizean people are particularly susceptible to contaminated water because Belize is a developing country that lacks the resources needed to implement an effective water quality management system. In addition, many Belizeans get water from shallow wells near agricultural areas, and this can lead to an increased chance of drinking water contaminated with high levels of nitrates. Therefore, monitoring the water quality of the wells and cisterns in the Belizean communities is important to the goals of this baseline water quality project. Not only is water testing

important to the people of Belize, this project also supports the efforts of the proposed Article 31 to the United Nations in the struggle for universal access to clean and sanitary water regardless of economic circumstances.

METHODOLOGY

To complete the project, water samples were collected from tributaries in the New River Lagoon and from the wells and cisterns in the Belizean communities. Ivan Gillett, our guide, helped to determine the sites that would be most beneficial to test along with sites tested by former McMaster scholars. The GPS coordinates and the pH readings were recorded at each testing site. Then each sample was collected in a 250 milliliter sampling bottle with the information of the testing site printed on the label. Subsequently, each contaminant was tested using a Hach surface water kit and a Hach ortho-/meta-Phosphate kit. The concentrations of the contaminants were determined in mg/L after completing the tests.

After testing each contaminant using the Hach surface water kit and Hach ortho-/meta-Phosphate kit, I compared the results with the standards set by the Environmental Protection Agency. In addition, I compared the results with the numbers from the previous years to complete an overall



assessment of the water quality in the New River Lagoon and surrounding areas. Furthermore, the test results for all sites were returned to Programme for Belize so that this organization may continue to monitor the water quality in the New River Lagoon and in the communities on the periphery of the Rio Bravo Conservation and Management Area.

RESULTS

Overall, thirty sites ranging from New River Lagoon tributaries to community wells to household cisterns were tested and analyzed. Dissolved oxygen and phosphate levels can be

potentially harmful to the environment, whereas the potentially harmful contaminants to humans include nitrate, ammonia, and chlorine. The tests for nitrates varied widely, from 0 mg/L at over half the sites to as high as 23 mg/L from the groundwater at Redecop's farm. Six samples tested over the 10 mg/L maximum nitrate contaminant level and two samples were close to this recommended level.

The dangerously high levels of nitrate may be attributed to run off from fertilizers used on the agricultural areas since there were heavy rains before the samples were collected. The well at Burnice Casacola's house in St. Paul was found to have a high nitrate level with 15.4 mg/L. San Carlos had the most sites that tested high for nitrates since the area is mostly agricultural. The well at San Carlos Government School was tested twice and the average nitrate level was 17.16 mg/L. In addition, the well across the street from the school also tested above the recommended level.

The values for ammonia were very low and all were under the maximum levels. At the San Carlos Government School well, a reading of 0.3 milligrams per liter was determined. The rest of the sites either had a reading of 0 or 0.1 milligrams per liter. The chlorine tests—free chlorine and total chlorine—did not have many samples that recorded a value. Values for chlorine ranged from 0 to .1 milligrams/liter which is far below the maximum contaminant level of 4 milligrams/liter.

The pH results ranged from 5.2 to 10.3. Many of the samples had a pH within the normal range of 6.5-8.5; however, St. Paul and San Carlos had some interesting results. In St. Paul, the well at Peter Casacola's house had a normal pH of 7.2, but after he ran the well water through a filter the pH increased to a basic pH of 10.3. The well at neighboring Burnice Casacola's house had an acidic pH of 5.2. In addition to St. Paul, San Carlos had two sites that had basic pH results. The cisterns at Gloria Corado's house and the Barrientos' household both had results above 9, and it is important to note that the roofs of these houses had a significant amount of plant growth. Dissolved oxygen and phosphate were also tested since they have an impact on the environment, whereas the other contaminants can be harmful to humans. Low levels of dissolved oxygen and high levels of phosphate can be detrimental to the environment; therefore, the dissolved oxygen tests look for high levels above 5 milligrams/liter. All of the samples had dissolved oxygen readings above the safe level of 5 milligrams/liter. Phosphorous can be detrimental to the environment if there is too much of it in water because it can speed up eutrophication. The only sample that had high levels of phosphate was the cistern at the Hillbank kitchen, and the cistern had plant growth on the inside; therefore, cleaning the inside of the tank would help

to eliminate the high levels of phosphate. The rest of the samples tested at 5 milligrams/liter and below which is not enough to cause a significant impact on the environment.

CONCLUSION

After testing thirty water sites – tributaries, wells, and cisterns – for nitrate, phosphate, ammonia, free chlorine, total chlorine, and dissolved oxygen, I conclude that the water of Belize is safe for use and consumption by humans with regard to chemical contaminants; however, there were a few sites located near agricultural areas where runoff may be leaching into the surrounding groundwater. Six sites tested above the maximum nitrate contaminant levels of 10 milligrams/liter. The readings for free chlorine, total chlorine, and ammonia were all far below the maximum contaminant levels. Additionally, the water is safe for the environment since the dissolved oxygen levels were above 5 milligrams/liter and the phosphate levels were low with many samples receiving a reading under 5 milligrams/liter.

REFLECTION

The baseline water quality testing addresses several goals of the McMaster School by examining the root causes of human suffering through research and improving the human condition. Belizeans who use the New River Lagoon as a water source can now be reassured that the water is safe to drink with the exception of a few wells that had high nitrate levels, and in those instances, results were sent to locations in San Carlos. Results were also returned to Programme for Belize so that they can notify the places with high contaminant levels and continue monitoring these sites.

Overall, the experience was priceless and I would not trade it for anything in the world. I grew as a person and became more globally and culturally aware, and feel that our group also evolved throughout the experience and exhibited great teamwork skills. Continued baseline water quality testing is important to improve the human condition in Belize and to create an overall analysis of the New River Lagoon and the wells and cisterns of the Belizean communities.

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INTEGRATING CALCULATOR USE IN SAN CARLOS AND ST. PAUL'S SCHOOLS

Brian Badenhop, McMaster Scholar

For my project, I conducted research on the benefits of using technology, specifically calculators, in schools in San Carlos and St. Paul's, Belize, and assisted teachers on the ground with using technology in the classroom. I created lesson plans that were implemented while on the ground to teach the students and teachers how to successfully integrate technology in the classroom, including the calculators that were left in Belize along with my lesson plans. In so doing, I have found evidence to support my hypothesis that technology implemented in these Belizean classrooms will further develop students' education.

LITERATURE REVIEW

Because the families in the rural Belizean communities of San Carlos and St. Paul, Belize, struggle just to feed their families, no extra money is left for luxury items like calculators. My project's goals to bring calculators into the schools and train teachers and students in their use will strengthen students' educational experience and opportunities because they will have access to technology that would otherwise be an unaffordable luxury. My project will enhance the use of technology for students in this area, and the use of calculators will mesh well with the curriculum standards of the Ministry of Education in Belize. The Belizean school curriculum has similar objectives to curriculum in the United States, and by providing calculators and training the teachers to use them efficiently I will be able to fill in educational gaps that the students in these rural schools currently experience. Also, based on the learning goals of this curriculum I will be developing and teaching useful lesson plans and leaving additional materials for teachers. Bringing calculators to students who have never before had the opportunity to use them is an amazing opportunity that will benefit the schools in San Carlos and St. Paul long after I am gone as students strive to achieve more in their classrooms and develop themselves as better educated community members.

Researching Belizean educational philosophy/curriculum and learning goals specifically related to mathematics, I have learned what is expected from the students, and what is needed in the classrooms. The Belize Ministry of Education (n.d.) defines mathematics as "the study of numbers and relations. It promotes a certain way of viewing situations, processing information, and making judgments that we refer to as 'mathematical thinking and reasoning.' Numbers are used every day for counting, measuring, and computing; how

they differ and how they relate to each other is essential in making most of life's decisions." (Belize Ministry of Education, n.d., p. 31). Thus, regardless of the level of education, an adequate level of math skills needs to be reached. One worry the Belize Ministry of Education has is that, because science and technology have grown at an exponential rate over the last 50 years, math education is having to keep up which is a struggle for schools to accommodate because of the state of the Belizean economy (Belize Ministry of Education, n.d.). This is one area where I know I will be helping to make a difference providing not only calculators but also working with teachers and students to utilize them in a way that will improve their math development. The "four pillars" that the Belize schools base their education on are "learning to live together, learning to be, learning to know and learning to do" (Belize Ministry of Education, n.d., p. 11). They understand that "mathematics is a useful, exciting, and creative area of study" and its importance, at least at primary levels, is to "help children understand and interpret their world and solve problems that occur in it." Furthermore, mathematics "promotes logical thinking and can help to free one from dependence on remembered procedures." and solve everyday problems (Belize Ministry of Education, n.d., p. 31).

Belizean educators stress that even though teaching as well as learning math is challenging, the techniques used should keep math as exciting and creative as it is when students first begin to learn (Belize Ministry of Education, n.d.). I believe math's excitement lies in its ability to give an instant reward and the many many opportunities even in a single assignment to be right and reach goals. Unlike science or writing where answers can be debated, there is no wiggle room in math to pick out what is wrong which I believe encourages students at young ages because math gives them a sense of accomplishment and even pride when they get answers correct. However, as students progress, mathematics becomes more difficult. Due to minor mistakes in simple things like addition, subtraction, or even signs students can become frustrated and lose interest in this very important field.

The Belize Ministry of Education believes that a shift needs to happen in the way students learn math, and that students need stronger knowledge and skills in this field to survive in today's society (Belize Ministry of Education, n.d.). The Belize Ministry of Education sees technology as a valuable asset that will enable them to keep up with other nations. I will be assisting in this goal by bringing calculators – a minor but important form of technology – to two rural Belizean communities. My hope is that these calculators might become a springboard for some students to continue with their education and accomplish goals that they could not otherwise have dreamed about. The goals set forth in the Belize National Syllabus are, "to be concept



oriented, actively involve students in doing mathematics, emphasize the development in mathematical thinking and reasoning, emphasize the usefulness of mathematics in application, extend the range of mathematics to cover more branches, and to make use of appropriate technology” (Belize Ministry of Education, n.d.). This final goal also goes very well with my project as I will be introducing the technology and teaching the kids how to properly use the calculators. With time and further implementation by the teachers, students will understand the appropriate use of the calculators. The teachers will foster this long after I have left to achieve students’ best knowledge and potential.

While researching calculator use in the classroom, I found that although teachers have some disagreement on the use of calculators, all ultimately desire “finding – in each lesson – the best way of ensuring the best results for each student” (Starr, 2002). In the same article, Linda Starr (2002) offers arguments in favor of calculator use. Among them, calculators “allow students to spend less time on tedious calculations and more time on understanding and solving problems” which “allows students to study mathematical concepts they could not even attempt if they had to perform the related calculations themselves.” Furthermore, calculator proponents

argue that calculators “make students more confident about their math abilities” (Starr, 2002).

The benefit of calculators has been researched extensively and the U.S.-based National Council of Teachers of Mathematics (NCTM) placed curriculum and evaluation standards so that every teacher was encouraged to promote using calculators in their classes (Starr, 2002). Mathematics professor Patricia Campbell from the University of Maryland said she would love for students in lower grade levels to easily “add and subtract two and three digit numbers” but doesn’t want to have “to spend class time adding and subtracting five and six digit numbers” (Starr, 2002).

In the article “Calculator in the Elementary Classroom,” Erin McCauliff (2009) identifies the biggest debate concerning calculator use in the classroom as taking away from “students’ ability to think and reason through problems.” McCauliff goes on to state that a “calculator should be used as a supplement to learning, not as a replacement” and that, when learning new concepts, students should first try and learn without calculators so they will not rely on them later on (McCauliff, 2009).

METHODOLOGY

While on the ground in Belize, I had numerous goals for the students. First, I simply wanted to teach them to use a calculator and to see that this valuable tool if used properly can help in many aspects of math and in turn make them better students. This project aimed to improve speed and reduce the number of minor mistakes made while doing things with paper and pencil type problems. I also wanted them to understand that the calculator is a tool to be used, not just relied on, because if they do not understand the concept behind the calculator then there would be no advantage in using it. For student placement, I grouped similar age divisions together and implemented different styles and levels of calculators so the youngest would be able to use the simplest calculators and do problems such as addition and subtraction.

My first step was to set a time aside with the teachers to explain what I was going to be doing and inquire when it would be possible to speak to the classes. This was beneficial as I was able to show the teachers the calculators and supplementary materials. Once in the classrooms, what I did was directly related to the amount of time that I had with the students. If I had additional time, I started off by simply showing posters of the calculators. Once students received the calculators, I gave some time to use the calculators on their own and do simple things by themselves before reviewing basic problems. During the review, I used the poster to display

what buttons needed to be pressed and in what order so students could follow along. I also used activity books I had distributed alongside the calculators to introduce a variety of sample problems. I used these books to accumulate problems and created some to go over with the students that grow in increasing difficulty just to see how well the students could understand them. While I would have liked additional time to go over past assignments with the calculators, I was unable to do so due to time restrictions. This activity was beneficial because the students already knew how to do the problems using the paper and pencil method and I was able to show them how to use calculators both for those situations and to then go through and show the students that a primary calculator use is to check answers. In teaching students this, I hope to have increased their capabilities and confidence when working on their math.

CONCLUSION

My project worked well in large part because of the 70 calculators which were funded by the generous contributions of Trinity Lutheran Church in Wauseon, Ohio. In each of the classes I visited, teachers saw the calculators as a valuable tool and were appreciative. They liked the idea that their students would now be able to check their answers and that they wouldn't have to take as long to get answers from the students during problems. One thing the teachers and I stressed was that the students needed to first understand the calculator as a tool for checking answers to the problems they had solved rather than letting the calculator do the problems for them. The students also seemed very willing and excited to use something that they had never seen before, and in a short amount of time each student was able to work with the calculators and get correct answers which I wrote on the board. As the students were working I also covered more of the background and taught the teachers how to use the calculators in their everyday lesson plans. The teachers also plan to continue using calculators in their classrooms, using lesson books provided to assist them.

REFLECTION

My project took me beyond my comfort zone and let me use what I know while experiencing a new culture and way of life. Belizeans have made the best out of what they have, and with my project the people living in San Carlos and St. Paul's may possibly be able to go even further. In two weeks' time, I went from being a person who had never traveled to someone who had lived for two weeks in an extremely different setting. The project and I both excelled and made me more capable of dealing with a variety of experiences and challenges. As a result, I have become more professional and will undoubtedly continue to benefit from this experience as my career and

life unfolds. The Belizeans' acceptance and continuance of these projects will help them make more out of their talents and aid in their future success.

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PARENTAL INVOLVEMENT IN EDUCATION IN SAN CARLOS, BELIZE

Jocelyn Tingley, McMaster Scholar

Belize is a country that is striving for educational development. In order to help improve the quality of life of the Belizean people I tried to identify factors that inhibit parental involvement. Research has shown that children have increased motivation and academic success when parental involvement exists within the school systems. In addition, research acknowledges that language barriers, income levels, and a family's education level can affect parental involvement. In order to help facilitate parental involvement in San Carlos school I interviewed teachers, students and parents to determine which activities would be the most successful in encouraging parents to be at the school. After combining my results and research I created a binder of activities that could help to increase the amount of parental involvement within San Carlos Government School and sent these suggestions to the school.

LITERATURE REVIEW

Education is a privilege developed countries take for granted. Without standardized education in the United States, we would not have as many job opportunities, resulting in more people living in poverty. Unfortunately, Belizean people understand the hardships to which limited education can contribute. Children ages 6-14 can attend free primary school in Belize. However, about ten percent of children in Belize never attend school, and of those who do attend, roughly thirty-six percent will not finish primary school. Furthermore, "Only about ten to fifteen percent of the children in Belize complete secondary education, which begins at 8th grade" (Micklos, 1995). By no means are the people in Belize unintelligent, they just do not have the same opportunities and resources as people who live in developed countries. According to Alyssa Shuherk (2008), "The primary education in Belize is equivalent to the United States 8th grade" (Shuherk, 2008). To reach the nearest high school from San Carlos, Belizeans must travel 41 miles over pothole-infested dirt roads. While buses are available to make the journey, most families cannot afford the expenses. As of 2008, only four individuals from San Carlos had graduated from high school (Shuherk, 2008). This past year only two students from San Carlos continued onto high school, showing that while Belizeans are capable of achieving a higher education, they often lack the resources needed to overcome obstacles and obtain the education. According to Drissen, Smit, and Slegers (2005), parental involvement is viewed as a method to increase effectiveness and enhance the quality of education. Parental involvement, they assert, drawing from a study in

Cyprus, can be divided into “three types of parents: strongly involved parents, an intermediate group and a fringe group (Phtiaka, 1994)” (Driessen, Smit, & Slegers, 2005, p. 513). A fringe group is composed of parents who have received a limited education, may feel intimidated by the school, and have trouble communicating with the school. Many parents who did not graduate from school or did not excel in academics may feel as though they do not belong in the school or cannot contribute to their child’s education, feelings that cause for “considerable difficulties communicating with the school” and a sense of being “powerless in relation to the school” (Driessen et al., 2005, p. 513). As of right now, there are only a few, if any, parents involved in the school in San Carlos. The low involvement may result from the presence of a fringe group as past McMaster research shows that the San Carlos area has high levels of poverty, with many people having limited education and working in agriculture to support their families.

In addition, Belize requires school lessons to be taught in English but many students struggle and some teachers resort to teaching the lessons in Spanish so that students will more easily understand the lessons. Because of the language barrier, communication may be a leading factor in the separation between the school and the community members. Driessen et al. (2005) write, “To the extent that parents are more involved in a school, the more



positive the climate in the school and the stronger the orientation of the school towards the surrounding environment" (Driessen et al., 2005, p. 515). Education serves as the center for resources, information, and jobs, all which result in a good quality of life. An education can provide people more job opportunities and allow them to increase their knowledge of a variety of subjects. This leads to a better life, requiring less manual labor and struggle to provide the basic family needs. Without an education one may feel inferior or unintelligent, when in reality they just have not been able to access the opportunities and confidence that an education can provide.

Parental involvement in activities that occur at school results in positive school engagement and performance as parents demonstrate that they value an education and that academics are important (Gonzalez-DeHass, Willems, & Holbein, 2005). When parents participate in school, take an interest in the information their children are learning, and make sure that homework is being completed, they are urging their children to work harder and perform better. A study of high school students by Gonzalez-DeHass, Willems, and Holbein (2005) demonstrated that "When parents were more involved in their child's schooling, their children had higher grade-point averages and were more engaged in school. Specifically, when parents were involved, students reported more effort, concentration, and attention across four main subject areas: maths, English, social studies, and science" (Gonzalez-DeHass et al., 2005, p. 109). No matter the age of the child, parental involvement will help that child succeed academically. Research shows that when the parents interact weekly with the teachers and their children witness their involvement, the students have more motivation for academics, factors which would positively influence San Carlos students.

Another positive result of parent involvement is a parentally supportive home environment for children's learning. Positive results come from parents showing that education is highly valued within the family. This may be achieved by the parents helping with assigned homework, reading together, or even asking what their children learned at school that day. Students who experience parental involvement take a sense of personal responsibility in their education, pursue more challenging assignments, and are more satisfied with their academic work (Gonzalez-DeHass et al, 2005, pp. 117-118). When parents are supportive, their children try harder and perform better. Therefore, parental involvement could help students at San Carlos to strive for academic success in school.

For parental involvement to occur, the parents need to feel welcome in the schools. Some parents may not have been academically successful in school,

but their interaction can still have a positive impact. One way to help increase parental involvement is to remove barriers that prevent the parents from being available. This could include setting up a babysitting or daycare system for mothers (Machen, Wilson, & Notar, 2005). If a library was built outside of the school or the school was open after the 3:00 p.m. closing it would help remove multiple barriers specific to San Carlos because reading material would be available to the entire community and the children would have a place to complete their homework. By working to remove barriers and make accommodations available, more parents would be willing and able to assist in the schools. Parents could come in to read to the class, walk around the class and help when students have questions, or work in the library so more children have access to books.

Parental presence in the classroom enables students to receive more help with their school work. Most importantly, it provides the message that education and the child's success is important. That message leads to a child's sense of confidence and support within the classroom (Machen et al., 2005). San Carlos parents would be applying this message by assisting in parent days, as mystery readers, and in field day activities. Children look up to their parents, replicate their actions, and emulate their values. While in the learning community, I learned of a Belizean family that had told previous scholars their grandchildren would not graduate from the school because neither they nor their children had graduated, demonstrating how parents' (and grandparents') experience and attitudes set a model for children to follow. But when parents go into the classroom to help with their children's education, the message is very powerful and positive, and lets students know that an education is valued not only by their teachers, but also their families. It gives the students the support they need to succeed within the classroom and the motivation to work hard to receive the education. The goal of parental involvement is to improve a child's education and give them a better quality of life by encouraging them to stay in school and end the cycle of quitting school.

METHODOLOGY

While on the ground in Belize I worked with parents and teachers and discussed possible parental involvement activities and possible barriers to involvement. I took a predetermined list of questions ranging from what activities the parents think they could do to help improve their children's education to what activities their children enjoy participating in. When I began my interviews and discussed my project with Ivan Gillett, our guide, he helped me to understand education in Belize and how I needed to begin my conversations. Through discussion with Ivan I learned that my

interviews needed to be as informal as possible to help the conversation flow and to increase the willingness of the San Carlos community to talk with me. A main concern that he stressed was that I needed to get the opinion of the fathers because they are the ones counting on the children to help them in the fields. He was extremely worried that the fathers would not be as supportive as the mothers to increase children's involvement within the school. However, the fathers and mothers were equally excited about the idea of sharing their talents within the classroom. The questions allowed me to identify how the parents felt about becoming involved in the school and which activities would be most successful. When all the information was collected I composed a binder full of possible involvement activities, supporting articles, and mock flyers. The San Carlos community will be able to use this as a resource when participating in activities that will improve their children's education.

CONCLUSION

By talking to some of the community members I realized that this involvement would be supporting both students and parents. A new mother was very excited because being involved in the school would provide her with the opportunity to stay involved in education, something she always wanted to do. Another member of the community mentioned how this would help the parents improve their English skills. The local reverend felt that this would greatly help the students be more successful in school, and the Vice Chairman, Mr. Perez, thought this kind of opportunity would help the entire community become closer and more successful. I could easily see the excitement in the community members' eyes and their openness to this new idea.

Possible activities to incorporate parental involvement included open house, parent days, performance days, field days, mystery reader, student assignments, and awards ceremonies. While some of these activities may not be immediately successful or incorporated right away, they can become a great asset to the community in the future when parental involvement becomes more common. Each activity offers the chance for parents to become comfortable in the academic environment with a focus on becoming more familiar in the school setting. Award ceremonies, performance days, and parent days provide the students with ways to show their parents what they are doing in school and allow the parents to see the impact education is having on their children. Field days are a great way for parents to begin feeling comfortable in the school by participating in physical education activities such as soccer, volleyball, relay races, and other games. An open house would provide parents the opportunity to come into the

school, discover more of what the students learn and do, and become more comfortable in the academic setting. Student assignments would consist of the students having to initiate a conversation with a parent or community about what they are doing in class, and could consist of asking what they think about a topic, help with homework, or explain what they learned. Mystery reader, the last activity and one for the future once parents are comfortable in the school setting, involves a parent coming to read to the students. Each activity can help parents become more involved in the school environment and can result in students increasing their academic success.

REFLECTION

My journey of being a McMaster Scholar to Belize has been life changing. It was my first international trip, and I was able to experience Belizean food, walk through the jungle, and observe the education system. Through my project I learned that parents everywhere are supportive of their children's education and want the best for their children. On the ground I discovered the stereotype that fathers are not as involved or interested in the education of their children as mothers to be completely wrong. The men showed their support of their children, families, and community in multiple ways, including being present during presentations that required taking time off from work. This provided the San Carlos community with a new outlook that both males and females are equally supportive of increasing the parental involvement in the school.

The work completed on the ground demonstrates to our partners the type of community San Carlos is, how the parents are supportive of their children's education, and that the work done by the scholars and fellows is truly helping to provide a sustainable development in a variety of ways. The experience also helped me grow as a person. Personally, this will enable me to communicate more effectively when entering my own teaching career. From working with the San Carlos community I know how to communicate effectively later on in my career to help my students become as academically successful as possible.

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CPR, FIRST AID, HEIMLICH, AND WATER SAFETY EDUCATION IN RURAL BELIZE COMMUNITIES

Ashton Judis, McMaster Scholar

The purpose of my 2009-2010 Belize project was to train students and community members in the small rural villages on the periphery of the Rio Bravo Conservation and Management Area to perform CPR, first aid, and water safety. This project worked to build the skills and knowledge necessary to enhance the health and safety within these communities relative to first response care. Interactive tutorials on each of the safety techniques were taught to the rural community members. The goal of this project was to improve the communities' access to emergency care on location and improve their ability to successfully stabilize and transport patients to more formal care hours from these isolated villages.

LITERATURE REVIEW

Everyday emergencies and accidents happen worldwide. While these emergencies may have many different causes, some areas in the world are more likely to experience fatalities due to lack of resources, education, or surroundings. Since there is no way of knowing when an accident or emergency might occur, the best solution is to be prepared and knowledgeable about what to do in any emergency situation and how to take immediate action. Cardiac arrest, choking, and unintentional injuries are just some leading causes of death that could possibly be prevented with the right knowledge and training.

According to the American Heart Association (2008), "approximately 95 percent of sudden cardiac arrest victims die before reaching a hospital," (AHA, 2008). While cardiac arrest is a severe emergency, death is not inevitable as CPR can save a victim's life. Studies show that a "victim's chance of survival is close to doubled if effective bystander CPR is provided immediately" (AHA, 2008). Every minute without CPR decreases the likelihood of survival. "Within four to six minutes, brain death will occur," and "victims of sudden cardiac arrest have chances of survival that fall 7 to 10 percent for every minute of delay" (AHA, 2008). Increasing CPR knowledge and training increases the number of people equipped to save lives.

In addition to cardiac arrest, unintentional injuries including "traffic crashes, fire, poison, falls and drowning" (Taft, Paul, Consunji, & Miller, 2002) are another leading cause of death globally, particularly of children in both industrialized and developing countries. "Studies have found that more

than a million children under the age of 14 die each year from unintentional injuries” and cite “a strong connection between injury and poverty” (Taft, Paul, Consunji, & Miller, 2002). In developing countries that suffer from severe poverty or simply lack the resources of developed countries, the chances of death from unintentional injuries are even higher for both children and adults. Globally, adults and children in rural areas are also at a higher risk due to the lack of resources such as health centers, clean environments, funding for medical care, lack of education, and knowledge of safety. Statistics show that for unintentional injuries, males are at a slightly higher risk than females because they are more likely to take on more physical jobs and to participate in more physical sports, activities, and projects.

Within the unintentional injury category is drowning, from which “Approximately 280,000 children die each year” (Taft, Paul, Consunji, & Miller, 2002). “Factors such as the proximity of homes to variety bodies of water or the early independence of children in agricultural economies contribute to the higher death rates” (Taft, Paul, Consunji, & Miller, 2002). The high rate of deaths from drowning could possibly be reduced if the water safety procedures were provided for rural areas that do not have access to this knowledge or resources. Most child drowning accidents occur due to lack of adult supervision, attention, or care, so first response in a drowning situation is crucial because, says pediatrician Dr. Javier Magaña in an interview, “It only takes a baby three minutes to drown” and “about a minute or two minutes” before the baby goes into “a deep coma” that “can lead to brain damage and serious side effects” (Chanona, 1999). Cardiac arrest can also occur to any victim that encounters a near drowning experience.

Another unintentional leading cause of death that requires immediate care is choking. According to the Heimlich Institute, the Heimlich maneuver has saved thousands of lives. “The Centers for Disease Control and Prevention explain that over 17,000 infants and children are treated for choking emergencies each year” (Choking Health Article, 2009). Choking is a major cause of death for children and also greatly affects the elderly. The common characteristic in these demographics is the lack of teeth. Without teeth, people are unable to fully chew their food to a state where it can be easily swallowed and processed without blocking the airway. Whatever the age of the choking victim, the Heimlich maneuver can help to clear the obstructed airway and prevent any further medical injuries (Sisk, 2006).

In all of the above emergency situations and more, prompt first aid care could help to save a life. While everybody benefits from first aid knowledge and skills, more rural countries or communities are at a higher risk for



fatalities due to the lack of resources. Belize in particular would benefit from knowledge of first aid care and safety procedures because of its risk factors. Belize's proximity to water creates a higher risk for water-related injuries or fatalities, while the population's high involvement with manual labor starting at young ages increases the risk of unintentional injury. In addition the poor infrastructure of the country results in a lack of immediate healthcare access, making it all the more important for Belizeans to have basic first aid knowledge and skills.

As a rural, developing nation, Belize faces these types of accidents on a daily basis due to the cultural and societal norms. According to the United States Central Intelligence Agency's World Factbook (2009), in a population of 307,899 Belize has a death rate of 5.8 deaths per 1000 of the population, and an infant mortality rate of 23.07 deaths per 1000 of the population (Central America and Caribbean: Belize, 2009). Trauma or advanced medical care is limited, even in Belmopan, the capital. "Serious injuries or illnesses often cause patients to leave Belize and rely on another country's medical expertise" (Belize: Country Specific Information, 2008). The Rio Bravo Conservation and Management Area is located two and half hours away from Belize City, which leaves the people in the conservation area responsible for reacting to emergency situations well before any victim can receive assistance from a medical professional in the next largest city,

Belize City. Many Belizeans are not educated in the appropriate first aid care response due to the lack of resources and would be unable to effectively rescue or respond to someone experiencing cardiac arrest, drowning, choking, or injury requiring any procedures beyond basic first aid attention.

According to the United States Department of State (2008), Belize has poorly designed infrastructure and roads that “vary from two-lane paved roads to dirt or gravel tracks. . . Even in urban areas, most streets lack lane markings, leading many motorists to create as many lanes as possible in any given stretch of street or road” (United States Department of State, 2008). Because of road conditions and lack of transportation, access to hospitals is limited and unlikely in an emergency. Complicating this, Belize also has massive storms that flood areas and cause the trails or roadways to become muddy and extremely hard to travel, making it even less likely that Belizeans will reach any health care assistance outside of their communities in an urgent situation or in enough time. The closest hospitals to Belize’s rural communities are located in the larger districts, which can be hours away in “Corozal, Orange Walk, Stann Creek, Toledo, and two hospitals in the districts of Cayo and Belize” (Belize Hospitals, 2009).

As previously stated, drowning is a serious problem in developing nations, and Belize is no exception given the close proximity of homes to natural bodies of water. Belize is bordered by the Caribbean Sea and, in relationship to the McMaster school research and community partners, the New River Lagoon located in Orange Walk district is close to the Rio Bravo Conservation and Management Area. There are also several other lagoons located in other districts of Belize, further increasing the risk of drowning and first aid emergencies.

In many rural areas of Belize, agricultural production is the main form of income for families, yet farming presents many dangers to these families because agriculture production requires mass amounts of manual labor. Some accidents prone to happen include heat exhaustion or dehydration due to Belize’s humid climate. Also, many Belizeans work long hours using heavy and crude tools that could lead to accidental injuries such as broken limbs or lacerations. Educating Belizeans on first aid procedures in these rural communities is crucial because it will create heightened awareness and comfort in knowing that if an emergency situation occurred, action could be taken confidently. Training the Belizean people in CPR, first aid, Heimlich and water safety skills will help to improve well being and should reduce the number of fatalities from delayed or lack of informed response. Education will help ensure that Belizeans will be confident and prepared to save a life

in a time of need. As such, this project serves as an example of providing services based on a direct community need.

RESULTS

Last year former McMaster Scholar Cassandra Burkhart led this project, and only five to ten people from the San Carlos community in addition the school children were present. This year the project saw significant growth with 23 adults present from the small village of San Carlos which has a total population of 150. Men, women, grandmothers, and grandfathers were present, along with all the children within the school and community. The village's chairman participated in each of the tutorials which made a major impact on the children and other community members, showing that this information was important to the community. One of the older children in the San Carlos community explained that he already had to save one of the other children from drowning in the lagoon a few months before our arrival using some of the techniques he had learned from last year's project.

The amount of people in attendance demonstrates the community's recognized need for the first aid and rescue training. These relationships and others being built within these rural communities evidences increased levels of trust and belief in the McMaster School. The first aid kits that were given to the families and schools are going to be a great advantage to the people within the San Carlos and St. Paul's Bank communities. The fact that first aid equipment is available at an immediate time of need coupled with the knowledge of what to do will help these communities save lives during emergencies.

REFLECTION

Through the research and groundwork of this project I have developed and grown tremendously not only as a student, but as a person. I am extremely grateful to have had the opportunity to do critical research and apply it to another country to become a member of the world community. I was able to apply my undergraduate major of communications to a real life academic project that will only help me in my future careers and in the process have developed the confidence to portray ideas, thoughts, or strategies in countries and cultures other than my own even though there may be cultural or language barriers. International relationships and communications are becoming more prevalent every day, and the opportunity to travel abroad and experience this first hand is a great advantage. I have learned to critically adapt to other cultures and appreciate their traditions, ways of life, and values.

Personally, I have also been reminded of how fortunate I am to live in a developed country and have running water, toilets, health care professionals and so many other parts of life that many people take for granted on a day to day basis. The people within the Belize communities are so welcoming and trusting to the McMaster program. The people were truly grateful for the information that I brought, asked questions and actively participated, which made me feel like I was truly making a difference or at least having a little impact on another part of the world. The McMaster School has provided me with an opportunity that I will never forget and always cherish. I have grown a passion for international travel and service as a result.

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THE NECESSITY OF NETWORKING

Samantha Higdon, McMaster Scholar

Through the creation and distribution of a newsletter containing information on the Belize team members, their projects, and the various partners we work with, I provided our donors, past scholars and fellows, and other interested parties with a continual link to the current Belize initiative members and projects. Additionally, by creating and storing both a hard and electronic copy of a newsletter template which includes the contact list provided by previous scholar Kyle Shong and guidelines on when and how to create a newsletter, I have equipped future Belize initiatives to remain in seamless communication with people and organizations interested in the McMaster School's work in Belize.

LITERATURE REVIEW

"It's not what you know; it's who you know." This statement is more true in today's business world than ever before (Mize, 2007, para.3). In business, the ability to network is vital to the success of any organization, especially to non-profit and non-governmental organizations (NGOs). Because of this, a business or organization must be able to develop and nurture connections in a manner that is not only beneficial to themselves but also to those with whom they are connected. This relationship is necessary so that both people and organizations seek to create relationships that are mutually beneficial (Mize, 2007, para.4).

The benefits of social networking are numerous. "The greatest benefit social networking communities offer is their ability to connect people and build relationships across boundaries of geography or discipline" (Gallimore, 2008, p. 5). Social networking also provides individuals with the opportunity to find others who share their interests, goals, and dreams (Gallimore, 2008, p. 6). People are able to develop contacts, create strategic alliances, and work toward mutually beneficial states of existence (Gallimore, 2008, p. 9). One amazing aspect of networking is that it grows exponentially with use. The more involved a person or organization is willing to become, the more extensive the possibilities for networking connections become.

Countries and organizations which have unlimited access to technology have quickly begun using social networking sites and other internet and cellular connections to network with individuals and organizations (Rutledge, 2008, p. 2). There are, however, individuals and organizations that lack access to this technology, challenging organizations with access to alternatively network with those organizations that lack it, which can present problems



because technology is so integrated into a developed society's daily interactions.

In her article "Onions or Papaya: The Dilemma on the Ground in Belize," McMaster Fellow Mary Ann Studer (2008) references some economic and infrastructural issues that plague the inhabitants of rural Belize. She explains that much of the lack of infrastructure and economic problems the farmers in rural Belize suffer from is a direct result of the country's status as a British colony (Studer, 2008, p. 35). Today, rural Belizean villages are isolated from one another as a result of the severe lack of infrastructure. Everything from agriculture to education is greatly hindered by roads that are treacherous at best, electricity resulting solely from generators, severely restricted educational access and limited communication with the rest of the world. This lack of infrastructure prevents the rural schools from having equal access to technology, information on educational organizations, and other resources (Shuherk, 2008, p. 55).

The remnants of British colonization have made it difficult for rural Belizeans to have effective communication with one another, let alone with individuals in different countries. The lack of adequate roads makes travel from one community to another rather difficult (Higdon, 2009). In addition, road conditions hinder mail delivery, thus creating another barrier to communication between international partners. Furthermore, the price

of telecommunication via phones is rather high considering the people of Belize's income. Costs for residential telephone range anywhere from five to ten dollars American (approximately doubled when converted to the Belizean dollar) per month. Cellular companies charge approximately twenty-five dollars a month for only 150 minutes of calls with rates following that vary somewhere between 12.5 and 25 cents per minute (Sluder, 2005). Such costs are considered extravagant and are not a viable option for most of the people we work with in Belize. This means that the typical means of social networking for businesses such as personal meetings, social networking sites, emails, and cellular updates are not relevant options for keeping our partners on the ground updated and informed as to our progress prior to arriving in December.

While Belizeans recognize and trust both our guide Ivan Gillett and Mary Ann Studer who has been to Belize multiple times, each year Studer brings a group of students who are, for the most part, strangers and so Belizeans experience an initial stage of distrust or wariness towards the newcomers. Reducing or eliminating this initial stage of uncertainty could potentially make the initiative run much more efficiently. The question then becomes, how does the initiative create a seamless system of social networking that benefits the initiative, the partners in the U.S., and the Belizean partners on the ground?

The answer is actually quite simple. The initiative must create a tool that can be distributed using a variety of methods (i.e. internet, regular mail, and hand delivery). The easiest solution for this would be a newsletter. For contacts with internet access, the newsletter could be uploaded and emailed. Regular ground mail could be used for contacts without email addresses. My template will help ensure that future initiatives remain in communication with various partners and donors. A newsletter nicely combines technology with the personal touch of human interaction in distribution, and it manages to keep all interested parties on the same page with the same information, a key component to an effective networking system.

San Carlos, a village that has experienced dramatic changes over the existence of the Belize initiative, offers but one example of why creating a cohesive social networking system is vital to the Belize initiative. The people of San Carlos are highly motivated to improve their village and their lives through the development of sustainable programs, and the Belize initiative has been lucky enough to help facilitate the programs and projects that the village has identified as key components to their continued progress toward sustainable development. Much of this assistance has been made possible through the generous assistance and unfailing support of the Belize

initiative's many partners, donors, and past scholars and fellows, all of whom benefit by remaining in touch.

METHODOLOGY

The four main components of my project – observation, documentation, debriefing and compiling – remained constant before, during, and after the trip. Once information had been compiled, a newsletter was distributed and a template for future use was created and filed with McMaster.

The first step was observation. Reporting the progress of the initiative was very important and had to be handled quite carefully. The people receiving the newsletters deserve and demand accurate information, and that expectation had to be met via the newsletters. I had to maintain meticulous notes on all of the happenings involving our group's progress. Observing the actions of the scholars and the interactions with the partners was a large part of my project.

People identify with faces, names, and stories. This means that our constituents are going to want to see the people that we work with in action. If they are donating money, time, or resources, they have a right to see where their donations are going. Furthermore, including pictures and personal stories and accounts will provide the type of closure and contentment to the donors vital for nonprofits. Letting the donors and other interested parties see the people we have worked with and allowing them to have visual evidence of the impact their assistance has served as a great way to keep donors content with their participation in the Belize initiative. To meet this expectation and to keep donors updated with the progress the initiative has made, I made a conscious effort to photograph as many conversations, events, and any other significant instances from multiple angles to ensure that I had a variety of options when choosing photographs to include in the newsletter.

The final piece of the working portion of my project was debriefing and compiling. Despite my best efforts to be present at all pivotal points of the projects, I knew that it would be impossible for me to be everywhere at once. Each night the group would sit around the dinner table and have a reflection time, discussing headway made on individual projects and any breakthroughs that had been experienced. This debriefing period served as a wonderful opportunity for me to catch up on anything I had missed, helping me compile and earmark additional information that I would sort for the newsletters upon our return.

A portion of my project's success must be credited to the assistance of my fellow scholars, the fellow, and associate fellows. When I was unable to be present at pivotal moments, my fellow members really stepped up for me, making sure to take notice of what was happening and more than adequately documenting their experiences. This was extremely beneficial because it meant I was able to draw on those experiences for the newsletter as well.

As part of my project, I partnered with various people in Defiance College's administration including Kathy Punches and the Office of Institutional Advancement, all of whom offered invaluable assistance. Kathy Punches, Director of Public Relations & Marketing, assisted in the design and content criteria of the newsletter. The Office of Institutional Advancement and the McMaster Office assisted in gathering names and contact information for individuals including donors, past scholars, and fellows who would be interested in being updated on the progress of the Belize initiative.

Additionally, I created a newsletter template so that future initiatives can easily pick up the project and keep it working in the most effective manner possible. The template includes an outline example of the newsletter with a possible color scheme and suggested topic areas. Naturally these basic suggestions will change as each future initiative will have a different dynamic and will personalize the newsletter to reflect the group's members. This template also incorporates the work of past Belize scholar, Kyle Shong, who created a comprehensive contact list for all of the Belize initiative's contacts including partners, donors, and other interested parties. Including Shong's contact list in the template will allow future groups to begin with a solid contact base with the opportunity for expansion as the scope of the initiative continues to grow. The template is available in both hard copy for filing within the McMaster program and in electronic form for ease of access to scholars and fellows.

IMPACT

My project helps ensure that the Belize initiative can function more effectively as it strives to reach its goal of equipping the people of Belize to help themselves while working towards sustainable development. Keeping in contact with partners and allowing them time to prepare for the team's arrival will allow both the team and the people of Belize to accomplish as much as possible while on the ground. Additionally, the continual communication with our partners in the United States will allow the initiative to function better prior to going to Belize, which further promotes a higher level of efficiency on the ground. This increase in efficiency on the part of the initiative means that the people of Belize will receive the tools needed to become self-sufficient and to develop in a sustainable manner.

REFLECTION

This project was a great experience for me both as a business student and as a person. Through my work with the Belize initiative, I have been able to put into practice the knowledge about networking and professionalism I have gained in the business department, and to interact with people from a vastly different background and culture in a business setting. Such experience is essential in a business world that is becoming more global by the day.

This trip also touched me on a personal level. As a second year scholar, I was granted the opportunity to return to Belize and see how the community had changed between initiatives. Recognizing the people and having the people recognize me further proved that the McMaster School develops relationships and partnerships that last. We are not a program that goes in, builds something, and leaves never to be seen or heard from again. The people we work with know our names and recognize us and we recognize them.

Truly the most poignant moment for me, the moment when this concept really hit home, was when I was at Muffles Junior College participating in an exploratory discussion about how to develop their business program. I had the opportunity to speak with a number of faculty and students, one of whom is actually applying to the same university I am for graduate school. Both of us are accounting majors so we exchanged email addresses and have been keeping in contact. Without the McMaster School, I never would have had the opportunity to make this relationship, and for that I am extremely grateful.

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