

Guánica Bay/Rio Loco Agenda to Neutralize Detrimental Inputs (GRAND)



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Mission Statement:

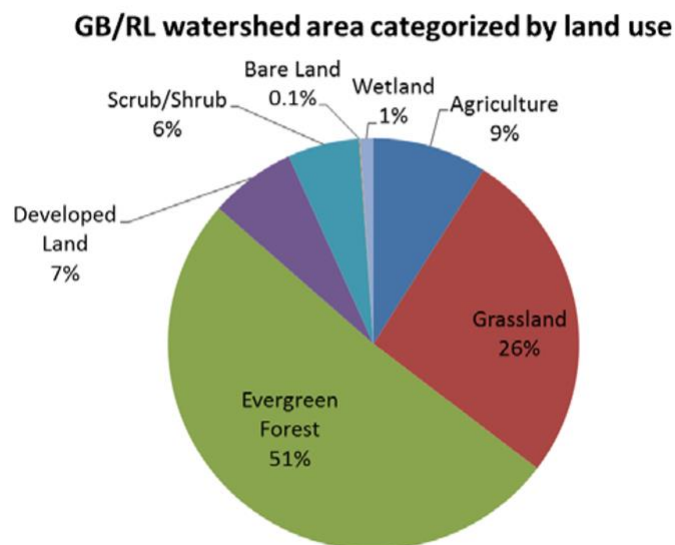
GRAND's mission is to attain the classification of fishable water quality standards by the EPA in the Guánica Bay/Rio Loco Watershed in the Southwestern corner of Puerto Rico by the year 2040.

Historical Background

Founded on August 12, 1508, Juan Ponce de León landed in the harbor. Ponce de León established a town which he named Guaynía, a word derived from the Taíno indigenous culture. Guaynía is believed to mean "here is a place with water" (CWP). The town of Guaynía was initially the capital of Puerto Rico; until, it was destroyed during an indigenous uprising of 1511.

In 1898, Guánica became the location where General Miles and the U.S. troops landed to take Puerto Rico from the Spanish during the Spanish-American War. This invasion, a small part of the war between Spain and United States, occurred in Guánica due to its sheltered harbor and proximity to Ponce, besides being such an unexpected site for such an attack, which had been anticipated at the heavily fortified city of San Juan. While just one small part of the war, this invasion helped lead to the acquisition of Puerto Rico by the United States.

Once re-founded, Guánica first became a part of the municipality of Yauco until March 13, 1914 when it was established as a separate municipality. Located near the town of Guánica is a body of water known as Guánica Bay. Guánica Bay, located in the southwestern corner of Puerto Rico, approximately 20 miles west of the city of Ponce and 100 miles southwest of San Juan, is the discharge site of the Guánica Bay/Rio Loco (GB/RL) watershed (Rodriguez). The GB/RL watershed differs from typical island land use due to its extensive mountainous forest cover in the north and the extensive Guánica Dry Forest in the southeast portion of the watershed. The current land use in GB/RL watershed specifically (based on natural hydrology) is 48% forested, 43% agriculture (Lajas Valley) and 9% urban (Yauco) (CWP). The watershed is approximately 151 square miles due to human alteration.

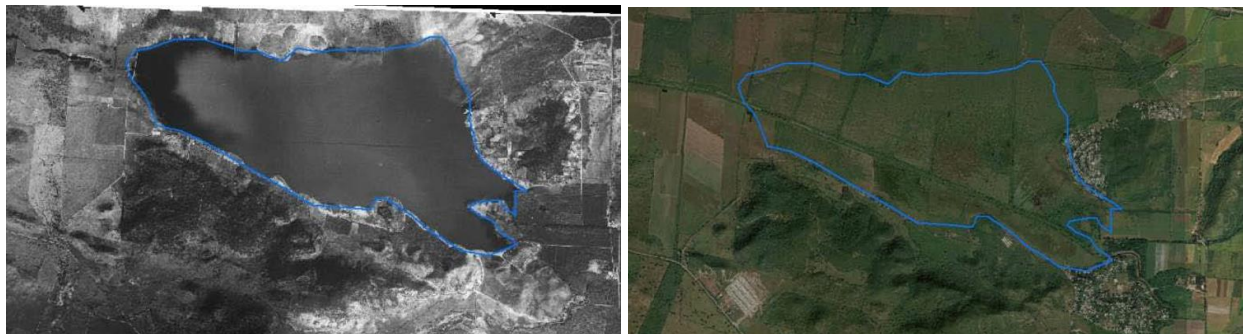


One major form of human alteration was done in an effort to increase the drainage area of the watershed (Rodriguez). This alteration was done by a series of inter basin or inter-watershed water transfers, five reservoirs and two hydroelectric plants. In addition to an increase in drainage area, another hope for the alteration was to increase and regulate potable water from the high elevation watersheds of the central cordillera (mountain region) for use by the local populations in Yauco, Guánica, and the Lajas Valley for irrigation of crops and flood control. Guánica Bay only receives water directly from the Rio Loco (“Crazy River”), but the actual total drainage area encompasses much more. Included in the total drainage area are the five smaller basins and associated reservoirs: Yahuecas Lake, Guayo Lake, Prieto Lake, Lucchetti Dam, and Loco Dam. Guánica Bay is essentially drained by both the Rio Loco, which receives flow from the four reservoirs north and upstream of it, as well as by historic Guánica lagoon.

Despite the large increase in contributing drainage area, the Rio Loco is usually without any base flow with the exception of intentional release of water from the Loco reservoir once every month or so and during the rainy season from August through October (CWP). Mean annual rainfall for Puerto Rico is 63 inches. But in this watershed, the rainfall regime varies significantly with elevation from 35 inches at sea-level in Guánica Bay to 80 inches at roughly 3000 feet at the highest point in the watershed in the cordillera.

Additional forms of human alteration on the watershed include the high levels of deforestation that the water has historically experienced. This deforestation has mainly occurred during sugar cane cultivation on the majority of arable land in the watershed. In addition, during the 1950s, the Southwest Water Project greatly increased the headwater land area draining to the Rio Loco including significant amounts of highly erodible soils where the majority of coffee growing areas are located.

The ditching and draining of Guánica Lagoon, a large historical lagoon and adjacent wetland system, in the 1950s had a profound effect on the filtering capacity in the watershed because the lagoon acted as a huge sponge and filter before Rio Loco passed into the Guánica Bay. In the photos below, the picture on the left represents the lagoon before the draining and the photo on the right shows the area where the lagoon once was as outlined by the blue line.

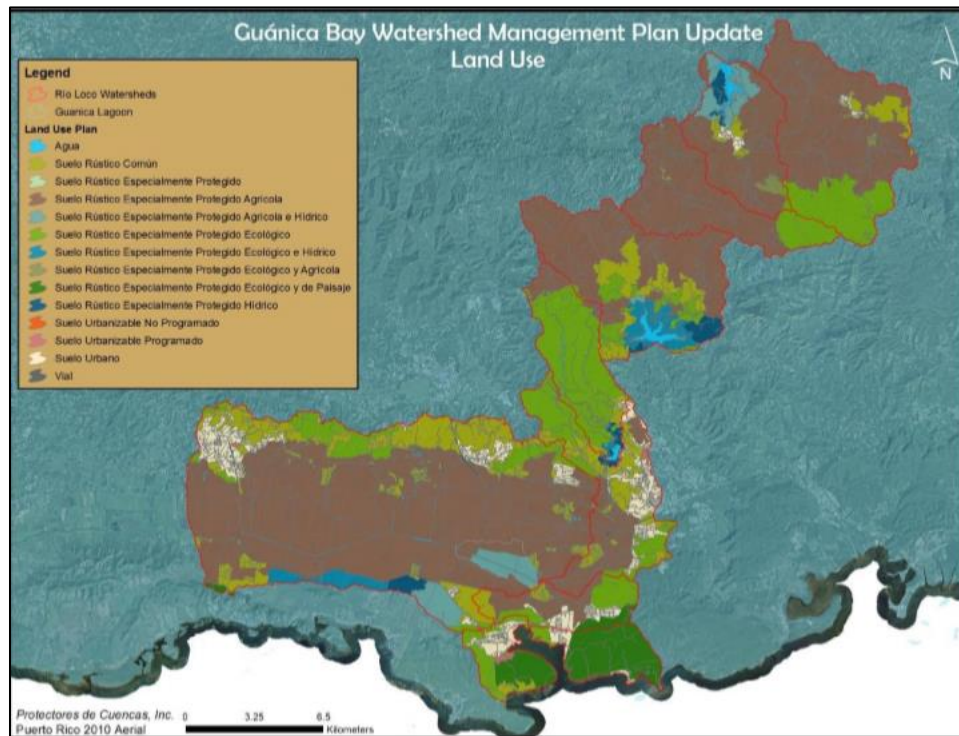


Policies and Mandates in Place

Historically, Guánica Bay was associated with some of the most extensive and healthy reef complexes in Puerto Rico. However, coral reefs have experienced an unprecedented decline over the past 30-40 years. In addition, an outdated infrastructure from the 1900s has led to a system where storm water, wash water, and sewage all mixed carrying a cocktail of contaminants into a large open vault before being pumped several times a day into Guánica Bay (Espinoza). In response to these environmental

challenges, the National Atmospheric and Oceanic Administration (NOAA), the Puerto Rico Department of Natural and Environmental Resources through the NOAA Coral Reef Management Fellow in Puerto Rico and in partnership with the Center for Watershed Protection, created Guánica's first Watershed Management Plan in 2008.

Since its creation in 2008, the plan have been updated once by the Protectores de Cuencas and their partners in 2014 (Rios, 2018). This update was done to address the EPA's nine elements of a watershed management plan to the greatest extent reasonable. In the revision, an updated watershed characterization based on new develop land use information provided by the Puerto Rico Planning Board was also used and can be seen in the image below.



Top priorities of the revised Guánica Bay watershed management Plan included: revising the original Guánica Bay Watershed Management Plan in order to meet EPA's A-I criteria, continuing support for restoring Guánica Lagoon, conducting community outreach, building local capacity to address the impacts of LBSP, strengthening partnerships between government agencies, academics, agriculturalists, coral reef managers, and other stakeholders.

Problem 1: Coral Degradation

Guánica Bay / Rio Loco is known for their agriculture, sun grown coffee. However, such agriculture needs certain criteria to be grown. In order to do so, very little conservational practices were put in place. Thus, the environment was left damaged. Coral reefs are vulnerable to sediment and pollution that originate from anthropogenic causes. High levels of contaminants lead to the destruction of coral reefs.

Since the 1900s, urbanization and use of agriculture of the areas around the watershed have caused detrimental issues. Pollution from different sources including oil spills, sugar mills, fertilizer plants, textile companies, and sugar and coffee plantations are deposited into the Rio Loco (Kumar 2015). The exposure of nutrients and contaminants from mass clearing, construction, as well as exposed soils from pre-existing condition elevated the level of pollutants in the water. Because of man-made alterations for agriculture and deforestation, the watershed was highly contaminated with several chemicals such as nitrogen, sediment, and polychlorinated biphenyls (PCBs). Urbanization has increased the population in the watershed area and have increased impervious cover. Due to the drastic adaptations in the environment, there was a flood of nutrients, bacteria, PAHs, and heavy metals infiltrated the watershed (CWP 2008). In lieu of population increase, sewage treatment was not considered in the development. Thus, much of the sewage was discharged to the ocean and rivers. Over the last couple decades, the health of the reefs have significantly declined, where it is estimated that live coral loss is greater than 50% (Wilkinson 2011). In order to preserve the reefs, several practices must be implemented to prevent further contaminations.

Goals

GRAND proposes to build basins in Lower Rio Loco to contain the sediment from reaching the reefs and to partner with several organization like the USDA or NOAA to stabilize the river banks along the Lower Rio Loco. Another proposed plan is to hydroseed the land with highly erodible soil. By practicing hydroseeding, the soil remains in place and prevents the sediment from reach the bay while it is fertilized. Instead of having lands dedicated to sun grown coffee, supplement with shade grown coffee. Organizations like NRCS and NOAA are willing to aid and educate farmers with conservation practices. Moreover, the main goal is to reduce the rate at which coral reefs in Guánica bay are dying by enforcing conservation practices.

Problem 2: High Nitrate Levels

With 43 percent of land in Guánica Bay being used for agriculture, local farms play a major role in the health of the watershed (CWP). When animal manure or nitrogen based compounds are used as fertilizers, rain carries these compounds to nearby streams and aquifers. Human sewage also greatly affects nitrogen levels (Perlman, "Nitrogen and water"). Because nitrogen is necessary for plant growth, large amounts allow algae to rapidly accumulate, leaving a dark, green layer on the water's surface. Algal blooms block the sunlight needed by aquatic plants and other algae for photosynthesis, depriving the water of dissolved oxygen (DO). In addition, bacteria consumes the DO needed by fish when decomposing this algae (Texas A&M). This is detrimental to wildlife since aquatic organisms do not use the oxygen that makes up water, but rely on dissolved oxygen, "ten molecules of oxygen per million of water" (Perlman, "Dissolved Oxygen").

The EPA set the maximum contaminant level (MCL) as 10 ppm for nitrate-nitrogen and 44.3 ppm for nitrate (Oram). These values are based on how toxic nitrates are to infants, but meeting this requirement will ensure a reduction in algal blooms. In 2013, in Guánica Bay, nitrate levels were measured to be .010 ppm while Nitrite was .004 ppm (Whitall). Contrastingly, in 2018, researchers at the University of New Hampshire found that nitrate levels were high nine months after hurricanes Irma and Maria. Nitrate levels had begun to drop back down four months after previous hurricanes, but remained high after these two recent hurricanes (University of New Hampshire).

Sources of nitrogen in Guanica Bay stem from nearby farms where cattle are raised for meat and dairy, and where rice is grown on a large scale. The rice industry accounts for a large portion of fertilizer use, while cattle production yields natural fertilizer (manure) which also contaminates the watershed (Rios, “Lajas Valley...”). Guanica Bay has a local fertilizer plant located right on the bay, shown below. The image on the left shows the plant located south of local farms, and the image of the right is a close up.



Goals

Due to Hurricane Irma and Maria, Puerto Rico is still recovering and would benefit more from financially frugal options. GRAND proposes the use of aquatic buffers. Buffers have several zones of forest and turf that utilize excess nutrients, preventing them from entering waterways.

Constructed wetlands reduce nitrates, among other nutrients, before they enter nearby waterways. These wetlands are most effective when surrounding a source of contamination, such as a wastewater treatment plant, or a contaminated waterway (Rios, “Implementation...”).

Shade grown coffee is known to reduce the need for pesticides as the plants balance extreme nitrogen levels. Shade grown coffee encourages bird diversity, resulting in a decrease in insects harmful to the plant. Without invasive insects, there is less need for pesticides that would have contaminated nearby water. Additionally, the surrounding trees and vegetation that provide the shade help to nourish the coffee plants when leaves fall into the soil, replacing fertilizer use (Byloos). GRAND proposes to continue this idea, benefitting Guánica Bay’s economy while also restoring its watershed’s health. Between 2007 and 2013, 32,000 coffee plants were planted by coffee farmers. As mentioned previously, nitrate levels were several orders of magnitude below the maximum contamination level in 2013, after shade grown coffee was implemented for several years. GRAND intends to donate 30,000 more shade grown coffee plants by 2040 to reverse the effect of the recent hurricanes on nitrogen levels (Almodovar). In order to do so, there are many organizations that are willing to help and provide incentives to the practice change. By evolving from old agricultural practices, nitrate levels will be reduced.

GRAND’s ultimate goal in regards to nitrogen levels is to reduce nitrate-nitrogen to 10 ppm by the year 2040.

Problem 3: Erosion and Sediment Transport

Guánica Bay has been altered frequently to fit human needs in the past century. Its drainage region has been artificially increased with inter watershed transfers by a series of reservoirs and hydroelectric plants. Thus, the total drainage area is greater than Rio Loco watershed. Growth in agriculture and lack of erosion reduction techniques have led to harsh erosion along the Rio Loco. River bank erosion is so extreme in some locations it has begun to reduce the area of usable farmland. (Rodriguez) Urbanization, as well as deforestation due to agriculture, have also increased soil and channel erosion. A lack of mature riparian trees and old irrigation infrastructure worsened the erosion issue. Because of harsh erosion and a combination with other major factors including unstable, dirt roads and sun grown coffee, and abundance of exposed soils result in high levels of sediment transport. The watershed is also affected by high annual rainfall, occasional hurricanes, and steep slopes with unstable soils creating accelerated sediment transport. Excess sediment draining into the Guánica Bay also has negative effects on the fragile corals. Sediment loss is also affecting various reservoirs in the region. By 2000, Lago Loco, a reservoir owned by Puerto Rico Electric Power authority, had lost 64% of its original carrying capacity. If sediment accumulation continues at a similar rate the reservoir will become nonfunctional. (Soler-López)

Goals

GRAND proposes to remove the remaining abandoned infrastructure sites along Rio Loco that were increasing erosion forces along with bank stabilization projects. Bank stabilization will include planting native trees and hydroseeding in areas of bare soils which was mentioned before. This will reduce sediments flows and stop the severe bank erosion, which also helps coral conservation. Another project we plan to pursue with the coordination of farmers is stabilization of dirt roads on coffee farms and other agricultural areas. This will decrease the sediment transfer and help increasing the life span of the Lago Loco reservoir.

GRAND Summary of Goals

GRAND aims to improve the GB/RL watershed in order to provide a safe environment for the people and restore the environment to better conditions. This plan is meant to provide practical steps towards a healthier and safer environment, not only for the people but the plants and animals as well. Building off of the 2008 Watershed Plan that have already been developed, the GRAND plan provides additional goals as well as altered goals to work towards improved water quality in Guánica.

A summary of the goals mentioned in this plan are listed here:

- Build basins/wetlands to contain the nutrients
- Introduce new agricultural methods such as hydroseeding
- Implement more farms to practice shade grown coffee
- Ensure nitrate levels are at 10 ppm or below throughout the watershed
- Carry out bank stabilization projects along the Rio Loco

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