

# ENVIRONMENTAL SUSTAINABILITY IN BELIZE

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## PROJECT FRAMEWORK

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McMaster School support for the WATER Project (Water Analysis: Targeting Engagement through Research) began in 2003 with a grant awarded to the faculty of the Division of Science and Mathematics. The grant provided equipment necessary to strategically develop the field skills of Defiance College science students to a level that would facilitate effective undergraduate research. During the 2004–2005 academic year two McMaster fellows and three McMaster scholars were selected to move the project to the international venue of Belize. All developed projects focused on the development of baseline water quality data from within the Rio Bravo Conservation and Management Area (RBCMA), the 260,000 protected acres that represent about 4% of Belize's total land area (Programme for Belize 2000–2003). Specifically, the baseline samples were taken from the New River Lagoon and its tributaries and constitute the foundation of the projects undertaken during the December 2005 initiative by the McMaster fellow, associate fellow, and five McMaster scholars. The WATER Project has expanded beyond disciplines and beyond the boundaries of the Rio Bravo. It touches the lives of the people who live on the periphery and provides data that will aid the efforts of Programme for Belize, the nonprofit organization that oversees the RBCMA, to effectively manage the conservation area.

## **INTEGRATED NATURAL RESOURCE MANAGEMENT RESEARCH**

The interdisciplinary projects of the WATER Project fall within the framework developed by the International Agricultural Research Centers to conduct effective Integrated Natural Resource Management Research (Sanchez, Palm, and Buol 2003, 159). Considering research in the context of real world conditions requires a multidisciplinary approach that facilitates evaluation of synergistic perspectives, issues, and needs. Agro-ecosystems that lay on the periphery of the 260,000-acre Rio Bravo Conservation District are driven by interactions among ecological, economic, and social values.

Belize has consciously chosen to develop economically while simultaneously focusing on ecosystem preservation, building its national economic foundation mainly through ecotourism. In reality this concept works better in some areas than others when one considers the actual livelihoods of the native Belizeans.

Coastal areas and the cayes have benefited directly from the tourist traffic of the cruise ships and the demand for dive excursions on the reef. Service and hospitality industries are thriving under the current wave of tourists in these areas. This is not happening in the northern interior agricultural region that boundaries the Rio Bravo Conservation and Management Area. This region is sprinkled with small towns like Double Headed Cabbage, Isabella Bank, and Indian Walk—connected by a network of pot-holed, narrowly paved roads—and the even more remote villages like San Carlos that are more easily reached by boat. These are areas in which the residents—a melting pot of Mestizos, Guatemalan refugees, Mennonites, Carib-Indians and Mayans—are largely surviving on marginal incomes and subsistence agriculture.

When these conditions are viewed through the framework of Integrated Natural Resource Management Research, the initial problem-based analysis focuses on three areas: (1) food insecurity, (2) increasing poverty, and (3) degradation to the natural environment. The same framework charges the researcher to seek solutions that enhance (1) productivity, (2) human well being, and (3) ecosystem functions. The work outlined in the project reports that follow are aligned with these concepts and indicate that our research is beginning to have an impact on the human condition in Belize (Sanchez, Palm, and Buol 2003, 159).

## IMPROVING THE HUMAN CONDITION

The challenge of the McMaster School for Advancing Humanity to improve the human condition was met as student scholars tested for pesticide runoff; for intestinal parasites in water sources used by native Belizeans; and for lead levels in soil. Continuing the project of the previous year, once again baseline water quality data was expanded and soil was tested for nutrient levels. This information was returned to Programme for Belize, an NGO focused on conservation. The information was also returned to the people we worked with, the farmers whose next decision to plant a particular crop will be made with more information than they had prior to our visit.

This excursion also recorded the stories of the people on the periphery of the tourist-focused economy of Belize. Determined to develop a sustainable agriculture- and forest-based micro-economy at the edge of a society that relies heavily on ecotourism, the people of the vast conservation area—the Rio Bravo Conservation and Management Area—described the impact that the Rio Bravo has had on their lives. We have just begun to see and to listen to the people of this region, and the more we hear the greater we recognize the need. In the essays that follow when we speak of the residents of the periphery we refer to them as they were introduced to us, so that there is some inconsistency in the use of titles, but we believe it is most respectful to refer to people as they prefer to be addressed.

There is a necessary synergy between the reserve and the periphery, according to Programme for Belize (PFB) director, Eldilberto Romero, and our PFB professional guide and contact person, Ivan Gillett. They have less than fifteen rangers to patrol over 260,000 acres, an impossible task without the help of the communities on the periphery. Our research team convinced some of the indigenous people on the periphery that bringing in researchers to Belize to work in the Rio Bravo can directly benefit them as well. Crossing the boundaries of the Rio Bravo is an essential step toward the sustainability of the conservation district itself and the preservation of the natural resources within its borders.

## REFERENCES

- Programme for Belize. 2000–2003. <http://www.pfbelize.org>.  
 Sanchez, Pedro A., Cheryl A. Palm, and Stanley W. Buol. 2003. Fertility capability soil classification: A tool to help assess soil quality in the tropics. *Geoderma* 114:157–185.

## 'MAPPING' BELIZE: CULTURAL GEOGRAPHY

Matthew Schultz

Most almanacs and atlases confidently declare that the country of Belize is in Central America. But is it? This would seem to be an easily verifiable, empirical question—a matter of reference, not interpretation. However, the relation between places is hardly ever simply geometric. Places are different from points; they have histories and trajectories in time. Even consulting an accurate map does not always end the arguments, as the meanings of places to different people continue to unfold long after the map creases are smoothed.

In some ways, Belize's location on the imagined globe of many North Americans is deceptive. Given that the nation's most populous metropolitan area, Belize City, is close to the meridian that intersects the Chicago suburbs (the 88th), many Americans would probably place the country in the Caribbean when asked to extend, in their heads, a line of longitude down from the Windy City. Belize neighbors Mexico, to the north; and Guatemala, to the west; placing it along the east coast of Central America. The continuity of the land between Defiance, Ohio and Belize City would be obvious to the growing number of Belizeans who drive back and forth between the United States and Belize, but many Americans find surprising the number of California license plates in the traffic of Belize. (Premdas n.d., 5)

The problem of Belize's misplacement in the minds of Americans, if they are aware of the country at all, is not a matter of literal geography. Many United States citizens assume that they now sit on a geo-politically "unipolar" world in which the U.S. seems to be on top economically, militarily, and even spatially. We must work against such prejudices, of course, and this is certainly a social goal of the McMaster School. Preconceptions—especially our own—must also be carefully excavated as we analyze and reflect on our travels and research. This is an essential academic goal of the McMaster School.

The placement of Belize can challenge scholars and the disciplinary categories which they use to analyze the world. The cartographers of Rand McNally are, when questioned, forced to fall back on a distinction between "Central" and "Middle" America which seems neither physical nor historical in its borders and is certainly a departure from standard usage

(Grover, Natunewicz 2003, 28). They stipulate that “Middle America” would include Central America, the Caribbean Islands, and all of Mexico.

A geographer and an historian at Duke University, who collaborate on Comparative Area Studies, have written a provocatively titled book called *The Myth of Continents*. They point out that, even using the least exacting taxonomies, the continental boundaries among the Americas are not at all congruent with the maps of animal distribution or climatic habitats (Lewis, Wigen 1997, 34). Many other variables measured and mapped by physical geographers also fail to delimit the continents. Yet, they emerge naturally in course titles and journal articles across the academic disciplines with their drifting substrate of assumptions unexamined. Even by the most objective definition—that of a contiguous landmass—separation of the Americas into North, South, and Central continents fails; or, at least, it succeeds only to the extent that it denies the existence of the Isthmus of Panama, in particular, and the importance of the Central American countries, generally (Lewis, Wigen 1997, 35).

The human geography of Belize also forces re-examination of preconceptions and the boundaries of specialist fieldwork. Linguistically, it is an English- and English Creole-speaking member of the British Commonwealth, despite being located in Latin America. While attached to the Hispanic remainder of Central America, the country is arguably more attracted by the Anglo-Caribbean islands: On the “Anglo” side of the hyphen, no less a figure of English nationalism and letters than John Milton, at the time when he was Oliver Cromwell’s Latin secretary in the middle of the 17th century, argued for a continental beachhead in what is now Belize from which England could displace its commercial rivals. A grand “Western Design” *contra hispanos* was urged by Milton and attempted by the Lord Protector (Von Hagen 1947, 84, note).

On the “Caribbean” half of the Anglo-Caribbean influence is the seismic evidence vibrating out of woofers everywhere—hip-hop, dub, and dancehall beat samples—and the singular example of the Garifuna. The contemporary Garifuna descend from the mixing of West African slaves and the indigenous Arawak or Carib people; thus, multiethnic Belize provides a rich culturing medium for the genetic and linguistic legacy of the people who gave their name to the Caribbean.

In an ever-changing proportion, Belize is at the intersection of the Caribbean and Latin America. It is where the one-pot *bail-op* (boil-up) meets rolled-up tortillas, side by side; furthermore, and sometimes further down the same road, one finds, in addition to tamales, similar shapes with

very different tastes: *dukunu* (in Twi, an African leaf wrap), egg rolls (Chinese), *shawarma* pitas (Arabic), *dosa* (East Indian), or *krautwickel* (Pigs in a blanket) from a Lancaster, Pennsylvania, cookbook (Mennonite). The Prime Minister of Belize, Said Musa, is of Palestinian, Scottish, and Mayan descent. The German-speaking Mennonites who migrated from Mexico and Canada starting in 1958, constitute an ethnic minority with a significant economic impact.

Despite the remarkable range of ethnic variation, the strongest vectors influencing the direction of change in Belize are Hispanic and Caribbean. In this push and pull of demographic forces, however, the cultural center of gravity is gradually shifting inland, toward “the continent.” Creole and Garifuna immigration to the United States is occurring at the same time as the immigration of Central American settlers to Belize, and the latter tend to retain ties to their home language(s) and countries of origin. The civil wars of the 1980s pushed many migrants out of Guatemala and El Salvador, in particular.

The literary view of Belize from the global “north” has been both foreshortened and fleeting. In the early 1930s, the English novelist Aldous Huxley visited what was then called British Honduras, the colony that became the independent nation of Belize at the relatively recent date of 1981. Huxley’s description of his visit is cited often because it is one of the few references to that area in English literary writing: “If the world had any ends [Belize] would certainly be one of them.” As visitors from North Atlantic countries do today, Huxley admired the natural beauty of the coast and mangrove cays, while also wondering at the pride and creative durability of a Creole culture that not only survived slavery and exploitation, but preserved an African- language neighborhood, “Iboe Town,” well in to the 19th century. On the streets and paths of Belize, one can still hear in the Creole second person plural, *unu*, an echo of Nigeria (Kriol n.d.,10).

The rain forests that appeared as obstacles or “the end of the world” to a visitor from the north were not wilderness, but workplace for slaves and then, after 1838, indebted Creole freedmen. The skein of racially restrictive laws—Masters and Servants statutes or Crown Land Grant fees to prevent former slaves from owning property—reminds one of Jim Crow, even if the skein was formed into a noose less often because of the differences between settled, populous plantations in the American South and the more scattered, seasonal, and migratory silviculture practiced in the mahogany “works” of Belize.

In addition to being moving targets in an inaccessible terrain, the more autonomous—though certainly unfree—slaves in the Belizean lumber camps were allowed firearms to shoot game and protect themselves (and hence the master's property) from enemies: Spanish or, sometimes, Mayan encroachment worried proprietors greatly (Stone). One of the reasons contemporary Creoles continue to take pride in the decisive defeat of the Spanish at St. George's Caye in 1798 is that the British had to enlist the help of the slaves to repel Hispanic invasion (Stone 1997, 74–75).

Jamaica is an obvious comparison to Belize that throws into relief the historical anomalies of the Belizean experience. Jamaica's ties to Belize date back to the third quarter of the 17th century, when the island was actually governed by the British from Belize. Despite a shared region and history of colonial administration, the very different early slave economies left still-visible effects far beyond the countries' current racial complexions: Belize, with more than twice as much land, has a little more than 10% of Jamaica's population. The island sugar plantations required dense settlement and workers with little autonomy. It also had no geographically contiguous colonial rivals to offer bargaining leverage to resisting slaves, as Belize did in Hispanic Central America, where "whipsawing" could predominate over—or at least compete with—the whip.

These historical differences in demographic density and labor discipline are crucial for understanding Belize's unique contemporary position between the Caribbean and the rest of "the continent." The sparsely populated wilderness forests of such value to life scientists and conservationists is better seen as the historical artifact of specific colonial regimes than it is a prehistoric, natural feature preserved from human interference.

To point out Belize's uniqueness should not distract us from recognizing its full integration, past and present, into a global economy structured by an unequal division of labor and resources. Some of the mahogany that darkened the finish of so many Victorian parlors was harvested by Africans in Belize, just as the "Chiclets" chewing gum snapped by teenagers in Huxley's day depended on the skill of Creole (and Mestizo or Mayan) chichelros who hung from sapodilla trees cross-cutting the trunk with machetes to bleed the chicle juice—and, hopefully, not severing the rope attaching the worker to the tree. This occupational hazard was described to the McMaster scholars in an interview with an elderly former chichelero, now a "pole farmer," whose subsistence milpa plot is cultivated by hand with a dibble—a pointed stick or "pole."





Attention to the Caribbean connection must be balanced by a recognition of the active and archaeological Mayan presence in Belize. With regard to the former, linguists today count ten active Mayan dialects in the country. Concerning the latter, Belize has excavations remarkable for both their height and depth. The monumental temple complex at Caracol in the south contains what is still the tallest building in Belize (and the third highest in the Mayan world). This is not surprising given that the population of Belize in the Classical Period was at least two-thirds more than its present census. The underappreciated Lamanai excavation in the north overlooks the New River Lagoon and has deep roots. The site is one of few in Mesoamerica that has been occupied through all five major periods of Mayan history.

Lamanai, meaning “submerged alligator,” was examined by the McMaster students in the shade of mythically proportioned ceiba trees and to the accompaniment of howler monkeys. As our local Creole informants, who seemed universally respectful of indigenous beliefs, reported (and later scholarship confirmed), some Mayans of Belize—K’ekchi’ and Mopan—say that the tree traditionally represents a kind of religious *axis mundi*: a symbolic vertical element, familiar to students of anthropology and religious studies, which both supports and separates the earth from



otherworldly planes, above and below (Fagan 1998, 4). It is significant that Belize's *axis mundi* should be a tree, instead of a mountain, such as Olympus or Sinai; or instead of a building, for example, a church spire of the type which still lies in ruin at nearby Indian Church after a 16th Century Mayan traditionalist uprising against the Spanish mission. The vast forests which cover close to half of this small nation sustain almost as many tree species, 700, as the U.S. and Canada, 730. A tree, the ceiba, has been proposed by academic environmentalists and indigenous groups as a "flagship" species to promote joint conservation efforts in Belize (Bowen-Jones 2002).

While declining to share a mental map of the world that places Belize at the margin, we can nevertheless admit some validity to Huxley's description of Belize as "the end of the world." The students and researchers of the McMaster School expeditions have discovered that Belize is a place especially well situated for considering first hand the "ends" of the world, in the sense of questioning what the earth is for and what we, as environmentalists and global citizens, should be for. The "ends" that require scientific and humanistic investigation are not only the accurate prediction of the *results* of human activity, but also the discovery of what goals we should *intend*. Most importantly, work in Belize highlights the question of how technical means relate to the ultimate end: the satisfaction of human needs on a global scale.

Zee Edgell, a black Creole Belizean author, has written a novel, *The Festival of San Joaquin*, whose plot illustrates why Belize is such an exceptionally good location for researching environmental conservation on the ground, at the grassroots. In the book, she shows how contradictions among the desirable goals or "ends" of economic development, environmental integrity, and self-determination grow organically out of and shape the daily lives of the ethnically diverse women of contemporary Belize. Solving the immediate problems of the characters' everyday family finances involves grappling with the ethics of a land sale that references global, even ultimate, questions. How can a sovereign Belize, and the book's main character, negotiate the land struggle between, on the one hand, hereditary latifundistas with their foreign investors and owners, and, on the other, the milpa farmers, "minifundistas," with their allies in the international environmental NGOs (1997)? Who, and what, is the earth for, in the end? How can patrimony and patriotism be teased apart from patriarchy and paternalism—"legacy" from "larceny," as Emily Dickenson put it (Dickenson 1960, 9)?

The environmental questions posed in *The Festival of San Joaquin* never appear instead of, or as an add-on to, the dramatic necessities of the realistic

portrayal of peoples' lives. In a similar way, the McMaster scholars were able to connect their areas of environmental expertise (or, as often, interest) to the immediate daily-survival concerns of the Belizeans they met. The Belizean environment facilitates the efforts of young scholars to "talk with" residents and helps them avoid the perennial academic dangers of either having to "talk up" your research to defend its value or, much worse, to "talk down" to people as if they were the objects of research or, at best, recipients of expertise and not its possessors.

Belize is a good place to study the "ends" of the earth because of the combined and uneven way in which it has developed and been integrated in to the world economic system. One of the senses in which Belize can seem like the end of the road is that it has so few of them: 1,785 miles with only 18% paved (and no railroads). As the McMaster students found on the trip from Hill Bank, in Belize, to Tikal, in Guatemala, many roads can vary seasonally from slick and sucking mud to jarring and hardened ruts. The colonial legacy of waterborne transportation necessary for the timber extraction economy explains much of this underdevelopment, but one suspects also the nationalistic need for impediments to contact, both commercial and (potentially) military, with neighboring Guatemala. O. Nigel Bolland points out that when Guatemala gave up its claims to British territory in a 19th century agreement, the settlement "bound both parties to establish 'the easiest communication' between Guatemala and Belize." The Guatemalans have cited the lack of a major road between Belize and Guatemala Cities as an ongoing breach of this treaty (Bolland 1977).

The magnificent, 185-mile long, barrier reef, which Defiance College naturalists explored with snorkels, was once significant for the fact that it was, indeed, a barrier. The reef is the second largest such formation in the world, and the largest that is living. Historically, its convoluted and hull-shatteringly sharp corals made it difficult to navigate; and, thus, made Belize a haven for maroons and marauders. The forbidding natural features which repelled so many mariners have become, themselves, conservation areas and attractions for modern excursion vessels. Disembarking cruise passengers have swollen the amount of tourist day-visits to 800,000 per year (2006): almost triple both the permanent population and the number of overnight visitors. Two-thirds of the tourists are from the United States and their views of Belize are likely to be in passing, if not entirely through a porthole (Conaway 2006, 17).

For more than twenty years, the tourist-oriented services (and the tertiary sector, as a whole) has dominated the national economy with recent data showing that “trade and restaurants” contributed almost half again as much value to Belize’s gross national product as the traditional, primary sector, sources – agriculture, fishing, and forestry – combined. The relative percentages in the labor force are even more disproportionate, with more than half the population in services and only a fifth in the traditional classifications listed above. (CIA and Britannica n.d.)

The McMaster destination, the Project for Belize Hill Bank research station in the Rio Bravo Conservation District is inland, north, and west of the major tourist destinations which tend to focus on the coast, the Mayan monuments, and the considerable artistic attractions of Garifuna culture. The water, soil, and land-use subjects of student research were directly relevant to a region economically dominated by lowland agriculture buffered by pine-oak savannah and rain forests. Farmers are struggling to find profitable and sustainable crops while coexisting with large forested tracts protected by environmental laws; a remarkable 40% of the nation’s total area is protected, and 60% of the protected area is forested (Conaway 2006, 17).

Modern agricultural development has struggled in Belize. It has done so since the abolition of slavery and the decline of logging in the early 19th century. Agronomists estimate that only about 15% of the potentially arable land is under cultivation, even though basic foods remain high on the list of expensive imports, and despite the fact that population densities are very low: 30.3 residents per square mile in Belize, compared to 293.1 in Guatemala, 132.6 in Mexico, and 83 in the U.S. (Britannica n.d.) .

The underdevelopment of Belizean agriculture has complex roots in both history and geography (Bolland). Belizean agriculture was actively “underdeveloped” in the colonial period, to use the word in Walter Rodney’s predicative sense: the Guyanese scholar’s most influential work was titled, *How Europe Underdeveloped Africa*. The colonial economy was run by its administrators in the interests of absentee landlords who benefited from unsustainable timber harvesting. In the last quarter of the 19th century, for example, the London-based Belize Estate and Produce Company (B.E.C.) itself owned about a fifth of the country’s land. The B.E.C seized Mayan lands in places such as Indian Church and used various legal means to keep former slaves and their descendents from farming in ways that might threaten their supply of wage labor or their possession of enormous, mostly forested, landholdings (Leslie 2004, 55).

The Rio Bravo Conservation and Management District, which is the largest forest reserve in the country, was one of the earliest and most extensive B.E.C. properties from which mahogany was cut (Rio n.d.). Agriculture, on the “family” scale with which Ohio farmers would be familiar, was prevented in Belize by steep inequalities, even monopolization, of land ownership by a relatively small class of mostly foreign investors. That this problem persisted into the contemporary period can be seen in the next largest donor of land to the Rio Bravo Preserve: the U.S.-based corporation, Coca Cola. The Rio Bravo is not an *undeveloped* wilderness that has been preserved; rather, it is a legacy of *underdevelopment* that is in the process of being redeemed (Palacio 2001, 1:214–215).

The *low* population density of the country is at least in part a result of a *high*, historical concentration of land tenure and foreign ownership. This imbalance continues to very much concern Belizeans. Edgell’s realistic novel, described above, has a plot which pivots on a land sale to foreign investors. The residents of the areas bordering the Rio Bravo Conservation District ask whether the conservation areas, protected with the help of international NGOs, are in the same category as the speculative holdings of multinational companies? Is there a difference between “protected” and “private” when it comes to land use? The opinions of residents of the border communities were a subject of research by a McMaster student.

The history of agricultural suppression partly accounts for low agricultural output, but in addition the nation’s meteorological and hydrological features have proven difficult for farmers. Hurricanes have caused periodic damage, not only to crops, but to the cities by which the commodities make their way to market: the nation’s capitol which had been in coastal Belize City was moved inland to Belmopan after a 1961 hurricane, Hattie, caused catastrophic damage. In addition to the obvious effects of hurricanes, the seasonal and annual variations in rainfall are a problem for all but the most adaptable of agricultural methods. Even in a northern district, such as Orange Walk, where the inter-annual variation and total precipitation totals tend to be less, they are still very significant: the top of the upper tercile range can be three times as high as the top of the bottom tercile range for historical rainfall records in the same months at Rio Bravo; remember that these are not predictable vacillations between the wet and dry seasons; or regional differences, which can range from 60 inches per year in the north to 180 inches per year in the south; but annual variations between measurements taken at the same time of year and in the same place (Belize Climate Outlook n.d.). The WATER Project’s concentration on collecting careful baseline data in the New River Lagoon—the biggest, inland body of

water in Belize—and the intensive, rather than extensive, pattern of sampling reflect the importance of these inter-annual variations.

High diversity in soil composition and chemistry—whose agricultural implications are the subjects of one McMaster Scholar’s research—are no less challenging to Belizean farmers. A Belizean geography textbook attempts a four-class typology of soil zones in the country, but concludes that, in the end, it might be better to ask a traditional milpa or “pole” farmer than a geologist: one scientist tested soil from multiple sites on a small farm (.75 acres) and identified 18 different soil types (A Geography 2002, 57).

Successful farmers—Mayan, creole, and mestizo—are using their knowledge of both soil and plant diversity to try new “niche” crops, but the enterprises often require storage, transport, and international marketing resources beyond the reach of small-scale farmers. Some farmers, with incentives from government import-substitution plans, are attempting to grow large fields of the same crop, such as soybeans, on the North American monocultural model. The Mennonite Bergen family, described below, have bean fields that need the aid of technology to work against what appears to be the drift of natural selection in the region about which Claude Levi Strauss observed: “tropical species include more varieties than those of the temperate zones, although each variety may comprise only a small number of individuals” (1992, 99). Variability in water and soil quality is a strategically important problem that provides McMaster scholars the opportunity both to learn from very knowledgeable Belizeans and to contribute their own developing scientific expertise with the goal of enabling sustainable agriculture in a part of northwest Belize.

Government policies to encourage diversification of crop production have been moderately successful: mostly in partially compensating for the fluctuations in the global commodities market—the decline of sugar and the rise of citrus, for example—less so with respect to national import-substitution targets. Balance of trade deficits and a national (external) debt that has surpassed 1.3 billion U.S. dollars (1.362), however, remain a worry to the current Belize government and to its creditors.(CIA).

In certain ways, the United States and Belize are politically similar. Ralph Premdas, a Political Scientist from the University of the West Indies, points out in a very perceptive essay that Belize is attempting to negotiate the transition from being a former English colony with a legacy of slavery to becoming an independent, multiethnic democracy with a Latino majority.

The United States shares this challenge, in addition to being surprisingly (geographically) close to Belize, no matter what our mental maps might indicate: migrants from Latin and Central America are increasingly passing through Belize (and learning English) on their way to the U.S. border.

Despite their differences in scale, the U.S. could learn much from Belizean approaches to our shared problems—for example, the regularization of residency status for necessary, migrant agricultural laborers. Both the United States and Belize are currently engaged in difficult debates over the conditions of migrant laborers and their legal status, although Belize did enact an amnesty program in 1999 for illegal immigrants, while the issue is still warmly debated in the U.S. Congress. Both nations are also experiencing multiple and competing claims for precedence between established immigrants (mestizo or Creole) and more recent arrivals (Central American). All of these “imagined communities,” to use Benedict Anderson’s phrase, have their own nationalist symbols or myths of origin, whether involving the antiquity of Mayan monuments or slave resistance and reparation (Premdas n.d., 4-5).

The McMaster students and scholars involved in the WATER Project are finding common ground with Belizeans in the field and in person as they use their technical expertise to explore our common interest in the health of both the New River in Belize and the Maumee in Ohio. The broad, if not global, interdisciplinary range of the Integrated Natural Resource Management approach, described below, is as necessary as geographical border-crossing, if the researchers are to work with the people of Belize to advance our common humanity.



## REFERENCES

- Anderson, Benedict. 1991. *Imagined communities: Reflections on the origin and spread of nationalism*. Rev. ed. London: Verso.
- Belize National Meteorological Service. 2007. Precipitation Outlook for the Caribbean and Central America. [http://www.hydromet.gov.bz/precip\\_outlook.html](http://www.hydromet.gov.bz/precip_outlook.html).
- Belize national parks, natural reserves, and wildlife sanctuaries: Rio Bravo conservation and management area. N.d. Casado Internet Group. <http://ambergriscaye.com/pages/town/parkriobravo.html>.
- Belize, Guatemala, and Mexico. V. *Encyclopedia Britannica, world data*. <http://search.ed.com/ebarticle-129446.html>.
- Bolland, O. Nigel. 1977. *The formation of a colonial society: Belize, from conquest to crown colony*. Baltimore: Johns Hopkins Univ. Press.
- Bowan-Jones, Evan, and Abigail Entwistle. 2002. Identifying appropriate flagship species: The importance of culture and local contexts. *Oryx: The International Journal of Conservation* 36 (2): 189–195.
- Central Intelligence Agency. 2007. *The world factbook: Belize*. <https://www.cia.gov/cia/publications/factbook/geos/bh.html>.
- Conaway, Janelle. 2006. Looking for balance in Belize. *Americas*, November–December, 10–16.
- Dickinson, Emily. 1960. Poem 7. *The complete poems of Emily Dickinson*. Ed. Thomas H. Johnson. Boston: Little, Brown, & Co.
- Edgell, Zee. 1997. *The festival of San Joaquin*. Portsmouth, NH: Heinemann.
- Fagan, Brian. 1998. *From black land to fifth sun: The science of sacred sites*. Reading, MA: Addison-Wesley / Longman.
- A geography of Belize: The land and its people*. 2002. 6th ed. Benque Viejo del Carmen, Belize: Cubola Productions.
- Grover, Brett, and Ann T. Natunewicz, eds. 2003. *Answer atlas: The geography resource for students*. New York: Rand McNally.
- Leslie, Robert, ed. 2004. *A history of Belize*. 9th ed. Benque Viejo del Carmen, Belize: Cubola Productions.
- Lewis, Martin W., and Kären E. Wigen. 1997. *The myth of continents: A critique of metageography*. Berkeley: Univ. of California Press.
- Lévi-Strauss, Claude. 1992. *Tristes Tropiques*. Trans. John and Doreen Weightman. New York: Penguin.
- National Kriol Council of Belize. N.d. *Belize Kriol Mini-dictionary*. [http://www.kriol.org.bz/LanguagePages/Language\\_Dictionary.htm](http://www.kriol.org.bz/LanguagePages/Language_Dictionary.htm).
- Palacio, Joseph O. 2001. Belize. *Countries and their cultures*. Eds. Melvin Ember and Carol Ember. Detroit: Macmillan Reference and Yale Human Relations Area File.

- Premdas, Ralph. 2001. Belize: Identity and ethnicity in a multi-ethnic state. Paper presented at the Belize Country Conference of The University of the West Indies. <http://www.cavehill.uwi.edu/bnccde/belize/conference/papers/premdas.html>.
- Rodney, Walter. 1973. *How Europe underdeveloped Africa*. <http://marxists.org/subject/africa/rodney-walter/how-europe/ch01.htm>.
- Stone, Michael C. 1997. Belize. *The historical encyclopedia of world slavery*. Ed. Junius P. Rodriguez. Santa Barbara: ABC-CLIO.
- Von Hagen, Victor Wolfgang. 1947. *Maya explorer: John Lloyd Stephens and the lost cities of Central America and Yucatan*. Norman: Univ. of Oklahoma Press.

## MACRO AND MICRO NUTRIENT SOIL ANALYSIS IN THE RIO BRAVO CONSERVATION AND MANAGEMENT AREA AND ITS AGRICULTURAL PERIPHERY AREAS, ORANGE WALK, BELIZE

Mary Ann Studer

Soil is one of the most significant natural resources for any nation. Yet today one of the major global environmental concerns is land degradation. It is estimated that over 40% of all vegetated land on earth has a limited capacity due to the direct negative impact of inappropriate land use. This translates into an estimated reduction of 10% in terms of potential economic benefits to the human beings who depend on the land for their livelihoods (Paniagua et al. 1999, 215)

In Belize and throughout Central America, however, there has been scarce interest in detailed soil studies, and poor regulation of soil use is common. In many cases land use is ineffective due to the lack of solid information and no serious commitment to soil sustainability. Exploitation of soil has a synergistic effect on other soil-related natural resources, such as water, vegetation, carbon reservoirs, and the like. Inattentiveness to sustainable soil quality disproportionately affects the economic basis of the indigenous populations of Belize and, therefore, is a critical factor in improving the human condition in this Central American nation.

*Evaluation of Human-Induced Soil Degradation in Mexico (2001–2002)*, a study overseen by Salvador Sánchez-Colón, General Directorate for Environmental Information and Statistics, Ministry of the Environment and Natural Resources, México, lists the major causal factors of soil degradation in the neighboring country as agricultural activities, overgrazing, and deforestation. It is suspected that the same factors are contributing to soil degradation in Belize. Therefore, this McMaster initiative in Belize was focused on (1) the baseline analysis of forested areas within the Rio Bravo Conservation and Management Area that have been selectively logged, (2) a survey of the types of agricultural practices that exist on the periphery of the Rio Bravo, and (3) a preliminary effort to obtain an inaugural point-in-time nutrient analysis of agricultural fields that border the Rio Bravo.

The goals of the project were to begin to use the results of the data collected to (1) provide a preliminary data set on soil-nutrient levels from a range of selectively logged sites within the Rio Bravo Conservation and Management Area for the managing NGO (nongovernmental organization) Programme

for Belize, (2) eventually increase the effectiveness and subsequent yield potential for indigenous farmers on the periphery of the Rio Bravo Conservation and Management Area, and (3) combine the concurrent movement toward more effective agricultural practices with a reduction in the negative impact on the surrounding rainforest. Managing soil for long-term productivity in Belize will be critical both for the improvement of the quality of life of native Belizeans and for the preservation of rainforest ecosystems in that nation: these two concerns are inherently tied.

Slash and burn (or shifting cultivation) is practiced by approximately 300 million people annually around the globe and affects nearly 400 million hectares of the earth's 1,500 million hectares of arable land (Giardina et al. 2000, 247). Managing soil for sustainability hinges on the ability of the milpa farmers in Belize, who employ traditional slash-and-burn methods, to respond to the changing conditions, that is, an increase in population and a decrease in available land due a decrease in deforestation.

In many situations, agricultural practice has responded to an increase in population by reducing the fallow time for agricultural fields. Agricultural practices in Belize are rooted in slash-and-burn methods that were effective with 20–25 year rotation periods. But these practices have progressively moved to bush fallow (6–10 year rotation), to short fallow (1–2 year rotation), and even in some cases to annual cropping and multi-cropping with irrigation (Syers 1997, 1011). This is an effort to maintain subsistence yield for an increased population with static resources. It is hoped that with the return of data on the soil-nutrient levels, indigenous farmers will begin to develop and implement restorative soil-management strategies that include systematic crop rotation and limited use of fertilizers. These practices to improve soil fertility thus have the potential to improve yield.

## PROJECT COMPONENTS

### **Baseline analysis of selectively forested areas within the Rio Bravo**

Programme for Belize selectively logs mahogany within the 260,000-acre Rio Bravo Conservation and Management Area. Soil was sampled at three specific sites that ranged from being recently logged (within the 6 months prior to sampling) to being logged 60 years ago. These sites were identified by Programme for Belize guide, Ivan Gillett. At each of these sites one to three trees had been removed with the stumps left in place. Each of these sites was located in what may be considered densely forested areas, and the area directly surrounding the logged site was untouched. Soil was sampled at each of the sites and returned to the laboratory for analysis. Analysis was

conducted to determine the macronutrient levels – nitrogen, phosphorus, calcium, magnesium, and sulphur – and micronutrient levels – manganese, iron, chlorine, aluminium, and ammonia.

The results showed that phosphorus levels were significantly lower in the older logged areas (20 years ago and 60 years ago) compared to the recently logged area (6 months ago). Phosphorus occurs in soil due to the weathering of minerals, especially apatite. It is critical for root growth, improves the efficiency of nitrogen uptake, and helps plants resist disease. Phosphorus tends to be the primary nutrient limiting growth in tropical land ecosystems because it easily leaches out of old soils in the absence of anchoring vegetation.

Levels of potassium and nitrogen showed no significant difference among the sites sampled. While there was a comparative difference in calcium levels, decreasing from the more recently logged site to the old site, the levels remained within the high to medium range. No significant difference was recorded in either magnesium or sulphur levels. Micronutrient levels were largely similar for all sites.

One can conclude from this preliminary data, specifically the decreased levels of phosphorus, that selective logging may have an impact on the actual site to the extent that over time it could reduce the ability of subsequent vegetation to thrive. This is only one aspect of the analysis needed to get a true picture of the extent of the impact that selective logging has had on the ecosystem as a whole. Testing for levels of organic matter in the soil of logged sites as well as coupling leaching rates with analysis of soil-nutrient levels would work to develop a more accurate impact study.

### **Survey of the agricultural practices of indigenous people**

During this December 2005 experience in Belize we were able to meet and talk with a number of Belizeans who make their living from the soil. Ivan Gillett, our Programme for Belize guide, provided strategic contacts as we worked to assess peoples' lives and livelihood on the periphery of the Rio Bravo Conservation and Management Area. Among the people we spoke to, farming practices varied widely.

Mr. Bergen, a Mennonite farmer, arrived in Belize in 1981 and began farming corn and then soybeans as part of a larger Mennonite community. His biggest challenges are producing a crop that is marketable at a good return and getting that crop to a place where it can be sold. Whole communities farming a single crop, in this case corn, in a limited market reduces the price to a minimum. Diversifying with soybeans has proven

problematic as well. Government initiatives to buy and export the soybeans have not come to fruition, frustrating Bergen and his community. The absence of good roads prevents these farmers from getting their crops to market, and the humid tropical climate prohibits them from storing the grain. Both of these factors keep this population at a near-subsistence level.

Mr. Polk also lives in a small community that is within the periphery region of the Rio Bravo Conservation and Management Area. Polk grows annatto in a large backyard plot along with cocoa yams. The cocoa yams are for the local market but the annatto is processed into a spice paste called ricardo. The ricardo is hand processed right on the property. Polk's Blue Dove Farm sells annatto to the local community and when possible, to tourists as well. His ability to do the latter is limited by the resources necessary to advertise and by the location of his farm in the interior of Belize: far from the bulk of the tourist trade that arrives and leaves via cruise ships.

Mr. Kelly, 60 years old, is a former ranger for the Rio Bravo Conservation and Management Area and a former chiclero. He harvested chicle during the height of its demand, before the introduction of synthetic gum. Kelly pole farms acreage that is about a four-mile walk from his home. He takes a





pole and after driving it into the ground drops in a seed. Kelly plants, harvests, shucks, and bags all the corn by hand. The bags of corn are stacked under the stilted floor boards of his house. He then uses the corn for seed and sells or trades the remainder to those in the community. The amount of work it requires to eke out a living by subsistence farming without any equipment, transportation, or technology became real in Kelly's story and added to our understanding.

Mr. Hernandez is a member of the village of San Carlos, located on the north edge of the New River Lagoon. San Carlos has a population of 100-150 people and consists of approximately forty-five families. The village itself is paying off a mortgage to the government for the land that it farms. Hernandez, who was farming approximately six acres at the time the group visited, explained the process by which a family simply requests from the village the acreage it can farm and the acreage is granted. The family farms the land, and any profit made from selling the produce locally goes to the village to pay off the mortgage. It is hoped that when the land belongs to the village it will be divided among the families of San Carlos.

The farms of San Carlos are heavily irrigated during the dry season, thus increasing the probability that the natural nutrients will be leached out of the soil. Getting a large crop to market is nearly impossible for these people. Therefore, they remain diversified and use multi-crop methods to provide onions, potatoes, peppers, melons, and habaneras through several growing seasons a year. Hernandez starts seeds in makeshift flats. He advised that in the process he loses about half of the seedlings due to root damage even before they are transplanted in the ground. Hernandez was anxious to have his soil tested and receive the results: he hadn't had access to that type of information before.

This preliminary glimpse into the reality of farming on the periphery of the Rio Bravo Conservation and Management Area evidences several issues that require long-term attention. The first deals with the balance between the development of infrastructure that allows for transport of crops and products to market and the preservation of natural resources through areas like the Rio Bravo. These conflicting goals represent competing stakeholders in the northern region of Belize. The second issue is that of sustainable land use. All stand to benefit, both the farmer and those interested in preserving the natural ecosystems, if agricultural practices become more precise. This precision would develop from monitoring soil-nutrient levels, planning crop rotation that would preserve and restore the soil, using limited and cost-effective fertilizer along with organic fertilizers, and recording long-

term agricultural histories of farmed land to increase effective analyses. Knowledge about better management of their agricultural property would help empower these farmers to break from the traditional slash-and-burn farming that results in nutrient-spent fields unable to support crops or forest vegetation. These fields currently litter the Belizean landscape and regrowth to forest is painfully slow.

Since the nation of Belize has set its economic course based on ecotourism, the preservation of natural resources, including the rainforest that covers the Rio Bravo Conservation and Management Area, has been legislated and funded largely through foreign entities. But without the support of the local population that currently struggles to farm on the periphery, the Rio Bravo has little chance of long-term survival. The indigenous populations in the interior of the country have yet to reap the rewards of ecotourism. Currently their lifestyles remain depressed, with little access to health care, minimal education, and little economic ability to move beyond a subsistence level.

### **Preliminary soil-nutrient analysis of agricultural fields**

Soil samples were taken from three agricultural fields in the area surrounding the Rio Bravo Conservation and Management Area, including the lands of Bergen and Hernandez. Soil was sampled at each of the sites and returned to the laboratory for analysis. Analysis was conducted to determine the macronutrient levels—nitrogen, phosphorus, calcium, magnesium, and sulphur—and micronutrient levels—manganese, iron, chlorine, aluminium, and ammonia.

Bergen has farmland that literally lays adjacent to the heavily forested areas of the Rio Bravo. Soil samples were taken from a field that was planted with soybeans. Nitrogen and phosphorus levels were very low and low, respectively. There were no limiting levels of micronutrients. The pH level of the soil was consistent with that which is optimal for soybeans.

Samples were also taken from the Hernandez farm, which is part of the collectively owned acreage of San Carlos. This agricultural village on the northwest edge of the New River Lagoon is on the periphery of the Rio Bravo Conservation and Management Area. Soil samples were taken from two of Hernandez's fields planted with onions. The first field tested had a low level of nitrogen but high levels of both phosphorus and potassium. The levels were evaluated specifically for an onion crop and were, even with the low level of nitrogen, within a range that would support approximately 80% of potential yield. The second field showed very high

levels of nitrogen, phosphorus, and potassium, and medium to very high levels of calcium and magnesium. The macro-nutrient levels were above that which is recommended for 100% potential yield. There may have been a number of reasons for these high levels. The field may have been recently fertilized, the fertilizer may have been improperly applied, or the field may have been over fertilized. The over application of fertilizer is both costly and counterproductive. Given the appropriate soil information, Hernandez could be more effective in his use of fertilizer, limiting application to cost-effective yield.

The results of the above field soil-nutrient analysis were returned to both Bergen and Hernandez within thirty days of the original sampling. It is hoped that this information provided a basis for more effective practices for the next growing season. But this was just the first step in building a relationship with and providing information to these Belizean farmers, who will allow ongoing testing and feedback. Recording a precise agricultural history of the land – its uses, crops, and treatments – will be needed to enable long-term sustainability.



## CONCLUSION

Belize offers some very positive arenas for continued research on environmental conditions within the Rio Bravo Conservation and Management Area and some significant challenges to efforts to develop the quality of life of the people who live on the Rio Bravo periphery. The country's commitment to natural-resource preservation and efforts to realize economic stability through ecotourism are commendably different

from choices made in other Central American nations. However these initiatives have a strangle hold on indigenous populations of the interior, specifically in north Belize where this study was conducted. The absence of good roads to transport crops to the coast and limited land availability due to the establishment of mega conservation areas does little to contribute to the earning potential of these people. They do not regularly have access to tourists or the money tourists bring into the country.

Agricultural systems are synergistic with ecological, economic, and social variables; Integrated Natural Resource Management research works across these dimensions. Sustainability in terms of both the environment and the human beings who occupy it is only possible when there is compromise: farmer-based private benefits—production and human well being—need to be balanced with global environmental benefits, such as the preservation of biodiversity (Sanchez, Palm, and Buol 2003, 160). In addition, efforts that result in the dissemination of information to all stakeholders—efforts much like this study—are needed to insure the benefit of ongoing analyses. Information about soil-nutrient levels help Belizean farmers make more informed decisions about the precious soil resources they have, decisions resulting in improved soil-nutrient sustainability and a potential increase in their yield-to-cost ratio. Monitoring and restoring soil quality will have synergistic effects on the livelihoods of the people of Belize.

## REFLECTION

While the schema of Integrated Natural Resource Management gives a viable framework for interdisciplinary studies such as the WATER Project in Belize, the value of working collectively as a diverse team is an experience of a lifetime. We speak of partnerships among the entities of McMaster School for Advancing Humanity, Defiance College, and Programme for Belize with an abundance of evidence about the effectiveness of institutional endeavors. But this effectiveness pales in comparison to the partnerships that develop between individuals on the ground. Partnerships between students and faculty and between our team from the U.S. and local Belizeans are the real strength of these experiences. I can literally count on one hand the opportunities in my lifetime that have resulted in such alliances. The McMaster School for Advancing Humanity has provided us with an opportunity to cooperatively share knowledge and expertise with individuals across geopolitical boundaries, across educational backgrounds, across gender lines, and across economic classes with a passion to improve each other's quality of life. For every way in which we were able to positively affect the people in Belize, we too were affected in a way none of us will ever forget.

## REFERENCES

- Giardina, Christian P., Robert L. Sanford, Ingrid C. Døckersmith, and Victor J. Jaramillo. 2000. The effects of slash burning on ecosystem nutrients during the land preparation phase of shifting cultivation. *Plant and Soil* 220:247-260.
- Paniagua, Alejandro, Johann Kammerbauer, Miguel Avedillo, and Ana Margoth Andrews. 1999. Relationship of soil characteristics to vegetation successions on a sequence of degraded and rehabilitated soils in Honduras. *Agriculture, Ecosystems and Environment* 72:215-225.
- Sanchez, Pedro A., Cheryl A. Palm, and Stanley W. Buol. 2003. Fertility capability soil classification: A tool to help assess soil quality in the tropics. *Geoderma* 114:157-185.
- Sanchez-Colon, Salvador. 2001-2002. Evaluation of human-induced soil degradation in México. Ministry of the Environment and Natural Resources, México. [http://webdomino1.oecd.org/comnet/agr/soil\\_ero\\_bio.nsf/viewHtml/index/\\$FILE/Mexico.doc](http://webdomino1.oecd.org/comnet/agr/soil_ero_bio.nsf/viewHtml/index/$FILE/Mexico.doc).
- Syers, J. Keith. 1997. Managing soils for long-term productivity. *Philosophical Transactions: Biological Sciences* 352:1011-1021.

## A SURVEY OF HUMAN INTESTINAL PARASITES IN THE WATERS OF THE RIO BRAVO CONSERVATION AND MANAGEMENT AREA

Eric Dix

Cases of human infection by parasites number in the billions worldwide. The diseases caused by parasites range from asymptomatic to fatal and constitute major human health problems throughout the world, with the incidence of many parasitic diseases increasing rather than decreasing in recent years. Aimpun and Hshieh (2004) report that in study of 672 participants in a district of Belize 66% found to have one or more intestinal parasites.

Since the New River Lagoon and Rio Bravo Conservation and Management Area are relatively unspoiled, pristine wilderness areas of the Orange Walk District of Belize, a survey of intestinal parasites was used in assessing the area's water quality and the general health risks of infection to the inhabitants. It was decided that an environmental survey of water sources in the area would be the most effective means.





The infective form of hookworm is a free-living nematode worm, making it a good candidate for recovery in an environmental sample. *Entamoeba histolitica* was also chosen because it is capable of using any mammal as a reservoir host. The environmental survey was to concentrate the recovery of these two organisms, with an identification attempted on any ova recovered.

Hookworm is the second-most common human helminthic infection (after *Ascaris lumbricoides*). There are two species that cause hookworm infection, *Necator americanus* and *Ancylostoma duodenale*. Both *N. americanus* and *A. duodenale* are found in Africa, Asia and the Americas. Hookworm has worldwide distribution, mostly in areas with moist, warm climate. The most common symptom of hookworm infection is iron-deficiency anemia, which is caused by blood loss at the site of intestinal attachment by the adult worms and can be accompanied by cardiac complications. Gastrointestinal and nutritional and/or metabolic symptoms can also occur. In addition, local skin manifestations, called "ground itch," can occur during penetration by the filariform larvae.

*E. histolitica* is recognized as a pathogenic amoeba associated with invasive and noninvasive intestinal and invasive extra-intestinal infections. The geographic distribution of *E. histolitica* is worldwide, with a higher incidence in underdeveloped countries. Infection by *E. histolitica* occurs by ingestion of mature cysts in food or water or from hands contaminated with fecal material. Symptoms of invasive intestinal amoebiasis include dysentery, colitis, appendicitis, and toxic megacolon. Invasive extra-intestinal amoebiasis symptoms include liver abscess, peritonitis, pleuropulmonary abscess, and cutaneous and genital amebic lesions.

## METHODS

The Environmental Protection Agency's Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA (1999) was the protocol used for this project. This method is used by the EPA to assess *Cryptosporidium* and *Giardia* occurrences in raw surface waters as source waters for drinking water-treatment plants. Filtration and vital dye staining with differential contrast microscopy could be conducted with satisfactory results for a qualitative survey.

While in Belize, seven separate sites were sampled. Irish Creek, a tributary of the New River Lagoon, was sampled at two locations. Harry Jones Creek was sampled where it empties into the lagoon. In New Hope Village, a Mennonite settlement west of the conservation area, a stagnant irrigation

pond was sampled. At San Carlos Village, a small subsistence agricultural settlement on the northwestern shore of the lagoon, two sites were sampled: an open hand-dug well behind a residence and a commercially drilled well with a hand pump. Sampling was also done at Ramgoat Creek, a spring-fed creek emptying through dense mangrove growth into the New River Lagoon.

## RESULTS

Both rhabditiform and filariform larvae of the hookworm *N. americanus* were recovered from the environmental water samples. *Balantidium coli* was recovered from a single sample source. Parasites were recovered only from samples taken from static sources of water. None were recovered from flowing water sources.

Hookworm appears to be the primary human intestinal parasite in and around the Rio Bravo Conservation and Management Area since both rhabditiform and filariform larva of *N. americanus* were recovered from the environmental water samples. *B. coli*, reliably identified by four specific features of the organism, was recovered from a single sample source only and in relatively few positively identifiable examples. This would indicate that the organism is fairly rare in the Rio Bravo area. It should be noted that parasites were recovered only from samples taken from static sources of water. None were recovered from flowing water sources, regardless of the velocity of the water flow. This is probably more attributable to lower organism concentrations than to a lack of organism representation in those sources.

## REFERENCES

- Aimpun, Pote, and Paul Hshieh. 2004. Survey for intestinal parasites in Belize, Central America. *Southeast Asian Journal of Tropical Medicine and Public Health* 35:506–511.
- U.S. Environmental Protection Agency. 1999. EPA method 1623: Cryptosporidium and Giardia in water by filtration/IMS/FA. Office of Water. EPA-821-R-99-006. [http://a257.g.akamaitech.net/7/257/2422/22jul20061500/edocket.access.gpo.gov/cfr\\_2006/julqtr/40cfr141.707.htm](http://a257.g.akamaitech.net/7/257/2422/22jul20061500/edocket.access.gpo.gov/cfr_2006/julqtr/40cfr141.707.htm).

## PESTICIDE CONTAMINATION AROUND THE NEW RIVER LAGOON

Jenna Kurtz

Researchers in Belize report very little on the subject of pesticide use and contamination in that country. Because of the impact that such research may have on the people of Belize, my project for the McMaster School focused on testing for pesticides in the water of the New River Lagoon. The idea was to provide information that could be used in making conservation management decisions.

The subcategories of pesticides are herbicides, fungicides, and insecticides. Determining the contamination of pesticides in the water is important for several reasons. First, contamination could severely harm a species in a specific habitat, in turn causing the whole food chain to become infected and harmed. Humans are not exempt from hazards. If humans become contaminated, they too may develop problems. Dangers include, but are not limited to, mortality, deformities, reproduction problems, behavior problems, and neural damage, depending on the specific pesticide. Thus, pesticides pose an immediate danger to humans and the environment through consumption, absorption, and/or inhalation.

### METHODS

Beginning this research project, I needed to determine which pesticides were being used around the New River Lagoon area. Pesticide Control Board of Belize (2004) sent a list containing all of the pesticides known to be used in the area, including several insecticides and herbicides. From the list, I chose two herbicides, atrazine and diuron, based on the equipment available and my level of expertise.

Five water samples were collected while in Belize. The sites included those where water was sampled during the previous year's trip, along with two new sites in a nearby community. The water collected was then transported back to Defiance College for analysis.

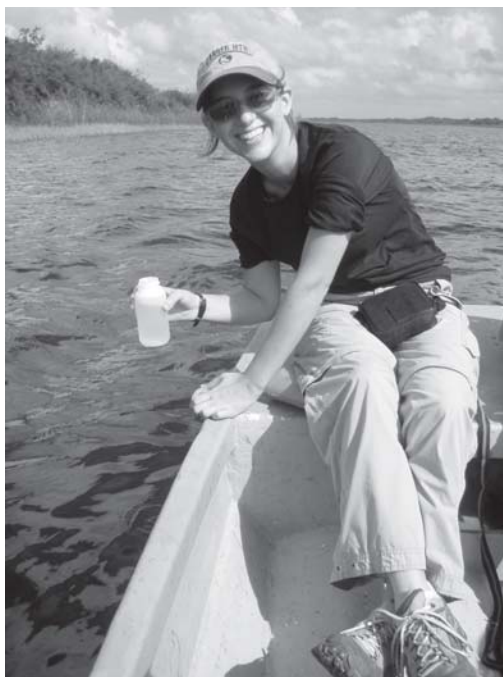
### RESULTS

In four of the five samples, diuron was found as a contaminant. The concentrations of diuron ranged from 0.006–0.02 parts per million. These concentrations are considered acceptable in the absence of a full evaluation of the herbicide, according to Integrated Risk Information System (IRIS) of the Environmental Protection Agency (2006).

Atrazine was found only in the sample that did not contain diuron. The sample site containing atrazine had a concentration of 0.095 parts per million. This is a cause for concern because the EPA regulation for atrazine is 0.003 parts per million, as reported by Pesticide Action Network (2000–2006). This site poses a serious threat for the organisms living in the water, as well as for humans and other animals that may use the water.

### REFLECTION

College is about opportunities, but I never imagined that I would be given the opportunity to take part in such a unique and amazing program like the McMaster School for Advancing Humanity. The experience changed my perspective of life and other cultures, and it strengthened my feelings about the natural world. Through my research on pesticides, I hope to have a positive effect on the Belize natural environment and the humans who live there.



### REFERENCES

- Integrated Risk Information System. 2006. Diuron. Environmental Protection Agency. <http://www.epa.gov/iris/subst/0233.htm#conver>.
- Pesticide Action Network. 2000–2006. Atrazine. *PAN pesticides database: Chemicals*. [http://www.pesticideinfo.org/Detail\\_Chemical.jsp?Rec\\_Id=PC35042#Water](http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC35042#Water).
- Pesticide Control Board, Belize. 2004. List of pesticides used in the Hillbank and New River Lagoon area. <http://www.pcbbelize.com>.

## TESTING FOR THE PRESENCE AND CONCENTRATION OF LEAD IN AND AROUND THE RIO BRAVO CONSERVATION AND MANAGEMENT AREA

Diane Perkins

The 2004–2005 WATER Project of the McMaster School for Advancing Humanity included sampling to establish abiotic parameters, but it provided no baseline data for lead concentrations. Research is scarce on this topic: no research is available on lead levels in and around the Rio Bravo Conservation and Management Area. Because it is important that such data be analyzed, I set out to test the soil for the presence of lead at sites in and around the Rio Bravo.

Avenues of exposure to lead include ingesting a substance with lead in it. Lead in gasoline, lead-acid batteries, and lead-based paint are also sources of possible contamination. Lead in soil is significant because if a person does not wash his or her hands after handling contaminated soil, lead may be transferred to food.

All of lead poisoning's numerous effects all lead to serious physical and mental health problems. According to the U.S. Department of Health and Human Services (HHS), lead poisoning can cause a lower IQ, decreased arithmetic and reading skills, loss of memory, hallucinations, elevated blood pressure, hypertension, decreased fertility, osteoporosis, chronic renal disease, decreased red blood cell lifespan, and anemia, to name a few. Lead is more toxic to children than adults because once lead enters the bloodstream, a greater percentage is absorbed by children than adults (2005, 7). Furthermore, according to the HHS, "about 99% of the amount of lead taken into the body of an adult will leave in the waste within a couple of weeks, but only about 32% of the lead taken into the body of a child will leave in the waste" (8). However, the risk may be substantial to adults as well, for lead targets the nervous system.

### RESEARCH QUESTIONS

The research questions I explored were these: (1) What is the concentration of lead in the soils in and around the Rio Bravo Conservation and Management Area in Belize? (2) What health implications do those levels have for the populations living in the areas tested? (3) If there is a serious problem, what can be done to restore the environment?

## LITERATURE REVIEW

Lead occurs in the environment as “pure metal, in alloys, and as inorganic and organic compounds” (Skerfving et al. 1998, 289). According to Kendler, “lead is unique among common metals because of its softness, malleability, low melting point, high density, capacity to form alloys with other metals, and resistance to corrosion,” causing it to be widely used in industry (1994, 13). The most prominent factor influencing the rate of deposition of lead in soil is the concentration of lead through the atmosphere, according to U.S. Department of Health and Human Services (2005, 293). Furthermore, most lead is retained in the soil instead of being transported by runoff to surface water or by leaching to groundwater (293–294). Lead in surface waters may be due to erosion of “soil particulates” that contain lead (294). When lead is transported by leaching to groundwater, it travels extremely slowly. Overall, “while the majority of lead releases are to land, they constitute much lower exposure risks than releases to air and water” (289).

Lead in soil also affects the plants present in the environment, which provide an avenue of exposure to humans. U.S. Department of Health and Human Services states that “lead may be taken up in edible plants from the soil via the root system” (2005, 295). When such a plant is eaten by a person, the lead is then transported directly into the individual’s circulatory system. When enough lead is ingested, symptoms of lead poisoning set in. Animals may also become poisoned from both lead in the air and from ingested contaminated plants. According to Skerfving et al (1998, 289), “Lead is an animal carcinogen, but conclusive evidence for carcinogenesis in humans is lacking.”

According to Clark and others, “Exposure to dust and soil contaminated with lead from lead-based paint, from fallout from the time when lead was used in gasoline, and from industrial and other sources is considered to be the pathway through which many children become exposed and poisoned” (2004, 273). When lead is absorbed by the body from exposure, it enters blood plasma and disperses between extracellular fluid and plasma. It then travels to blood cells. According to Skerfving et al (1998, 291), “The turnover of lead in plasma is very rapid; the half-life after intravenous injection in humans was ~1 minute.”

## METHODS

There were seven sites where soil samples were taken in Belize. Two were taken from Mennonite agricultural fields, three from previously logged sites within the Rio Bravo Conservation and Management Area, and two from



agricultural fields of the village of San Carlos. I also tested local Defiance, Ohio, soil from an agricultural site.

I employed an acid-digestion process with multiple reflux steps to arrive at a filtrate that could be analyzed through the flame atomic absorption spectrometer. The absorbance of the filtrate was compared to prepared standard lead concentrations.

## RESULTS

While lead was detected in the soil from the sites in Belize and in Defiance, Ohio, the samples were well below U.S. Environmental Protection Agency limits.

Therefore, there is no threat of lead poisoning to the people working in the areas immediate to the sample locations. However, it is important to keep in mind that the sample locations were generally a distance from any dwellings or buildings, and the farther away from the lead source, the less the contamination. In the future it will be important to test the soils in and around residential areas, specifically at the foundations of houses and highly trafficked areas.

## REFLECTION

I am infinitely grateful to have had the opportunity to experience learning in an entirely different way. My project allowed me to gain knowledge and experiences that I would not have received otherwise. Most importantly, this experience allowed me to grow as a person by viewing the human condition firsthand in a place that was completely foreign to me and my way of life. I sincerely wish everyone could be so lucky as to have experiences beyond familiar territory. Besides personal growth, this opportunity has allowed me learn much about subjects that I would not have encountered through the many discussions with both my team members and the Belizeans we met.

I was most surprised—and realize upon reflection that I should not have been—by how nice the Belizean people were. Upon arriving in Belize and



finding our car-rental place closed, we were immediately given assistance by the employees of the other car rental next door. They helped us contact our car-rental person, who promptly arrived and gave us the keys. As the sun set, a young Belizean man voluntarily climbed on top of our land rover to help pack our suitcases. After everything was secured, even though he left with a bleeding finger, he gave us a smile and wave.

Working within the Belize learning community was truly a blessing. To be able to learn and work with people who respect and appreciate others is phenomenal. I have never experienced teamwork like I did with my peers on this trip, and all of the Belize projects benefited from the combined efforts of the group.

## REFERENCES

- U.S. Department of Health and Human Services. 2005. *Draft toxicological profile for lead*. Prepared by Syracuse Research Corporation, contract no. 200-2004-09793. Atlanta, GA: Agency for Toxic Substances and Disease Registry.
- Clark, Scott, William Menrath, Mei Chen, Paul Succop, Robert Bornschein, Warren Galke, and Jonathan Wilson. 2004. The influence of exterior dust and soil lead on interior dust lead levels in housing that had undergone lead-based paint hazard control. *Journal of Occupational and Environmental Hygiene* 1 (May): 273-282.
- Kendler, Barry S. 1994. Environmental lead contamination: A metaphor for destructive industrial practices; Lead abatement: A model for ineffective societal responses. *Structural Survey* 12 (3): 13-23.
- Skerfving, Staffan, Lars Gerhardsson, Andrejs Schütz, and Ulf Strömberg. 1998. Lead: Biological monitoring of exposure and effects. *Journal of Trace Elements in Experimental Medicines* 11:289-301.

## ANALYSIS OF WATER QUALITY IN THE NEW RIVER LAGOON AND TRIBUTARIES

William Fix

Programme for Belize (2000–2003) is using a multifaceted approach within the Rio Bravo Conservation and Management Area. They are enforcing strict protection of a targeted area of the preserve and emphasizing sustainable forestry practices, including planting trees on lands around the preserve and in the buffer zones. They are working to establish low-impact, alternative economic activities, such as ecotourism, for both inside and outside the preserve. Furthermore, Programme for Belize is working to cultivate local appreciation and support for the preserve through hiring practices, education, public relations, and improvements in local people's lives through economic stability.

The primary goals for this project included collecting water samples and monitoring the water quality in and around the New River Lagoon and its tributaries in the Rio Bravo Conservation and Management Area, and identifying pollution sources that are critical to the health of this area. This



research was a part of the continued effort to establish baseline water quality analysis in this important ecosystem.

## METHODS AND RESULTS

The same locations that were visited in 2004 were again sampled for comparison. In addition, several other monitoring sites were added. The sites from which water was collected were the Mouth of Irish Creek, Ramgoat Creek, and Harry Jones Creek (all three tributaries of the New River Lagoon), as well as New Hope Village, which is on the periphery of the Rio Bravo Conservation and Management Area.

The water quality parameters tested were pH, dissolved oxygen, ammonium ion concentration, calcium ion concentration, turbidity, temperature, and phosphate ion concentration. The level of dissolved oxygen may be considered an indicator of the health of a system. Levels of ammonia and phosphate may be especially high around areas used for farming and animal production. Turbidity, the transparency or clarity of the water, may also be higher around these areas.

At all locations tested, results were within normal ranges. It appears that the locations around the lagoon that were tested have been minimally impacted by human activity. The goal of continual water quality testing is to establish baseline data to ensure this ecosystem stays healthy.

## REFERENCES

Programme for Belize. 2000–2003. <http://www.pfbelize.org>.



## **THE RIO BRAVO CONSERVATION AND MANAGEMENT AREA'S EFFECT ON PERIPHERY FARMERS**

Jordan Plant

Managing the Rio Bravo eco-wonder is the staff of Programme for Belize (2000–2003), which protects the wildlife area from outside incursion and promotes scientific efforts to keep the area pristine. Through the efforts of Programme for Belize, scientists from abroad are invited to stay at the Hillbank Research Station. They are encouraged to study every aspect of the Rio Bravo Conservation and Management Area and its outlying regions, so long as all data that are gathered are reported to Programme for Belize, thereby furthering their understanding of the ecosystem they work so hard to protect.

Because the Rio Bravo Conservation and Management Area is so vast, many communities exist on its borders, including industrial centers like Shipyard and farming towns like San Carlos. Also, individual homesteads are set up around the border of the preserve. Whether immigrants from Guatemala or Mexico, Mennonites or native Mayans, people struggle to make a living for themselves on the borders of this lush environmental preserve.

However, the people on the periphery of this natural wonder may be suffering because of its very existence. With such a great amount of land being withheld from the population of Belize, those living on the borders may struggle to have access to the bountiful resources the protected land has to offer. This is the issue that I wanted to study.

### **RESEARCH QUESTIONS**

The following questions guided my research: Does the Rio Bravo Conservation and Management Area contribute to the poverty of its outlying communities? Specifically, would the periphery communities be better off if they could use the conservation area for hunting, fishing, and farming? Or is Belize as a whole better served by maintaining the conservation area? This project also has allowed me to ask whether there are other means to raise farmers on the periphery out of subsistence farming into more profitable enterprises.

### **LITERATURE REVIEW**

Research does not directly link the Rio Bravo Conservation and Management Area to poverty in the Orange Walk District, which is on the periphery of the conservation area, but research shows that poverty and

poverty-based issues are present in the Orange Walk District of Belize. The national poverty line for Belize is \$1,287.48 according to a report of Caribbean Development Bank (2002). According to this report, 21% of Orange Walk households are poor and almost 25% of the overall Orange Walk population is poor. Trends for the poor, as detailed in the report, include employment mostly in agriculture and fishing with subsistence farmers being caught in “a low level equilibrium trap.” Thus, the poverty of farmers is a major problem in Belize.

The Belize Ministry of Agriculture and Fisheries *Annual Report* (2004) provides information about ongoing governmental efforts to help farmers in the Orange Walk District. The government laid out plans for agricultural land rehabilitation, seed donations to farmers, and loans for farmers. The government also planned for increases in farm production in quantity and type of agricultural goods produced. This leads to the question of whether farmers on the periphery of Rio Bravo Conservation and Management Area are receiving the promised government help.

## **METHODS**

The hypothesis that drove this research is that the protection of the natural resources of the Rio Bravo Conservation and Management Area contributes to the poverty of community members living on its periphery. My methods focused on understanding perceptions of community members trying to raise themselves out of the poverty that often goes with subsistence farming. Thus, I traveled to Belize to interview people who live on the periphery of the Rio Bravo Conservation and Management Area in order to find out how they felt the protected land was affecting their lives. In addition, I sought to discover if there were other factors contributing to poverty in those communities. If so, remedies based on further research might be needed.

The interviewees from Hillbank Research Station included Ivan Leopold Gillett, who was the expert guide for the McMaster Belize learning community, and two other workers at the station. Interview subjects on the periphery included members of the subsistence-farming Hernandez family of San Carlos, subsistence “pole” farmer Mr. Kelly, a small commercial annatto farmer, and a Mennonite farmer. These interviewees provided insight into issues plaguing their communities and gave opinions about the best use for the land in the Rio Bravo Conservation and Management Area.

Wendy Hernandez of San Carlos spoke with us on behalf of her community and translated for those of the community who did not speak English.

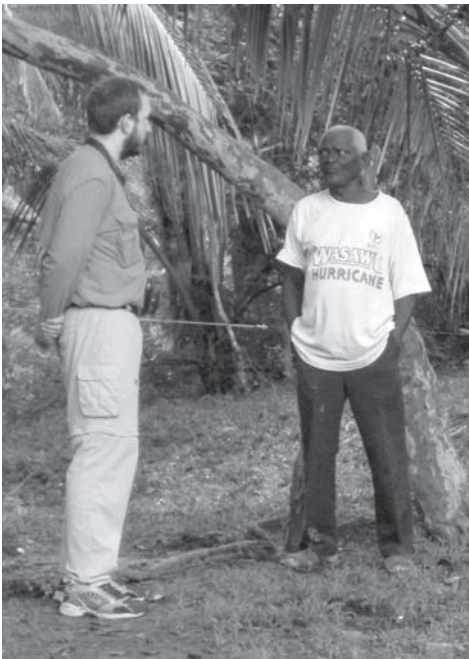


When asked about the Rio Bravo Conservation and Management Area, she said the land was used well because the air and water were kept clean. She mentioned how she had been to the Mennonite town of Shipyard, an industrial center that has smelly air and polluted water. Hernandez's concern for maintaining the conservation land was primarily environmental. She felt that if the environment around her town were maintained, then the lives of her townspeople would be better.

During a truck ride out to view San Carlos farmland, the group's expert guide, Gillett, was asked for his opinion about the use of the Rio Bravo Conservation and Management Area. Openly biased in favor of the reserve, Gillett pointed out the prevalence of land already available to farmers, noting the many fallow acres of farmer-owned land. He talked about Belize's habitual use of slash-and-burn farming techniques as well as the problems of logging, over hunting, and commercial fishing. He commented on the general laziness of the younger generation who sit inside and watch TV while their elders farm the land. For Gillett, these concerns would have to be resolved before he would even consider opening up the Rio Bravo Conservation and Management Area to farmers, hunters, and fishermen.

Kelly felt that some of the conservation land should be opened up for farming, but not all. He felt that this land would give people on the

periphery more of a chance to continue their way of life where they currently live. Kelly did not feel that it would be appropriate to open up the land for hunting and fishing.



In contrast to Gillett and Kelly, another of the interviewees favored hunting in the Rio Bravo Conservation and Management Area. He described how people in his village would shoot the local wildlife whenever they wanted meat to eat because it was cheaper than buying from a butcher. That trend, according to the interviewee, led to the extermination of most of the local animals and resulted in most wildlife avoiding the town. He explained that while most people do

have enough farmland to cultivate, he hopes that the Rio Bravo Conservation and Management Area might be opened up and used for hunting and fishing purposes, thereby giving his community an inexpensive supply of meat. This interviewee was also vocal about other issues, including taxes, power tools, and oil costs and “spotlight” taxes, which are ad hoc, local taxes.

## RESULTS

A number of concerns emerged from people living on the periphery. On the one hand, farmland seems plentiful for everyone who would like to farm, but available farmland is not being cultivated. One interviewee emphasized the expense of diesel (about \$5 U.S. per liter) and the scarcity of power machines and tools, preventing isolated families from using the land they own. Another concern pertained to perceived breakdown in governmental promises to transport or process the goods from farms, making large-scale farming operations less likely. Without government assistance the cost of the human labor needed would be too great for farmers to bear. These factors make arable land underutilized.

The San Carlos situation does seem to be an exception. In this place cooperative farming provides enough hands to cultivate the land. The large quantity of goods produced allows for both selling abroad and consumption by the community. Despite this, difficulties have arisen for San Carlos. The town was the victim of a scam when they sent a crop of habañera peppers to Florida but never received any compensation. Problems like that are exactly why farmer-government relations need to be improved. In the end, farmers need support to safely sell their products abroad.

The message that came out during the interviews is that the Rio Bravo Conservation and Management Area is, in fact, very beneficial to the people on its periphery, offering environmental stability and ecotourism. In the grand scheme of things, opening it up even to just the locals might cause the destruction of precious forest and wildlife through the use of traditional slash-and-burn techniques. What the people on the periphery of the Rio Bravo Conservation and Management Area need are better roads, funds to afford powered farm equipment, and governmental policies that support the efforts of farmers to rise above subsistence farming.

## REFLECTION

While much remains to be done to apply research findings to the actual improvement of the communities on the Rio Bravo Conservation and Management Area periphery, many goals have been met through the

schema of Integrated Natural Resource Management, the framework developed by the International Agricultural Research Centers (Sanchez, Palm, and Buol 2003). This year's research has recognized the periphery farmers' need for economic growth and empowerment within decision making processes.

Interviews and other types of research have isolated the specific areas in which farmers could use help. The research of the WATER Project has revealed competing interests of the Rio Bravo Conservation and Management Area and its periphery members. Research also suggests that working together to form flexible policies that favor all concerned may best benefit the region. It is my hope that with the dissemination of data collected by the members of the McMaster expeditions to Belize, policies will be adopted to maintain the Rio Bravo Conservation and Management Area while taking action toward ending poverty on its periphery.

## REFERENCES

- Caribbean Development Bank. 2002. *Poverty assessment report: Belize*. Prepared by Kairi Consultants and National Assessment Team of St. Belize, report no. 495. <http://ambergriscaye.com/BzLibrary/trust495.html>.
- Ministry of Agriculture and Fisheries. 2004. *Annual Report*. <http://www.agriculture.gov.bz/Publications.htm>.
- Programme for Belize. 2000-2003. <http://www.pfbelize.org>.
- Sanchez, Pedro A., Cheryl A. Palm, and Stanley W. Buol. 2003. Fertility capability soil classification: A tool to help assess soil quality in the tropics. *Geoderma* 114:157-185.







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