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Article Title	Haiti Calls for Soil-Fertility-Rejuvenation, Soil-Erosion-Amelioration, and Afforestation

Article Preview

The following text will unveil the thought-provoking truth of why Haitians turn out to be consuming "dirt cookies", a local food made of edible clay from Haiti's Central Plateau.

Full Article Text

Geographically, Haiti is located at Hispaniola Island in the Caribbean Archipelago, and shares the island with the Dominican Republic. Long known as the first Latin American Republic founded by a slave uprising[1], Haiti deeply embraces the spirit of independence as a national ethos. However, what happened next did not align with the brightness of Haiti's resplendent history. Haiti is now one of the most underprivileged countries in the western hemisphere. To seek for the answer to the implicit transition, investigators have to first trace back to the 17th century. (figure 1) (figure 2)

Before Haiti succeeded in the revolution, it was a French colony, and was named Saint-Domingue. At this point in time, the plantation was the main force of economics. The economic crops were originally tobacco and indigo, and later cotton, sugarcane, and cocoa bean. In order to maximize the economic benefit, all the previously unused lands were utilized to the maximum. Sugarcane was planted on the moist plains, cocoa was sowed on dry hills, and people planted cotton on dry plains. Some remote or nonarable places were instead used for raising cattle. Solely in 1767, Haiti exported 72 million pounds of raw sugar and 52 pounds of white sugar to Europe.[2] Such high efficiency in production raised economic success in Haiti, but the cost was unmeasurable. The yearly repeated cropping pattern exhausted the nutrients in the soil and reduced the soil fertility. Because the rate of inputting nutrients into the soil is less than the rate of using the nutrients, it is conceivable that the yield was reduced due to the decreased nutrient in the soil. (figure 3) (figure 4).

Even worse, some lands naturally are not suitable for the crop. Alexis et. al. found a surprising fact that on the southern border between the Dominican Republic and Haiti, soils in some areas have a high content in **Cadmium** and other heavy metals, and they originate naturally in the **geological substrate**.[3] The presence of Cadmium in high content definitely dwindles agricultural production[4, 7], and, together with the contamination of water and food by **aflatoxin**, human health is in jeopardy.[5] Because of the undesirable hazard and underdeveloped economy, people emigrated out of the land of Haiti, and the emigration peaked right after the independence.[6]

Edgar Griffin, an 80-year-old resident living in the town of Petit Goave, said the agricultural condition deteriorated a lot since he was young. Peasants living down on a hillside of the town once attempted to grow peanuts but failed because of the poor soil condition: fertile topsoil are

washed away by rainfall and run into the ocean. There are many factors that lead to the soil erosion, including **land gradient**, rainfall patterns, **deforestation**, soil types, and the unsustainable farming practices.[8]

"Haiti" in the indigenous Taino language means "land of high mountains". Haiti is mountainous, where over half of the terrain has a slope gradient exceeding 20%[11]. When it is raining, the rainwater can run down the hill easily and carry the water-soluble nutrients. This decreases the amount of nutrient in the soil. Before the trees were removed, they served as a safeguard of retaining soil and their quality. The roots of trees penetrate deep down the ground and attach the soil firmly. Once the trees are removed, they do not perform these ecosystem services anymore. The deforestation makes the soil less likely to stay on the hill. Haiti is already naturally susceptible to **soil erosion**[9], not to mention people are constantly operating unsustainable economic practices on the land. (figure 5)

The weather patterns in Haiti also contribute to soil erosion. Haiti has a tropical climate with two rainy seasons with drought seasons alternating in between[11]. Such weather patterns polarize the climatic conditions and make Haiti either too moist or too arid. In watery seasons, rainfall washes off the topsoil, while in dry seasons wind picks up and carries the soil away.[9, 10] Time is proceeding, and it gives no exception to soil erosion in Haiti. (figure 6)

Deforestation is severe in Haiti. On the one hand, people removed the forest to grow economic crops, since the leaves of the trees blocked the sunlight and therefore decreased **photosynthesis**, and on the other hand, residents cut down trees for energy supply or commercial exchange. People outside of Haiti have criticized their unsustainable logging practice, but at this stage, burning charcoal is the main source for Haitians to get energy. The consequences of deforestation spiral out of reach. The absence of firmly attached roots makes the soil less adhered, and wind and rain carry the **topsoil** away. Deforestation and the polarized weather pattern incur a synergistic effect to the soil degradation in Haiti.[8,13] (figure 7)

The soil type is another biophysical contributor to the soil infertility and erosion in Haiti. The **pedogenesis** in Haiti results in four major subtypes, which are known as Udepts, Ustepts, Fluvents, and Udults. Udepts and Ustepts are capable of supporting forests and grasslands respectively, while Fluvents are relatively sandy, which makes them less competent in holding water-soluble nutrients. To Fluvents, the rate of erosion exceeds the rate of soil formation, so they are destined to undergo soil erosion. Udepts have low native fertility and require additional nutrients to facilitate regular crop production.[8, 12] According to the soil profile in Haiti, good quality soil is of minority. (figure 8)

Human activities in Haiti accelerate the process of soil erosion and infertility. In 2017, the population in Haiti reached 10.98 million. In light of the constantly growing population, the nutrient demand is correspondingly rising, and it exceeds the national regenerative ability of the soil.[8] The rural population on average is 300 people per square kilometer, and 85% of the total population uses fuelwood as a source of household energy, which translates to a large logging demand for wood. Because of the widespread poverty, people have little access to **synthetic fertilizers**, and it leads to almost no replenishment of the mineral, furthermore contributing to the deficit in soil

nutrient. Because of the lack of agricultural product, some people make and consume “dirt cookies” to pacify their hunger. The “dirt cookies” is made of clay from Haiti’s Central Plateau, and they are not guaranteed to be safe to human digestive system. (figure 9) (figure 10)

When considering the whole picture, deforestation could be considered one of the most ferocious culprits of the Haiti regression. It could be traced back to the French Colony era when Haiti was manipulated as an instrument of economy. The colonial cut down the trees for energy supply, and made furniture from mahogany. After the 13-year-long Haitian Revolution, the former slaves stood on the land as both the winner of the war and the owner of the land. However, Haitians developed and expanded the economics alone the previous system, the deforestation was not come to a pause.[15] The Deforestation leaves the soil unattached, which leads to soil erosion and **infertility**, consequently decreasing the yield of agricultural product. With the population surging up, the already limited amount of food becomes scarce. Economically, at this stage, people switch to product substituting. Whereas the demand for food is almost perfectly inelastic in Haiti, people find no **substitution** in the short run and few substitutes in the long run. However, people see food as a necessity, and it is crucial to humans’ lives. In this case, the local residents resort to making “dirt cookies”, and claim the edible clay supplies nutrients and minerals in a fulfilling way. Haiti is definitely in need of soil-fertility-rejuvenation, soil-erosion-amelioration, and **afforestation**.

Sadly, Haiti is frequently attacked by hurricanes and earthquakes. The governmental revenue falls short in recovering the loss from natural disasters, not to mention ameliorating the environmental conditions. In 2010, the aftermath of the 7.0 $\mathbf{M_w}$ earthquake leaved Haiti 200,000 death and 1 million homeless, and almost all the industries and structures were destroyed by catastrophic disaster. This incident posted an approximately $7.8 billion total damages.[16] Even more saddening, Haiti is now the poorest country in the Western Hemisphere.

In response, many people take actions to assist Haiti in dealing with the conundrum. The Church of Jesus Christ of Latter-Day Saints donated 40,000 trees to Haiti in 2013, and about two thousand Mormons and their neighbors participated in the planting.[17] Deforestation is a historically existing problem, and has exasperated the environmental conditions. In this sense, planting trees serves as anti-deforestation, and it is a potential path to lessen the pain. (figure 11) Eden Reforestation Projects (ERP), a nonprofit organization, is gathering donation for planting trees and plants. In the past 3,215 workdays, they planted 321,500 trees in Haiti. Their two current projects focus on the afforestation in both North and Central Haiti. Based on the geographic difference, they plant mangrove in the coastal North Haiti, and citrus, mango, papaya, moringa trees in Central Haiti.[14]

As people across the nations provide solutions to the situation, some aspects of the puzzling problem are met with breakthroughs. Since 2006, Sustainable Organic Integrated Livelihoods (SOIL) has devised ways to transform waste into resources. They give away toilets to households, and collect and transport the waste to their treatment sites for the transformation into compost by **thermophilic composting**.[18](figure 12) If they are not given SOIL toilets, Haitians otherwise have almost no access to clean toilet, and the unmanaged human waste will be a

potential hazard in contaminating the limited water sources. SOIL toilets not only make a management to human wastes, but also magically paves a way in bringing nutrients to the soil. Until last year, SOIL gave accessible toilets to over 6500 people, and during last year, 510 tons of waste were transformed into agricultural grade compost.

By consulting an erudite scholar and educator, Steven K. Lower, there exists some potential engineering and chemical approaches in solving the soil erosion problem in Haiti. One of the most feasible one comes to planting cover crops on the hillside. Grass, for instance, is capable in its liquid retention. When the rain falls, the cover crops such in and store the nutrient-containing water before it runs all the way to the river. Additionally, cover crops help in increasing soil quality. As a plant dies or a petal falls, they remain in the soil and are gradually decomposed by microorganisms. Through the decomposition, the nutrients are given back to the soil.

Though some experts state that it is too late for Haiti to take actions, when there is progress, there is hope.

Search Words

Haiti, deforestation, soil infertility, erosion, economy

Figure Legends

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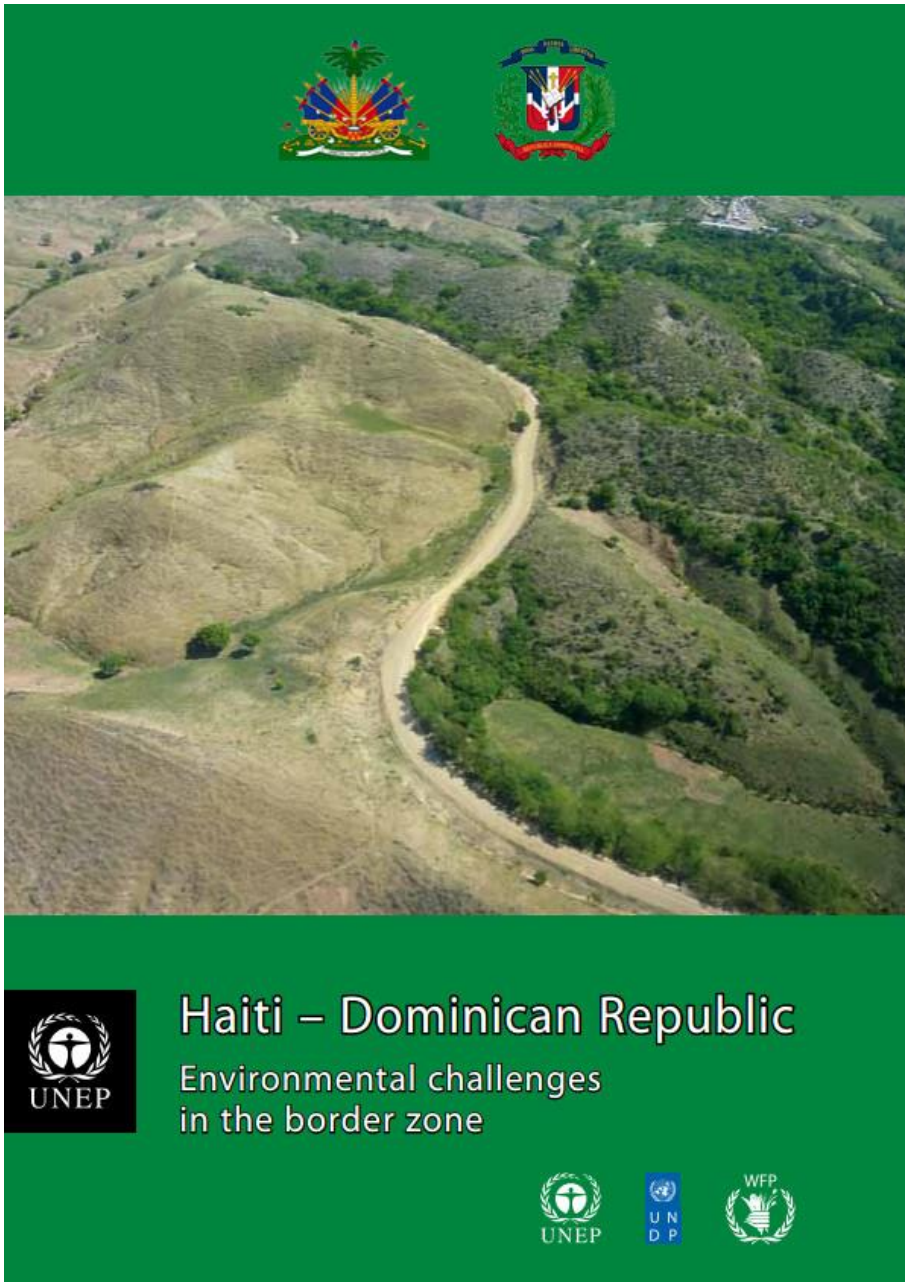
Glossary

Cadmium ----- a toxic chemical element symbolized Cd with atomic number 48
geological substrate ----- consists of soils, sediments, mineral, and bedrock, functions as carrying or storying water
aflatoxin ----- a toxin produced by certain fungi that are found on some agricultural crops
land gradient ----- measure the steepness of the terrain
deforestation ----- remove forest for other use
soil erosion ----- displacement of upper layer of soil, known as one form of soil degradation
photosynthesis ----- the way plant synthesize foods from CO_2 and water with sunlight
topsoil ----- the upmost layer of soil, have the highest concentration of organic matter
pedogenesis ----- the formation of soil
synthetic fertilizers ----- man-made inorganic compounds
infertility (soil infertility) ----- when soil not able to sustain agricultural plant growth
substitution ----- a good or service that can be used in place of another
afforestation ----- planting trees
$\mathbf{M_w}$ ----- moment magnitude scale (MMS), one seismic magnitude scale used to measure the size of earthquake.
thermophilic composting: the practice of breaking down biological waste with thermophilic (heat-loving) bacteria

Figure 1



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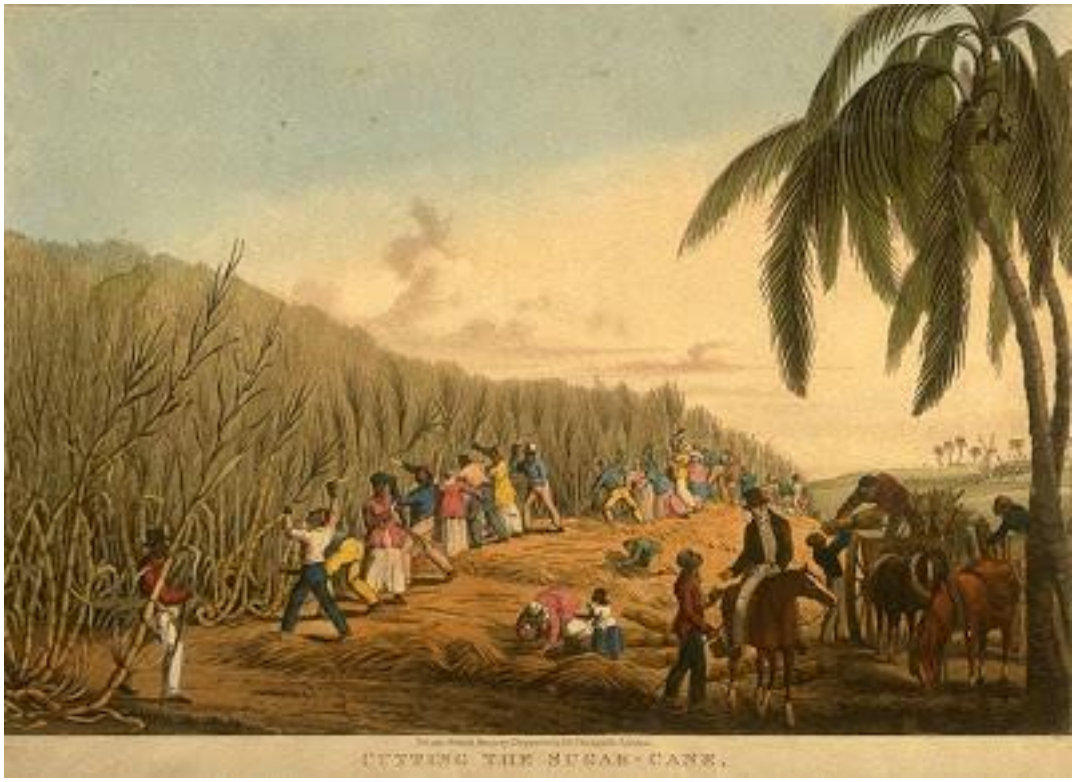
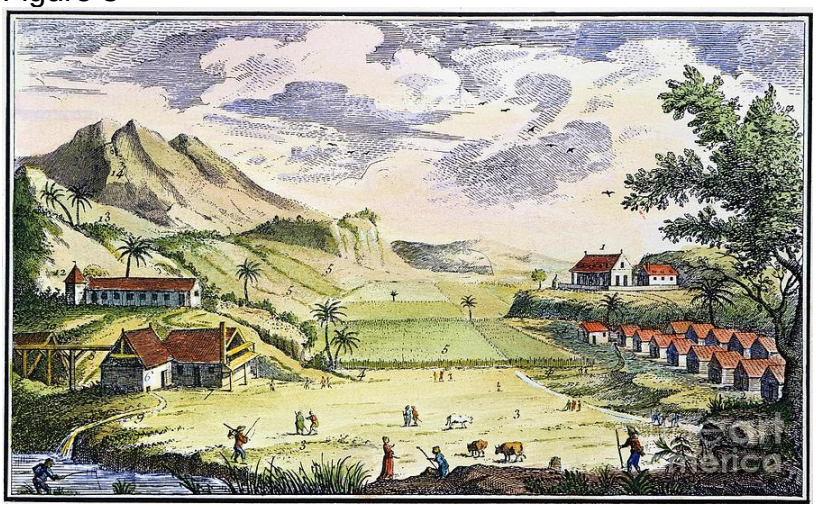


Figure 3



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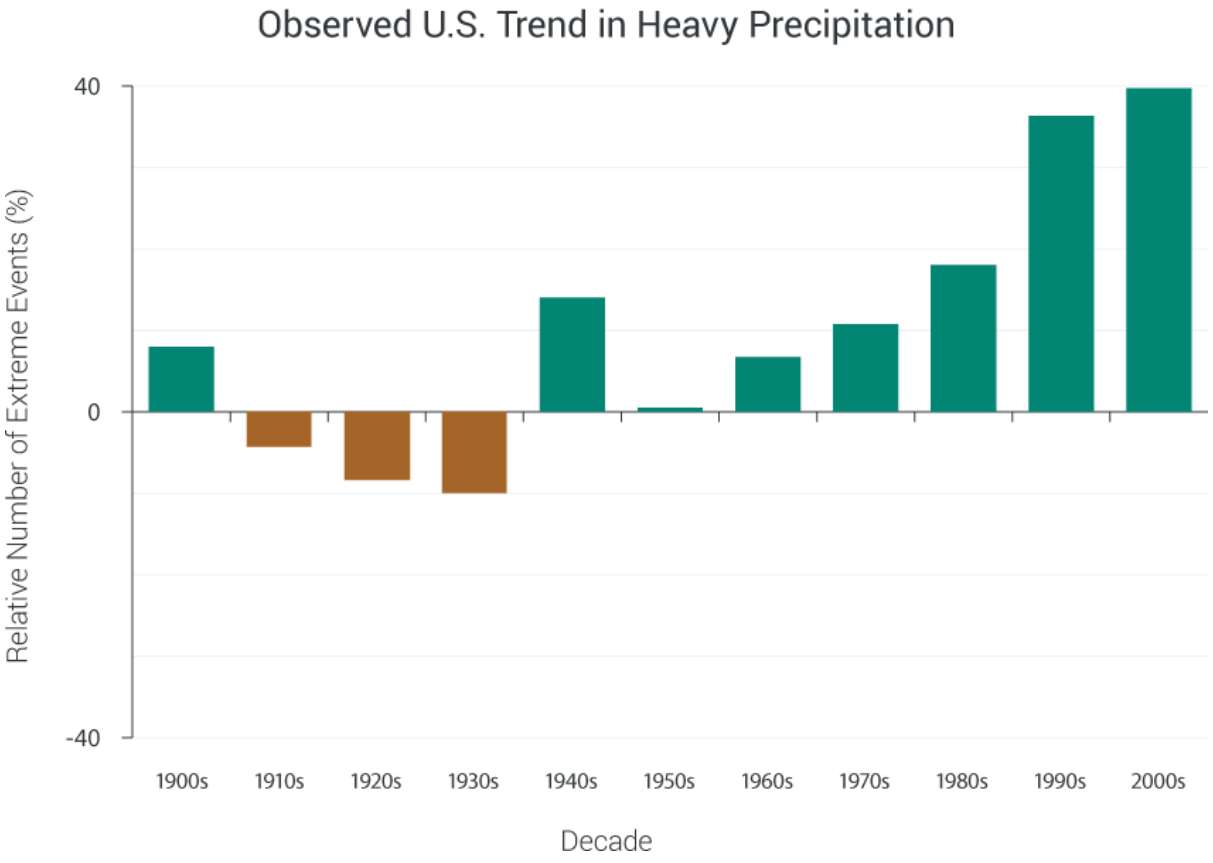

Figure 6

Figure 7

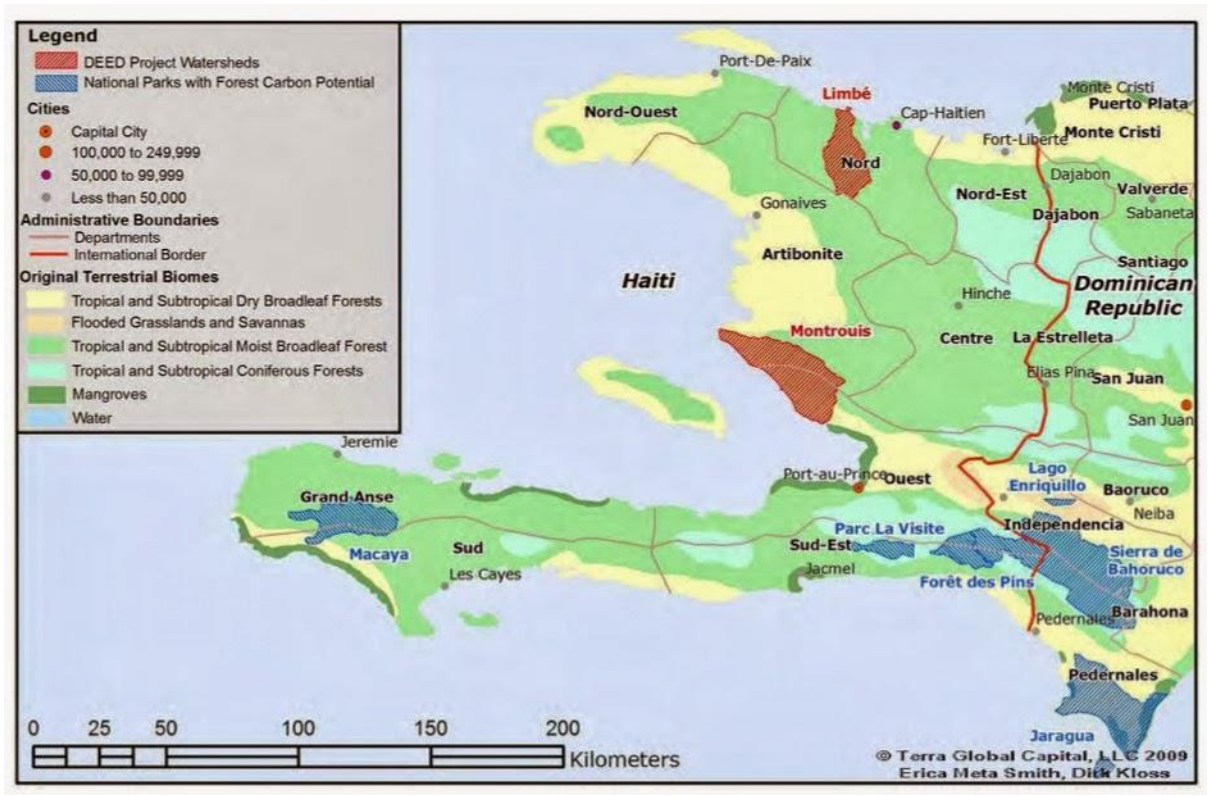

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12