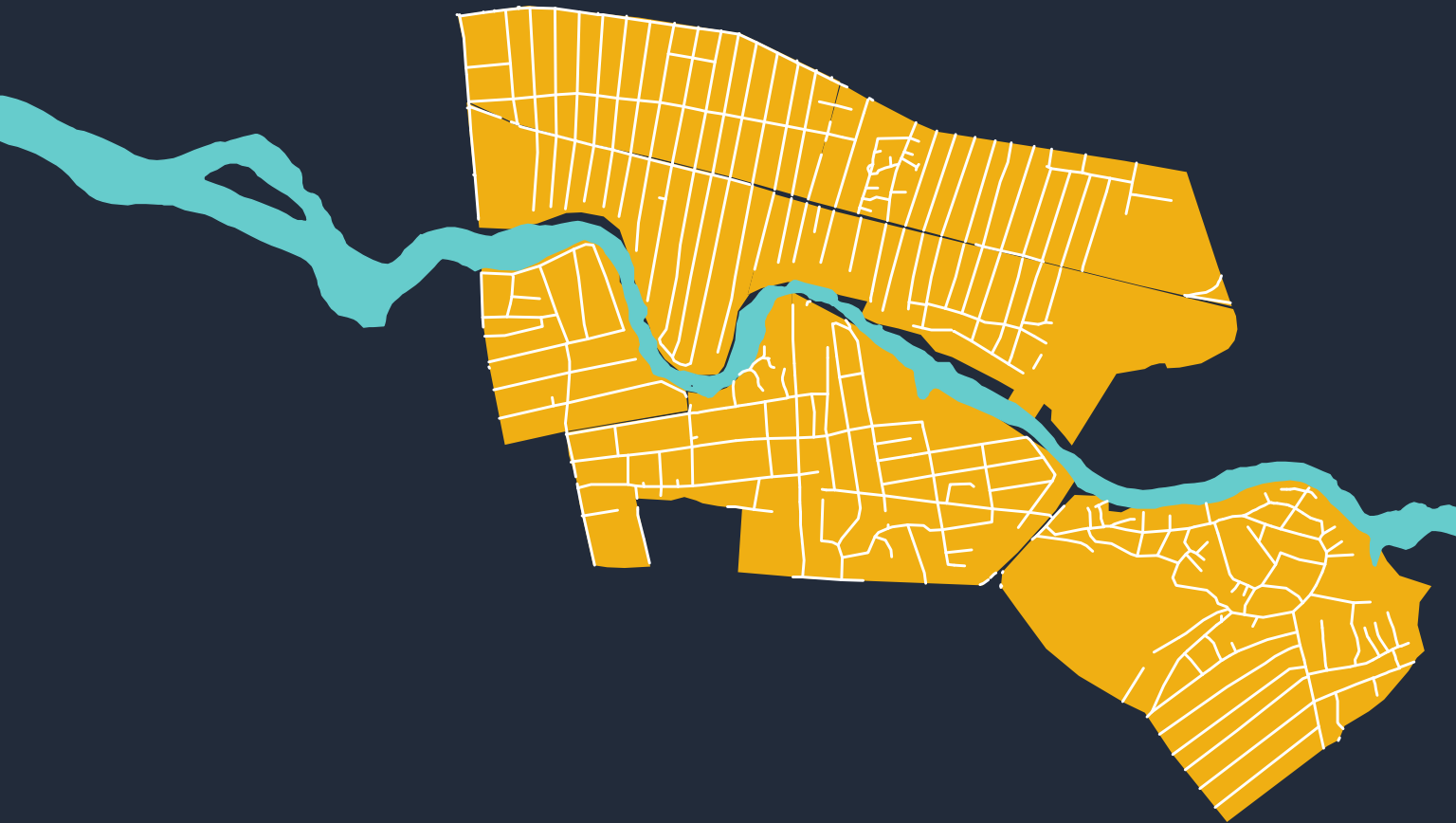# Puerto Rico Planning Studio Final Report

Georgia Institute of Technology
School of City & Regional Planning
Spring 2019

Puerto Rico
Planning Studio
Final Report

Georgia Institute of Technology
School of City & Regional Planning
Spring 2019

Acknowledgements

This Studio would not have been possible without the generous support of the American Planning Association (APA) Foundation, which provided essential funding through their first round of Disaster Recovery Grants. Students would like to thank the APA for believing in the idea and helping to carry it to fruition. In addition, students would like to thank Georgia Tech's Career, Research, and Innovation Development Conference (CRIDC) supporting Studio activities through funding provided from their annual poster competition. This Studio also would not be possible without a strong partnership with the Graduate Planning School of the University of Puerto Rico, which provided essential on-the-ground support, logistics, coordination, and communication functions. Finally, students would like to thank staff at ENLACE, the Land Trust, community leaders in the G-8, and external stakeholders for their generous time and feedback that has helped guide this project.

CLIENT	FACULTY
ENLACE	Dr. Alberto Fuentes (GT)
	Dr. Catherine Ross (GT)
	Dra. Criseida Navarro Díaz (UPR)

STUDENTS AT GEORGIA INSTITUTE OF TECHNOLOGY

Anna Baggett	Laura Geronimo
Adam Borsch	Jennifer Johnson
Paul-Emile Brice	Nicholas Johnson
Carson Cooper	Roberto Morales
Paul DeMerritt	Ryan Schlom
Mirit Friedman	William Tucker
Meng Gao	

STUDENTS AT THE UNIVERSTIY OF PUERTO RICO, RIO PIEDRAS

Misael Correa Robles
Juan Seguí Cordero
Génesis Tayché Collazo
Roberto Torres Torres

OPPOSITE Image of the Georgia Tech City Planning class. Photo courtesy of Jennifer Johnson.

Contents

"*The simple things are also the most extraordinary things, and only the wise can see them.*"

Paulo Coelho, The Alchemist

OPPOSITE Image from the bicicaño tour. Photo courtesy of Genesis Tayché Rivera.

Contents (continued)

OPPOSITE Pineapple from the community garden on the Bicicaño tour. Photo courtesy of Mirit Friedman.

"The greatness of a community is most accurately measured by the compassionate actions of its members."

Coretta Scott King

Introduction

Studio Conception, Partnerships, & Financing

The Disaster Mitigation and Recovery Studio of 2019 pilots an experimental model in co-designed, student-driven planning studios. Rather than a faculty-led approach, this studio is designed in close collaboration with students and leverages student experience and connections in the studio location. At Georgia Tech, several students in the SCaRP program have close ties to Puerto Rico and the Caribbean region, either being from Puerto Rico or having lived and worked extensively in the region. Concerned with the devastating impact of Hurricane Maria in September 2017, students proposed a studio focused on disaster mitigation and recovery, which was accepted by the SCaRP administration at Georgia Tech. Students drafted a letter of collaboration with the University of Puerto Rico, and obtained signatures from both Universities with agreed upon areas of cooperation, including:

- Designation of faculty to lead parallel studios in both Universities
- Development of exchange opportunities for students between campuses
- Collaboration on joint research projects and the development of products
- Exchange of data and technology
- Collaboration to jointly pursue funding to support the studio efforts

To meet these terms of collaboration for the studio, in Spring 2018 Georgia Tech designated Dr. Catherine Ross, a Harry West Professor of City and Regional Planning, and Dr. Alberto Fuentes, an Assistant Professor of International Affairs and of the City and Regional Planning as studio advisors at Georgia Tech. Dr. Norma Peña, director of the Graduate School of Planning at the University of Puerto Rico, designated Dr. Criseida Navarro Diaz to advise the parallel studio for Spring 2019.

In collaboration with faculty, students helped to draft several proposals to fund the studio, including through the NOAA Coastal Resilience Grant Program, the American Planning Association (APA) Disaster Recovery Grant Program, and institutional funding sources like the Steven A. Denning Award for Global Engagement at Georgia Tech. The only successful proposal was the APA Disaster Recovery Grant program, which awarded $15,000 to support travel costs for the exchange portion of the studio. Through the generous support of the APA grant, the only significant cost students had to cover for the field portion was their round-trip flight.

The partnership with UPR was critical for providing cost-savings, as the University supplied a van and chauffer for transportation as well as a work space. UPR also leveraged its local network to coordinate meetings with the client and local stakeholders, as well as organizing the two final presentations to key stakeholders and officials.

Students also raised an additional $1000 through a poster competition at Georgia Tech's Career, Research, and Innovation Development Conference (CRIDC), which helped to support a kickoff dinner attended by UPR, GA Tech, and the University of Utah, as well as a bicycle ride led by community leaders through the study area. The SCaRP administration generously supported the studio project by helping to subsidize faculty travel. In December 2018, Georgia Tech faculty visited UPR to finalize studio logistics and jointly identify the client for the studio, ENLACE.

Students were engaged in all phases of studio fundraising, planning, and logistics, from conceptualization to booking lodging and maintaining constant communication with all partners. Though students learned a lot through this process, it also placed a significant burden of coordination and fundraising on students. Developing a studio for the first time is a difficult task to manage on top of normal graduate student work load. This model may not be sustainable over the longer term without further support. As such, students have two recommendations: First, students recommend that the Universities and their partners attempt to establish a revolving funding support for student-driven studios. Second, students recommend that Universities establish administrative support and draw clearer lines between faculty and student responsibilities. Despite these limitations, students believe that there is immense opportunity in the co-design model. With the proper support, graduate students with strong local networks can leverage institutional resources to effectively channel planning and technical assistance to communities in need. In this way, Universities and planning departments can grow and become more effective incubators of community resilience.

Studio Objectives

Overall, the studio had two main objectives:

- To develop a transferable model to channel planning assistance to other vulnerable communities – one which captures local and institutional resources and talent.

- To enhance the capacity of next-generation planners to manage climate change issues and devise transferable tools and analytics that strengthen the planning capability of local communities and organizations.

These objectives dovetail with Professor Cecilio Ortiz Garcia's (of UPR Mayaguez) emphasis on identifying gaps articulated by local communities (NCSE, 2018) as the greatest need. The studio forms part of a wave of interventions on the island of Puerto Rico which local universities are working to leverage for disaster mitigation efforts (NCSE, 2018). David Godschalk, a thought leader in hazard reduction, has called for a "hazard mitigation corps" where state universities partner with local communities to provide hazard information and mitigation assistance (Texas A&M, 2019).

The studio also forms part of 'Planners for Puerto Rico,' which is a consortium including the Federal Emergency Management Agency, American Planning Association, Urban Institute, the University of Puerto Rico, the Center for Puerto Rican Studies, and multiple universities and institutions of higher education and the mainland. During the studio visit, faculty and staff at Georgia Tech and UPR had the opportunity to meet with another studio directed by Dr. Ivis Garcia from the University of Utah, who was just finishing up a site visit with her students for a studio focused on the more rural community of Comerio. Linking the GA Tech-UPR studio with other studios and wider planning initiatives on the main island make it part of larger on-going efforts to plan for a more resilient island through transparent, participatory, and effective planning processes.

OPPOSITE Image of Georgia Tech and UPR students on the bicicaño tour. Photo courtesy of Mirit Friedman.

Studio Client

The client for the studio is the 'Corporación del Proyecto ENLACE del Caño Martín Peña' (ENLACE), which is an independent government organization that serves as an umbrella for efforts to alleviate poverty and improve quality of life for eight low-income communities in San Juan, Puerto Rico. These communities are located along a degraded 3.75 mile-long tidal channel that connects two important water bodies in San Juan. These communities developed informal settlements along the borders of the channel, which has since become clogged with sediment, debris and waste. Over 3,000 structures still discharge raw sewerage into the channel (EPA, 2015). The communities experienced severe damage during Hurricane María, and remain vulnerable to climate threats such as hurricanes, sea level rise, and extreme heat. ENLACE is charged with coordinating efforts to dredge the channel and restore its ecological health, while preserving the integrity of the community.

ENLACE emerged after the Government of Puerto Rico designated the Caño Martín Peña (CMP) and neighboring communities as a special planning district in 2002. Extensive participatory planning activities over the next two years led to the creation of Law 489 in 2004, which led to the Comprehensive Development and Land Uses Plan for the Caño Martín Peña Special Planning District (CMP District Plan). The ENLACE corporation was created by the same law with the purpose overseeing the implementation of this plan (Brodine, 2017).

The law and corporation emerged out of grass-roots and participatory planning processes. In English, the word 'enlace' translates to 'link.' This summarizes the function of ENLACE, which is to serve as a link between various partners working to alleviate poverty, reduce exposure and risks to public health, restore that natural ecosystem of the watershed, and improve quality of life for the eight communities in the CMP. ENLACE serves as the umbrella organization for these efforts, and works closely with two other entities within the CMP. The first is the Land Trust, or Fideicomiso de la Tierra del Caño Martín Peña (Fideicomiso). This Land Trust was created by the same Law (#489), with the purpose preventing gentrification that may result from the ecological restoration projects. The second is the Grupo de las Ocho Comunidades Aledañas al Caño Martín Peña (G-8), Inc., which is a non-profit organization composed of community leaders representing the eight communities in the Special Planning District. This group ensures participation of residents in decision-making processes, and works to prevent involuntary gentrification and displacement (Brodine, 2017).

ENLACE has developed many partnerships, and in 2013 it was designated an Urban Waters location that involved 16 federal partners, ten Puerto Rico Agency partners, 13 NGO partners, and the municipality of San Juan (Brodine, 2017). ENLACE and its partners represent a novel and innovative "model of equitable development, resiliency, and participatory democracy" (Rodriguez, 2017). For its work in preventing gentrification and displacement, the Land Trust was awarded the 2015 United Nations World Habitat Award (EPA, 2015).

ABOVE Description of the client organizations (NASA, 2018).

Political Context & the Impact of Hurricane María

Hurricane María made landfall over Puerto Rico on September 20th, 2017, as a Category 4 hurricane with windspeeds of up to 155 miles per hour (Government of Puerto Rico, 2019). The hurricane caused catastrophic damage across the island, impacting all sectors and causing a collapse of critical infrastructure systems. This included a complete shut down of the power and communications grid, disruption to transportation systems including airports, ports, and the road network, and interruptions of food and water supplies. The hurricane halted all economic activity on the island and paralyzed the government.

While originally the official death toll was reported at 64, later studies, such as one released by the Milken Institute School of Public Health at George Washington University, raised questions about these estimates and put the death toll at 2,975, numbers that were adopted by Puerto Rico Governor Roselló (Brindley, 2018). Lack of access to clean drinking water resulted in an outbreak of Leptospirosis, a bacterial illness which spreads through water and soil. At least 26 people died from Leptospirosis, according to a joint investigation by CNN and the Center for Investigative Journalism in Puerto Rico (Sutter, 2018). Over 1 million homes experienced damages, and the blackout in Puerto Rico was one of the largest in history. It took nearly a year to restore power across the island (Sullivan, 2018). Damages across the island are estimated at $94 billion (Government of Puerto Rico, 2019). Recovery efforts in Puerto Rico are made more logistically difficult given that this is an island community. Goods cannot as easily be trucked in like on the mainland, and instead must arrive by boat or airplane.

Hurricane María exacerbates and brings to light existing problems on the island. Prior to the hurricane, the island was in the midst of negotiating how to manage $74 billion in public debt that it has accrued over the past several decades. To manage the debt, the U.S. government passed the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) in 2016, which established a Financial Oversight and Management Board (FOMB) charged with restructuring the island's debt. There is controversy over the role of this entity, given that its members are appointed by the President of the United States, which residents of the territory are not allowed to vote for, and it has absolute control over Puerto Rico's budgets and even veto power over laws adopted by the territory. Further, the Board is rife with potential conflicts of interest. For example, two members of the board, Carlos M. García and

José R. González, previously worked with Santander Bank which issued much of the island's debt in the first place (Meléndez & Martínez, 2017). The Puerto Rican public continues protests against severe austerity measures imposed by the FOMB, including severe cuts to public education, the closing of several hundred schools, raising costs of tuition for University, and cuts to healthcare support and food stamps and other public services (Mazzei, 2018).

ABOVE Image of Hurricane Maria (NOAA, 2017).

Official death toll and displaced persons uncertain...
Estimates of death toll range from 3000 to over 4000

Estimated costs due to
hurricane damages:

$94 Billion

Image Source: Washington Post

ABOVE Damages done by Hurricane Maria (Retamal, 2017).

PROMESA and the FOMB exemplify the complex relationship between the United States and the territory and the ongoing issue of the island's status, which has been a divisive political issue for decades. On the one hand, the independent movement has sought support from the international community. Recently, the United Nations Special Committee on Decolonization has approved a draft resolution calling upon the United States to facilitate the realization of the right of Puerto Rican's to self-determination (United Nations, 2018). On the other hand, a bipartisan group of lawmakers has recently introduced legislation to admit Puerto Rico into the Union as a 51st state (Montoya-Galvez & Begnaud, 2019). The unresolved status issue is a major barrier to developing a stable, equitable, and sustainable economic development model for the island, and has complicated the post-disaster response and recovery process.

In addition, Hurricane María further brought to light severe poverty and inequality across the island. Prior to the impact of Hurricane María, unemployment was at 11 percent, and over 40 percent of the population was living under the poverty line, which is more than triple the rates of poverty on the mainland USA (Government of Puerto Rico, 2019). As the vegetation was stripped away by the hurricane, these problems became more visible. Communities in the Martín Peña Channel are particularly vulnerable to the impacts of hurricanes such as wind damage and storm surge, as well as longer term impacts of climate change, particularly sea level rise. This is due to the nature of the communities and the built environment, which consists of mostly low-income people living in informal settlements built on the borders of the channel. Hurricane María caused significant damage to at least 1000 houses in these communities which had their roofs completely or partially blown away. Many lost material possessions, were without electricity for months, and had limited access to safe drinking water (Rodriguez, 2017). The impact of Hurricane María demonstrates the urgent need to continue the process of relocating vulnerable families out of areas and structures susceptible to storm surge, wind damage, and sea-level rise. However, during this process it is important that communities are not simply displaced to other vulnerable locations, as has happened in the past.

Communication & Determining Client Needs

It is within this difficult political and post-disaster context that the studio sought to intervene to provide support to the client. There were several challenges to operating a studio in this context. The first was simply communicating. Communication was difficult for several reasons. First, there was the language barrier. Luckily, five of the Georgia Tech students speak Spanish conversationally or fluently and were thus able to act as translators for the rest of the team. Despite that almost half of the Georgia Tech studio spoke Spanish, there were significant burdens of translation for the five students tasked with transmitting the information.

Second, the internet connection was often very poor, so it became very difficult to understand the client at times. Video-conferencing is an important element of long-distance studios because it allows clients and students to see and get to know one another and helps in establishing familiarity and trust. Students and the client had to work past frustrating interruptions, and ultimately resort to phone calls without the video component. Third, there was the difficulty of also coordinating phone calls with students from UPR who held class in the evenings. Most UPR students have full time jobs to support their studies, further constraining their schedules. In addition, there was an hour time difference between Puerto Rico and Georgia which had to be taken into account when scheduling calls.

Fourth, the client expressed from the outset that they were severely resource strapped and had limited and very busy personnel. They established a point of contact through whom students tried to channel all communication to not stress the client or consume essential resources and time. For the most part, this system worked relatively well, and students are thankful to the generous time the point of contact and essential personnel set aside for communication. However, it was a bit difficult to get the communication going and obtain vital information to help move forward with useful deliverables. The first phone call with ENLACE did not occur until February 12th, leaving only about a month before the site visit. Students took advantage of the first month of the studio to do background research and process a multitude of plans and files that the client sent over. However, it quickly became apparent that we were lacking critical information, such as parcel-level data and information about the location and nature of the priority infrastructure projects and the sites for housing developments and relocations. Despite multiple data requests, this information only became available once at the site. This impeded students from moving forward with deliverables, but also proved to be a learning experience for students who had to adjust to working with a resource-constrained client.

After the February 12th phone call, there were two more exchanges prior to the site visit. These proved to be crucial for determining the specifics of the client needs. The third call, which occurred just about a week before the trip, was essential in understanding the nature of the project management tool the client needed. Students were able to have an in-depth discussion with the project manager about challenges and needs, which helped to rescope the deliverable. Throughout the studio, students learned how essential but consuming communication is, and worked hard to develop and tailor targeted lists of questions aimed at understanding but not overwhelming the client. Despite the challenges of communication, all parties worked to collaborate towards a mutual understanding of the deliverables, which helped inform overall studio structure and the methods used during the field visit.
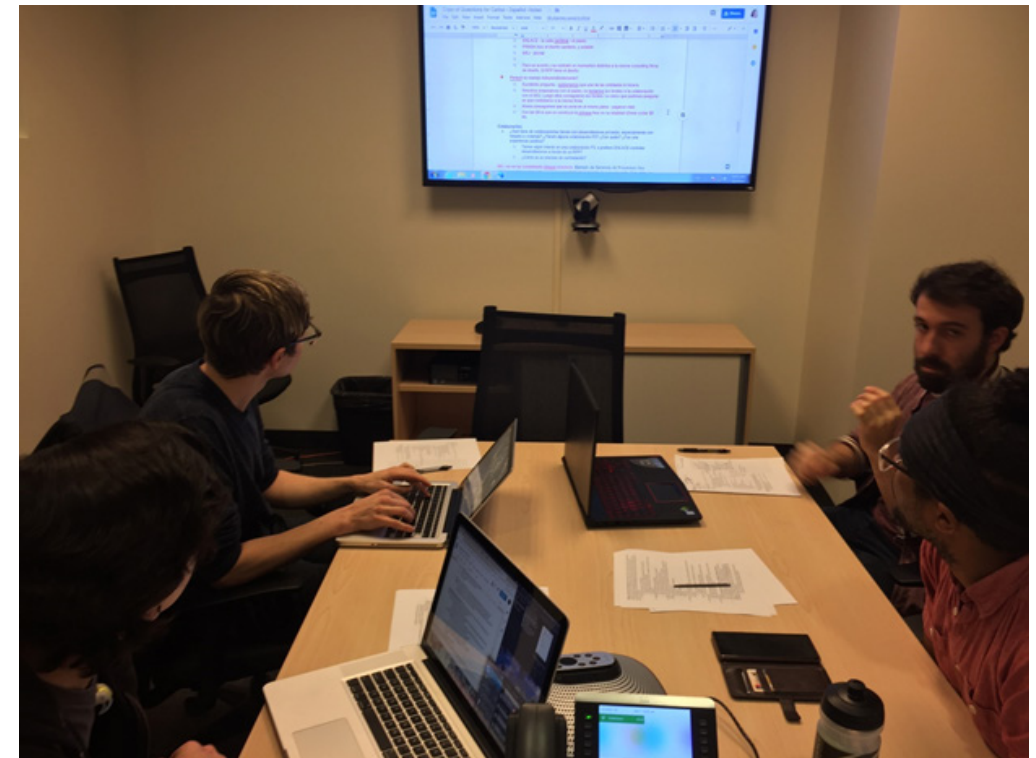
ABOVE Image of a phone call between ENLACE and Spanish-speaking students in the Studio. Photo courtesy of Laura Geronimo.

Studio Structure

The studio had a unique structure that was both informed by general research needs to understand the overall context, and discussions with the client about their particular needs. First, given that neither faculty from Georgia Tech are specialized in Puerto Rican or Caribbean studies, students with experience in the island proposed a 1-credit hour course during Fall 2018 to develop background knowledge and context. About half of the students registered for the Spring studio course signed up for the Fall credit hour. Professors divided students into four groups according to ranked preferences, including 1) Economic Development, 2) Service Infrastructure, 3) Public Transportation, and 4) Informal Housing. Students examined the historical and current context in Puerto Rico through these four lenses, and presented the findings to the rest of the class at the beginning of the Spring term. The 1-credit hour fall course proved fundamental in developing familiarity with the local conditions and context.

During the studio itself, students were primary agents in conceptualizing and developing deliverables based on client needs. Faculty provided critical structure and guidance for the studio based on their conversations with UPR and their visit to the client. Per faculty recommendations, students at Georgia Tech were divided into four working teams: 1) Project Management, 2) Funding Streams, 3) Data Collection, Analysis, and Visualization, and 4) Coordination, Synthesis, and Outreach. The first three teams conducted in-depth research to develop the studio products, while the fourth team focused on maintaining open lines of communication with partners, writing and translating meeting minutes, communicating client needs, prepping studio logistics and facilitating internal communication between working groups. The studio at Georgia Tech met three times a week in four-hour blocks, for a total of 12 hours a week. The studio in Puerto Rico met twice a week in the evenings, from 6pm to 9pm.

Georgia Tech students visited Puerto Rico during the week of March 16 through the 23rd for the exchange component. During this time, students took full advantage of the face-time with clients and other stakeholders including community leaders. The first activity was a bike tour through the eight communities led by a youth leader for the G8. This bike provided important perspective about the nature of the community, and allowed students to see firsthand issues with the contaminated channel.

The first meeting with ENLACE occurred early in the week on Monday, and proved essential for further understanding the context, priority projects, available data, and needs. Over the following days, students used the workspace at UPR to work together on deliverables. Georgia Tech and UPR students worked in breakout groups and

conducted interviews with various employees in ENLACE, the Land Trust, as well as the G-8, including a visit to a local community center. Other important stakeholders were consulted, such as the Puerto Rico Housing Authority. These external stakeholders provided important perspective and shed light on the complexity of the problems at hand.

The last two days included presentations, both of which were conducted in Spanish. Thursday students presented their findings and draft deliverables to the client, and Friday students presented to other entities and agencies like the Puerto Rico Planning Board, the Department of Transportation and Public Works, and the Highway and Transportation Authority. Both the client and the external entities provided important feedback which was incorporated into the final deliverables.

ABOVE Image of the the Georgia Tech and UPR students at the bicicaño tour. Photo courtesy of Mirit Friedman.

Innovative Models for Resilience Planning

Both the structure of ENLACE as an organization and the current studio exemplify innovative models in resilience planning tailored to meet contemporary needs in a rapidly changing world. On the one hand, ENLACE, the Land Trust, and the G-8 represent a creative model for participatory development, planning, and disaster mitigation that seeks to help improve quality of life and reduce risk for residents while avoiding problems of gentrification and displacement. At the same time, ENLACE has demonstrated a need for more technical support. The co-designed studio represents an innovative way to channel technical support at a relatively low cost to clients like ENLACE and the communities it serves. The following sections describe in greater detail the deliverables of each sub-group, after providing a bit more context and background. It is our hope that these deliverables will serve ENLACE and the community in their goals, and perhaps extend to a wider audience. However, these are just a few tools and strategies that require much larger efforts and coordination. Ultimately, community resilience can only be achieved by continuing collaborations, extending and strengthening networks of partnerships, building local capacity and education, responsible public policy-making and investment, and political will across all levels of government.

ABOVE Image of the meeting at ENLACE. Photo courtesy of Laura Geronimo.

Background & Context

Informal Settlements
Historic Context of Caño Martín Peña
Institutional Context

Informal Settlements

Informal settlements are so prevalent in Puerto Rico (PR), they can almost be said to form part of the nation's culture. Decades of extreme poverty, dependent industrialization, a lack of affordable housing, and the impact of hurricanes have all played a part in the emergence and duration of these settlements throughout the Archipelago. At the time an agrarian economy, Puerto Rico entered the 20th Century with significant changes to its political and economic structures. In 1898, as a result of the Spanish-American War, Spain ceded the Archipelago to the United States, establishing a new colonial regime over the nation. As the coffee industry, it's principal economic activity during the last quarter of the 19th Century, began a sharp decline, the US began implementing a structural transformation of Puerto Rico's economy to promote sugar cane and, to a much lesser extent, tobacco monoculture as the archipelago's main economic drivers. Among other major changes, the provincial currency was exchanged for the American Dollar at a rate of 60 cents on the dollar, a value significantly lower than it was before the invasion (Scarano, 2008), allowing American investors to purchase vast stretches of farmland at a discount. The emergence of these latifundia, along with the promotion of monoculture, which only provided work for about half the year, left many poor rural residents without land to farm for food or regular work to sustain themselves. Much of the rural population thus begins relocating to the coasts in search of work and better living conditions. Most settled in San Juan, Puerto Rico's current capital.

As early as the first decade of 20th Century, San Juan began experiencing a critical shortage of housing for the growing number of poor, displaced agricultural workers that poured into the city (Plan Integral, 2002). Migration to the coasts peaked between the 1930s and the 1950s, when the Great Depression and later the effects of WWII would plunge Puerto Rico into even deeper misery. San Juan's population doubled from 114,715 to 224,767 people in just 20 years (Plan Integral, 2002). As poor rural families flooded into coastal towns and cities, most settled around their peripheries, providing themselves with housing by establishing unplanned communities on unoccupied lands that were mostly unsuitable for development. By 1950, between 90,000 and 100,000 people lived in these settlements (Plan Integral, 2002). It is in this context that communities were established on the wetlands and mangrove areas around the Caño Martín Peña.

OPPOSITE Image of Caño Martín Peña. Photo courtesy of Laura Geronimo.

Historical Context of Caño Martín Peña

The Caño Martín Peña (CMP) is a 6km-long, navigable body of water and estuary that connects the San Juan bay, to its west, with the San José lagoon to its east. By 1930, displaced rural workers had begun settling the to the north and south of the CMP, where land was unoccupied and close to job sources. In 1932, the deadly San Ciprián hurricane sped up this process by displacing thousands more from their rural homes. The improvised nature of these communities gave them an irregular physical-spatial form. Settlers shaped the form of the community as they went, laying out streets and pathways to fit the topography of the land. As a result, the land-use pattern for most of these communities is "a labyrinth of paths, stepped walkways, narrow and dead-end streets, with houses crowded close to one another, and few public spaces such as parks" (Fuller Marvel, 2008, p. 118). And while settlers did manage to address their housing needs, other challenges arose from the spontaneous or informal nature of these communities. Residents built on land they did not own in places that represented potential risk of disaster or where there was no adequate infrastructure. These communities lacked utilities hookups, garbage collection services, and paved roads. Electricity was obtained from neighbors who had obtained theirs from other neighbors, and so on. In place of plumbing facilities, settlers built latrines and septic tanks or installed pipes so that sewage and water runoff could flow into the nearest stream or waterway, in this case the CMP. Families that settled along the Canal built their homes on stilts over swampland, mangrove areas, and along the banks of the CMP. Some established foundations for their homes by filling in the wetland under their houses with construction residue, "discarded tin cans, coconut husks, old tires and other detritus" (Fuller Marvel, 2008, p. 112), as well as material that would later be supplied by the San Juan municipality itself. The central government eventually installed some electricity, water, and sewage infrastructure, paved streets, assigned addresses, and built schools, community centers, health clinics, and small parks, among other facilities (usually right before general elections). Environmental and health risks remained, however, and even worsened with the passage of time.

Unfortunately, the process of filling in the wetlands and even edges of the Canal itself, as well as illegal dumping by people external to the community created conditions that increased the communities' vulnerability to environmental phenomena. A canal that once measured between 60 and 120 meters in width can now be crossed on foot (Plan Integral, 2002). This has dramatically reduced the Canal's flow, which, in combination with ineffective pluvial sewage systems allows for even moderate rain events to flood the Communities with contaminated water. A significant part of the CMP communities still lacks a sanitary sewer system, so used waters flow into the Canal, along with sanitary discharge from combined sewers and infrastructure that serve other communities in San Juan. The water in the Canal shows alarming concentrations of fecal coliforms and other bacteria and pathogens, as well as hydrogen sulfide. Exposure to this has led to high rates of gastrointestinal and allergic diseases, such as asthma and atopic dermatitis, as well as mosquito- and rat-borne diseases, like dengue fever, zika, Chikungunya, and leptospirosis (Algoed, Hernández Torrales, & Rodríguez Del Valle, 2018).

Institutional Context

For many years, the Puerto Rican government's policy was to eliminate "slums" and relocate their residents, an often-violent practice supported and funded by the Federal Government's Urban Renewal and Slum Elimination programs. A powerful example of this slum clearance policy is the elimination of the communities that made up the vast area along the northwestern bank of the CMP known as El Fanguito (the Mud Pit). Between 1950 and 1980, at least 30,000 residents were displaced from these communities. At the same time, partly in response to demands and complaints from informal settlements themselves, the Government adopted contradictory policies, such as providing residents with land titles, services, and infrastructure, which implicitly recognized their legitimacy. Unfortunately, however, none of these programs addressed the fundamental problems which underlay the development of these communities, mainly poverty and access to housing.

One attempt to address the root causes of informality was the adoption of Law 20-1992, which created the Corporation for the Comprehensive Development of the Cantera Peninsula, the CMP's easternmost settlement. After the destruction left by 1989's hurricane Hugo in the CMP communities, the residents of Cantera uncovered plans to replace their community with hotels and marinas and reacted by organizing and, with outside help, achieving the adoption of this Law. A development plan for Cantera was approved in 1995 and residents were handed land titles. Later, in 2001, the Government of Puerto Rico sought to address these wider issues through the Law for the Comprehensive Development of Special Communities (Law 1-2001).

Over 700 informal settlements and other communities with high poverty rates were identified as special communities, and the Government assigned each one a budget of $500,000 to carry out construction projects chosen by their residents. This program helped draw attention to the poverty problem in Puerto Rico and strengthened organizing processes. However, the solutions it offered had no major structural transcendence. This same year, the Government identified the dredging of the CMP as one of the administration's top projects and assigned its implementation to the Roads and Transportation Authority (RTA). The RTA managed to have the Puerto Rico Planning Board establish the CMP Special Planning District (District), which included the seven communities that were not included in Law 20-1992.

The Planning Board then ordered the RTA to begin work on a comprehensive development plan for the District using participatory planning techniques. Between 2002 and 2004, over 700 community meetings were carried out to facilitate dialogue with residents, who, understandably, showed very little trust in the Government. As a result of these meetings the dredging project turned into one of comprehensive socioeconomic development which came to be called Proyecto ENLACE del Caño Martín Peña (ENLACE). Leadership from all eight communities began meeting with frequency and finally created the G-8, an incorporated organization that represented all of the communities located along the CMP. ENLACE and the G-8 then began working on various initiatives geared toward addressing the Communities' most pressing needs. One such pressing need was tenure security.

Discussions about land tenure emerged from residents' complaints regarding technical problems with land registration, as well as a lack of land titles for a significant number of residents. According to a census taken by the RTA in 2002, 34% of residents stated that the owner of their housing unit did not hold title to the land it was built on (Algoed et al., 2018). In 2003, ENLACE held a workshop for community leaders regarding the different forms of land tenure that could be adopted within the District. After establishing the specific tenure issues, they sought to address, community leaders concluded that collective tenure would be the most adequate way to address them. The District's development plan included a recommendation for the creation of the Martín Peña Community Land Trust (CLT).

In order to safeguard the work that had been done so far, community leaders pushed for legislation guaranteeing the implementation of the Plan. This led to the passing of Law 489-2004, which recognized the G-8 as the entity that represented the CMP communities, established ENLACE as a statutory corporation with the mandate to implement the Plan, and created the CLT as a nonprofit, independent entity. Law 489-2004 transferred to ENLACE all public land within the District and ordered the corporation to transfer said land to the CLT. The Land Trust now owns over 200 acres of land and guarantees housing affordability giving surface rights to the residents who live on it and controlling the prices at which units may be sold, as well as to whom they may be sold.

Project Management

Introduction

ENLACE has identified to the Studio team that Project Management is one of the key areas where the studio team can add value. In an effort to most effectively advise ENLACE the project management team within the studio has attempted to first understand the current method by which projects are managed at ENLACE, identify some key areas where challenges exist, then finally recommend a tool that best addresses these challenges and needs of ENLACE.

Learning the ENLACE Way

While the literature review and case study are helpful for identifying best practices in complex project management, the studio needed to better understand how ENLACE approaches project management. To do so, the studio hosted several calls prior to the site visit, in addition to meetings with key staff in project management once on site. Below are the key takeaways from this discovery process.

ENLACE Projects
ENLACE has long prioritized the dredging of Caño Martin Pena to reduce the flooding risk of the eight communities that border the canal. Prior to dredging Caño Martin Pena, there are five infrastructure projects that must occur:

Project 1: Paseo el Caño Sur (por Bitumul)
This project is the replacement of the waterline and the construction of a new street above. THe design for bot the waterline and the street have been completed, however they are separate designs and will need to be merged prior to construction beginning. The project is partially funded, though there are barriers to accessing capital. The estimated cost of this project is 35$ Million, to date, $9 Million have been allocated to the Municipality of San Juan, which is the amount required to finance Phase 1 of four phases.

Project 2: Troncal Sifon Rexach
This project is the installation of a of a siphon sewer system under the Cano to remove the obstacle for the dredging operations that will eventually take place in the Cano. The estimated cost for this project is $15 Million however ENLACE Currently does not have any of the required funds for this project and the project is of critical importance for Projects 5, or phases 1c, and 1d.

Project 3: Linea Potable Borinquen
This project includes the replacement of a potable drinking water line that runs through the Cano Martin Pena neighborhoods. Total project cost is $5 M. They have a collaborative agreement with PRASA (sewer and water authority) that established the $5 M for construction, management, and unforeseen costs. They have 100 percent of the funds for construction The project has completed the bidding process

Project 4: Paseo del Caño Norte e Infraestructura en Buena Vista Santurce (Phase 1a)
Projects 4 and 5 are multiple phases of the same infrastructure and streetscapes project that includes the construction of a baseball with stormwater infrastructure. THese are the key projects that take the line of development back from the edge of the cano and have the highest number of relacitonshassicated with them. The project has been assigned a budget of $3.3 million with 835,000 specifically designated to design and the rest presumably to begin construction; however it is unclear if the phases (In project 4 and 5) can be completed with this budget.

Project 5: Paseo del Caño Norte e Infraestructura en Buena Vista Santurce (Phase 1c and 1d)

See Project 4 Description.

These projects require the relocation of around 800 households that fall within the project boundaries. With the support of the community land trust and the G-8, ENLACE's Vivienda (or housing) branch helps relocate families through a matching process of open properties and families in need of relocation.

ABOVE Image of Meng Gao outside of ENLACE. Photo courtesy of Jennifer Johnson.

Project Management Process
The management of the priority projects and relocations involves many moving parts, is greatly complex, and without easy standardization. Only once all the families in a priority project area have been relocated, can ENLACE then move forward with the other phases of the project management process. In order, including relocations, each project happens in the following phases: (1) housing relocation; (2) design of infrastructure projects; (3) predevelopment; (4) construction; (5) operations and maintenance. Although ENLACE hasn't completed any of the priority infrastructure projects yet, the studio was able to learn about some of the critical challenges in the five areas of project management.

Challenges
Upon completion of the information gathering exercise and discussions with the staff at ENLACE, the studio team began to distill where the major challenges exist in the current project management process. The client, ENLACE, identified the section of a project management tool as one of the highest priority deliverables from the studio team, however, in order to determine which tool best fits the needs of the client, the current challenges must be distilled. The current challenges faced by ENLACE can be placed into five key areas. These four key areas are outlined in the following section, as well as the recommendations from the studio team for each specific area as it relates to project management.

Complex Multi-Actor Processes: The five priority infrastructure projects that ENLACE is working on are very complex. The projects have multiple phases which are handed off between departments, some of these are in house and some are external to the organization. The communication between the phases and parties is vital to project success. This is one area where a tool can be helpful to streamline the coordination under a single project management tool. In addition to the tool, a robust systemization of the PM process is necessary to make the tool work most effectively and alleviate knowledge transfer difficulties..

Knowledge Transfer Difficulties: The two ENLACE project managers interviewed during the course of this project has a combined experience of less than 12 months with ENLACE. One of the difficulties expressed was building an understanding of the existing ENLACE processes. A lack of institutional knowledge has made things

difficult to pick up and run with employee turnover as well as between the different departments and organizations at work in each of the project phases. In addition, transfer difficulties were expressed between employees with difficulties accessing information and files located on different computers due to the lack of a centralized network location.

Data/Document Management: This challenge area was not one of the areas expressed by ENLACE, but rather observed while interviewing the project managers. There is no centralized server for the storage of documents, schedules and other items at ENLACE. The project managers face delays and difficulties getting files that may be located on another computer, and this lack of centralization has create an environment where several copies of the same document exist with slight modifications, and it takes time from the the project managers to determine which document is most appropriate. The documentation process need to be formalized as there are too many versions standard documents and no set document for each process. The lack of the file server will make the successful implementation of a project management software impossible. Without a centralized location, multiple copies of the GANTT chart would exist with no way to track revisions. ENLACE can alleviate many of these difficulties by Investigating Cloud Server Opportunities and selecting one that best meets the specific needs of ENLACE.

Project Management Software: The need for a more functional project management tool has been identified in the previous 4 difficulty areas above; the search for a tool has been the impetus for the research as we have worked to identify tools that meet the needs of ENLACE, both expressed and observed. While the tool can be a helpful aid, there are more structural barriers expressed above that must be mitigated prior to a project management tool being able to alleviate any of the project management difficulties currently being expressed by ENLACE.

Literature Review

To better support ENLACE's needs for improved project management, the studio looked to two key sources of information: (1) project management literature, and (2) best practice examples. The studio focused on project management literature that provided different frameworks for effectively managing complex and multi-project project management environments. For best practices, the studio used Georgia Department of Transportation's (GDoT) project management process as a way of illustrating the management of difficult and interdependent timelines. Below are the findings from these sources.

Project Management Literature
The project management literature identified several key areas that require attention when managing complex project pathways. Those areas are:
1. Concept development
2. Policy challenges
3. Uncertainty
4. Flexibility
5. Implementation

Below, the studio explores the different key areas that will later be the basis for a critique of ENLACE's project management style. The studio will use these key areas to identify potential strengths, weaknesses and opportunities to help ENLACE utilize other tools for more effective project management.

Concept Development
Beginning with concept development, both GDoT (2016) and the State of Queensland (2017) identified data gathering, the initial concept meeting, public engagement, options analysis, and a concept report as being critical to a strong project foundation. This is the critical first step to outlining the specific details of the project prior to performing any outreach about it. Data gathering requires proactive and continued effort to ensure the information is updated. As project teams are developing a concept, they should be able to use the data to tell the story of why the project is of importance and how it will support growth. The data is then used to frame the initial concept meeting where all project partners are involved. At this meeting it is important to establish clear key roles and project governance structures with the different levels of approvals and reviews required. After developing a clear concept with the core partners, the public engagement phase gets underway to secure public support and feedback. Once the concepts have received feedback from the public, only after should there be the development of different options for implementation with clear cost provisions. Finally, with the concepts codified and feedback solicited, the project management team can develop a concept report with a project management plan and next steps.

Policy Challenges
As a project concept moves forward, there are simultaneously policy environments working in opposition to project goals. In Bent Flyvbjerg's article, Policy and planning for large-infrastructure projects: problems, causes, cures, he suggests that complex political and economic environments lead project managers to misrepresent costs, benefits and risks involved. To move projects forward when there is little support, project managers inflated the benefits and underrepresented the costs and risks, making the project more appealing. In his recommendations, Flyvberg articulates that reform is necessary in large infrastructure projects in two main recommendations: "(1) better forecasting methods, and (2) improved incentive structures, with the latter being more important" (Flyvberg 2007). Forecasting is referring to the forecasting of costs and timelines for project implementation; while incentives refer to the accountability of public and private entities.

To properly forecast project completion, the author distinguishes between inside and outside forecasting. Inside forecasting is focusing on the project, the resources, and potential obstacles for completion. Whereas, outside forecasting is using a reference class of similar projects and their completion times to gauge how long a new project would take. Flyvberg notes that the following problems lead to inaccurate inside forecasting: long planning horizons; unstandardized technology; multi-actor processes; unpredictable events; misinformation; and overruns and shortfalls. To remediate inaccurate forecasting, Flyvberg looks to incentive structures; both in the oversight of project implementation and in market competition for supplying services. Difficult conversations of the various priorities of public and private actors in the infrastructure project management environment are critical to producing accurate forecasts of project completion.

Uncertainty

Outside of the political context of forecasting in project management is the uncertainty of events that will happen during the management process. In Giezen's article, Keeping it simple?, he builds on Flyvberg's arguments of a complex political environment, but contextualizes uncertainty in a greater context. He suggests that there are three main types of uncertainty in complex project management: (1) risk; (2) structural; and (3) unknowable. Risk is inherent in any project, but can be mitigated with proper planning. Structural uncertainty has to do with how the project is set up in the pre-planning phase. During the pre-planning stage, optimism bias, strategic misrepresentation, technological sublime, and scope creep all contribute to various forms of structural uncertainty. Lastly, unknowable things can happen at any part of the project management process, whether it be natural disasters, political upheaval, or others. During project implementation, Giezen suggests that there are two ways to mitigate uncertainty. The first option is to predict and control; predict the possible avenues of uncertainty and put mechanisms in place to mitigate those issues. The challenge with this method is that is still assumes its predictions are as accurate as possible, and that nothing outside the predictions will occur. This puts projects in jeopardy when unknowable uncertainties present themselves. Alternative to the predict and control method is the prepare and commit method. This method assumes uncertainty is a given and prepares in various ways to adapt to issues as they come up. This can be in the form of financial cushions, flexible staffing arrangements, and multiple plan implementation options based on a thorough options analysis in the beginning.

Flexibility

Embedded in preparing for uncertainty is planning to be flexible. Derek Walker and Yue Shen (2000) state that construction time and team flexibility are closely linked. They assessed project team understanding and knowledge transfer as two critical components to flexibility. To better support flexibility, the authors identified conditions of error including: vagueness of workflows, ambiguity in tasks, untestable management, scattered information, withheld information, undiscussability, uncertainty, and inconsistency. All of these errors led to poor working conditions for project teams and ultimately unsatisfactory outcomes for construction timelines. To improve errors, the authors broke up their recommendations into two categories: (1) organizational core support and technical ability, and (2) organizational commitment and motivation. Project success ultimately relied on a committed and technically proficient team.

Implementation

Team dynamics are critical to successful project implementation. In Akkermans and van Helden's 2017 article on vicious and virtuous cycles in implementation, they further discuss critical success factors similar to Walker and Shen, however they provide an added layer of organization. The authors recognize that the critical success factors, such as top management support, clear goals and objectives, project champions, and more, are important, but they must operate in a series of supportive and redundant feedback loops. While management support must be a given, it should be accompanied by a project champion, team competence, and other critical success factors. Redundancy helps reduce risk and uncertainty by providing an added layer of protection from unknown events; multiple people within the project management process can support resiliency measures.

Lessons From the Literature Review

The literature review indicated that there are several areas in complex management that require special attention, many of which are helpful insights into ENLACE's project management process. Next the studio provides a case study example of the Georgia Department of Transportation (GDOT) and their infrastructure project management process to demonstrate how these literary-based challenges apply to a major project manager. After the GDOT example, the studio situates these challenges in ENLACE's project management process as a basis for the subsequent recommendations.

Review of GDOT PM Process

In an effort to better understand the complexities associated with project management and observe them on a local level a case study was completed of the Georgia Department of Transportations (GDOT) Project Development Process (PDP). While this is a much larger organization than ENLACE many of the challenges as related to project management are very similar. GDOT is a large organization managing many projects going on at any given time. Within the organization there is a significant amount of turnover and different stakeholders working on different parts of the project due to the fact the projects often span for a minimum of 4-7 years. Handoff between different project managers and stakeholder groups over the duration of the project requires a formalized process to ensure coordination and a consistency between phases of the project. The figure below highlights the various phases of the projects.
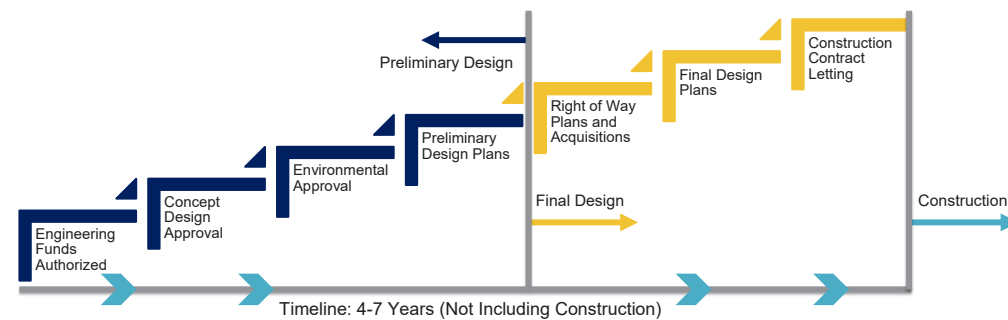
As shown in the figure there are three main phases to each project, Preliminary Design, Final Design and Construction. Within each of these phases are several steps. Key Indicators are assigned to each of these steps to track and guide the projects as they move through this process.

Milestone Dates of Design Approvals, Funding Deadlines and the right of way acquisition process are mapped and continually updated by the project manager. This is very similar to ENLACE in the sense that funding date and managing relocations are two of the major phases that need to be mapped. GDOT has a robust documentation process for each of these phases and keeps track of them in a project scheduling tool that has been developed in house. Without the formalized processes and structure, however the project management tool would not be nearly as helpful. The key part of the entire process from the GDOT perspective is the GDOT project manager. The following figure outlines the map of commutation of all parties involved in a project. At the center of the web is the GDOT project Manager. It is their responsibility to ensure that all dates are being tracked and followed up with, that funding is being tracked down as needed and to ensure that all parties in the project are communicating as necessary.
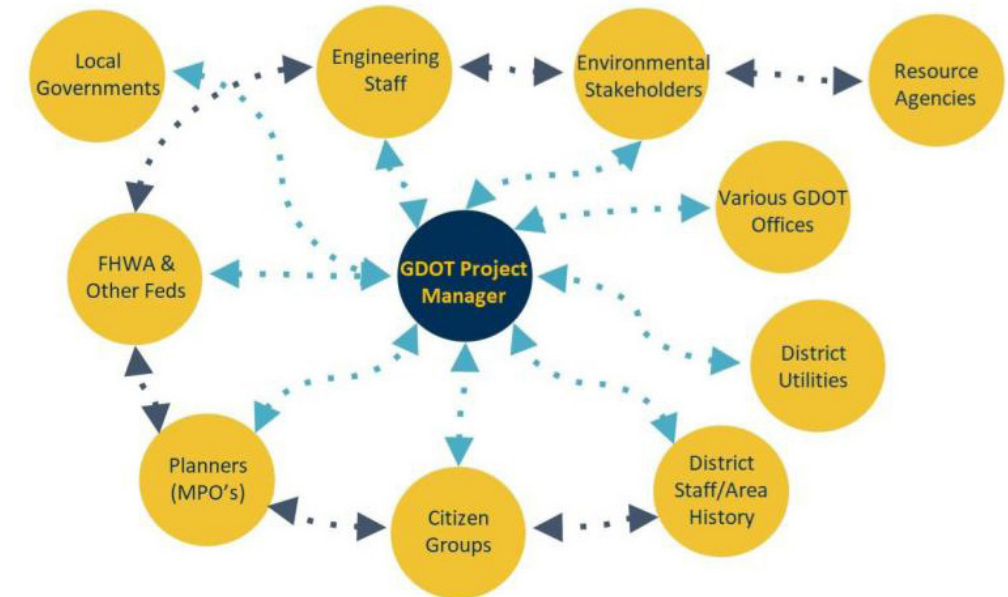
The project manager on the GDOT projects does not complete any of the tasks but is merely a centerpiece of project communication and the gatekeeper of scheduling and funding information. HAving the project manager be in this positions allows them to insure that information is flowing as efficiently as necessary and that the necessary channels of communication between stakeholders are open and being taken advantage of. This model allows for smooth transitions between other members of the process, which is especially important with the high rates of turnover that exits within the project teams. The key to all of this is for the process to be formal and followed at every step. The PDP process has a 250 page manual and lengthy seminars are required to be taken prior to managing any project. This allows for consistency among the different project managers and allows for a new project manager to easily pick up where a previous one left off.

A project management tool has been created by GDOT to help the project managers do their Job. This tool is a combination of and in house tool and the use of primavera. These tools are both Tailored to Transportation Projects. All inputs to the tool are entered manually and updated by the project manager manually as the schedule change. The GDOT pm is the only member who has total access to the tool. This software, while very useful to the project managers, is not a replacement for a Project Manager and does not reduce the level of attention they must pay to their projects at all times.

Critique of ENLACE Project Management

It was observed that ENLACE is looking for a project management tool when they have not completed a project in their 20 years of existence. With this being said, it doesn't seem that a project management tool is the end all solution to their problems. Instead they need to evaluate the structure of the project management team and evaluate the strengths and weaknesses of their current structure. By doing so, they will be able to optimize their processes before adding a project management tool into the mix.

Another concern the studio had was the organizational memory when an individual leaves ENLACE. Much of the information for how various processes work is kept in individual memory and is not written down anywhere. It's vital that the organization's memory be transcribed into some written format so incase anything were to happen, there would be a written memory of how things performed. This is also an important consideration for employee turnover.

ENLACE requested a recommendation for a specific tool that they could use for project management. In our final recommendations, we suggest a tool for ENLACE, however, it is important to recognize that tools don't solve problems, instead they optimize processes that are already in place. ENLACE has an opportunity to optimize their current processes in addition to adding the project management tool. If a current process is flawed, adding a tool will not solve the organization's structural challenges. Instead adding a tool will simply add more things to keep up with and maintain. It is recommended that ENLACE make these structural changes prior to adding the project management software.

Specific recommendations to improve ENLACE's processes are to create standards, have clear communication methods, and have a network server for file backups. In conversations with the project management team, it is clear that standards for file sharing, saving, and naming would benefit the team by providing a clarity of files. By streamlining the process to be more efficient, have clear communication, and standard methods for saving and organizing files, the organization can better focus on the day to day tasks instead of putting out fires when they arise. Adding an additional 1-2 staff people to the project management team will relieve existing project management team members who are overwhelmed with the sheer amount of work and allow them to more efficiently dive into specific projects.

OPPOSITE Image of a community garden. Photo courtesy of Carson Cooper.

Tool Usage

Upon learning of ENLACE's need for a project management tool, a subset of the Studio team set out to identify programs best suited to meet the client's needs. The Studio's approach to generating its recommendation was systematic: the process is broken into two periods – pre-visit and mid-visit – each of which is comprised of a research and analysis phase. The Studio's final project management software recommendations for ENLACE follow this analysis.

Pre-Visit Research and Analysis
Research was conducted in two parts: through periodic conference calls with ENLACE, which aided the studio in developing an early understanding of the organization's needs, and through an exploration of available options in the software review website Capterra.com (hereafter, Capterra). Conference calls with ENLACE enabled the studio to produce a list of ENLACE's needs, which are broadly categorized below. For a project management software to receive any consideration, Gantt chart integration was prerequisite.

1. Relatively Low Price
2. User Friendliness
3. Task Dependency Tracking
4. Visually Pleasant – Presentability
5. Other Capabilities, such as
    a. Budget management
    b. Project cost tracking
    c. Data dashboard integration
    d. Mobile integration

Having Gantt chart capabilities was not placed on the list of needs, then, as the Studio's conversations with ENLACE established that this capability was the most important.

Analysis conducted in the pre-visit phase followed the creation of the list of criteria above. Using Capterra, the studio was able to sort through a list of 530 unique project management programs. The list above corresponded with filters available on Capterra, allowing the studio to create an inventory of potential programs by sorting through the website's 50 most popular, most affordable, and most user-friendly programs. Using this method, the studio was able to reduce the list of potential recommendations to roughly 50.

With this collection of potential recommendations, the studio proceeded to analyze features and reviews against our list of ENLACE's needs. Noting features, limitations, and costs, the studio was able to reduce this list to 9 potential recommendations, which we brought to Puerto Rico for the second phase of research and analysis.

Name	Manage projects over time	Calculate financial costs	Update in real time	Social intranet	Data integration	Integrate graphics
Agantty	X		X			
Bitrix24	X		X	X		
Asana	X		X	X		
OpenProject	X	X	X			
Salesforce Non	X	X	X	X	X	
Zoho Reports		X	X	X	X	X
Celoxis	X	X	X		X	X
Mavenlink	X	X	X	X	X	
Tableau	X	X	X		X	X

Name	Integrate funding streams	Gantt chart creation	User friendly	Mobile integration	Pricing
Agantty		X	X	X	Free
Bitrix24		X		X	Free version; Full CRM $69/month for 6 users
Asana		X	X	X	Free version w/ limited features for 15 users; $9.99/month/user
OpenProject					Free version; Cloud storage for paid version, $28.00/month
Salesforce Non	X	X		X	Nonprofits receive 10 subscriptions free; $36/month otherwise
Zoho Reports			X	X	5 users - $45/month, 15 users - $112/month
Celoxis	X	X		X	$25.00/month/user
Mavenlink	X	X			$19.00/month/user
Tableau	X	X		X	$35/month/user

ABOVE Screenshot of the excel table.

Mid-Visit Research and Analysis
RESEARCH during the Studio's trip to Puerto Rico was conducted by two members, who attended several meetings to confirm the Studio's understanding of ENLACE's needs for a project management software and develop a ranking system which prioritized the needs a project management software must meet. The Studio was able to confirm through its meetings that the predeveloped list of needs matched ENLACE's necessities. Yet conversations with staff members working in different departments within ENLACE revealed that each department weighted the importance of these needs. Despite the variation, the Studio was able to aggregate which software capabilities were most important, therefore enabling the studio to conduct a weighted competitive strength assessment (WCSA).

Analysis conducted by a WCSA enables one to simulate the quantification of qualitative information – it is a method to quantify what cannot be measured. Often employed in business management settings to help managers differentiate between competing opportunities for future action, the tool is easily transferable to the decision at hand.

First, the analyst lists all key success factors. In this decision, the key success factors are listed above – low price, user friendliness, task dependency tracking, presentability, and other capabilities. Next, each key success factor is assigned a weight between 0 and 1 such that, combined, the weights all sum to exactly 1. The importance weights function as multipliers; success factors with higher importance weights have greater influence on the total score each competing alternative receives. See the figure below.

Key Success Factor	Weight
Price	0.2
Ease of Use	0.2
Dependency Tracking	0.25
Presentability	0.25
Other Capabilities	0.1
Sum of Importance Weights	1.0

Once key success factors have been listed and assigned importance weights, competing alternatives – in this case, project management tools – are added to the table. Each alternative is assigned a strength rating between 1 and 10 for all five key success factors, then that number is multiplied by the importance weight to generate

a weighted score. This process is repeated so that each competing alternative is assigned a weighted score for each success factor. All weighted scores are then summed to generate an overall weighted competitive strength for each competing alternative.

Conversations with ENLACE staff revealed that Microsoft Project was failing the organization's needs because of its poor ability to visualize project timelines in a simple, graphically pleasing format. Presentability was thus weighted highly because of the role that visualization could play in communicating project updates to community members, organizational partners, and potential funders. In addition, dependency tracking was similarly weighted due to comments from ENLACE staff detailing the difficulties of easily updating their Gantt chart and creating connections between linked projects. Thus, creating dependencies became a crucial component as a result of the changing timelines and budgets of ENLACE's projects.

The studio performed the WCSA for each of the 9 potential project management tools identified prior to its visit to Puerto Rico. Only three programs generated scores of 7 or higher – Tableau, Mavenlink, and Salesforce Nonprofit. However, conversations with ENLACE staff revealed that due to its status as a government corporation, ENLACE would not be eligible to receive the free licenses Salesforce gifts to qualifying nonprofits. As a result, Salesforce Nonprofit was deemed too expensive and was removed from the list. Tableau and Mavenlink were then compared to ENLACE's previous project management software, Microsoft Project, below. The table below displays the WCSA the studio presented to ENLACE during its trip to Puerto Rico.

Weighted Competitive Strength Assessment							
Rating Scale: 1 = very weak, 10 = Very Strong							
		Tableau		Mavenlink		Microsoft Project	
Key Success Factor	Weight	Strength Rating	Weighted Score	Strength Rating	Weighted Score	Strength Rating	Weighted Score
Price	0.2	4	0.8	6	1.2	6	1.2
Ease of Use	0.2	6	1.2	7	1.4	4	0.8
Dependency Tracking	0.25	8	2	10	2.5	6	1.5
Presentability	0.25	9	2.25	7	1.75	4	1
Other Capabilities	0.1	10	1	8	0.8	6	0.6
Sum of Importance Weights	1						
Overall Weighted Competitive Strength Rating		**7.25**		**7.65**		**5.10**	

Final Recommendation
Following its presentation of the WCSA, the studio made a preliminary recommendation for Mavenlink, adding an important caveat: should ENLACE prioritize the visual appeal of its project management software, Tableau would be the superior choice. Tableau would also become the preferred choice if ENLACE decided to purchase Tableau licenses, as recommended by our Data Team, and leverage the software's data visualization capabilities. Mavenlink was initially chosen due its ability to manage intricate dependencies between tasks in addition to its Gantt chart creation features. During the Studio's presentation, the positives and negatives of both softwares were discussed, along with a brief showcase of how Gantt charts could be visualized within Tableau.

Following the Studio's presentation, ENLACE provided feedback, noting its particular interest in the presentability of a project management software in addition to its desire of harnessing Tableau's ability to map demographic data throughout the community. ENLACE staff expressed a desire to link the Tableau-generated Gantt chart to specific project boundaries also mapped in Tableau. Ideally, ENLACE would be able to easily showcase not only the demographic data of the Caño Martín Peña neighborhoods, but visually present the schedules, budgets, and associated project relocations by hovering over the mapped project boundaries with a computer mouse. Ultimately, ENLACE placed a high priority on the integration of the Gantt chart and data visualization capabilities of Tableau.

As a result of this feedback, the studio made a final recommendation that ENLACE should procure Tableau licenses. For organizations, the following three different Tableau licenses with varying prices and differing feature capabilities are available for purchase: Creator, Explorer, and Viewer. Every deployment of Tableau requires at least one Creator license, which is priced at $70 per user per month, billed annually. The Creator license offers full Tableau functionality, including the ability to publish new workbooks and data sources, manage users and permissions, and create new data flows.

The Explorer license is priced at $45 per user per month, and would be the best fit for most ENLACE staff. This license offers the core functionality of Tableau, such as creating dashboards, Gantt charts, and data visualizations. Finally, the Viewer license is priced at $12 per user per month, and offers stripped down functionalities that limit users to only the ability to interact with dashboards and downloading summary data. The studio does not believe Viewer licenses would be useful for ENLACE's needs. Every license also includes Tableau Server, which is essentially an online hosting platform to store all Tableau workbooks and data sources.

The studio has prepared a tutorial that explains the mapping, data visualization, and Gantt chart creation features within Tableau. This tutorial also details Tableau's ability to update Gantt charts in real-time by editing and saving the Excel sheet serving as the chart's data source, and then refreshing the data source within Tableau. In order to simulate ENLACE's project dependencies, the studio has also created simple 'Finish to Start' (i.e. activity A must finish before activity B can begin) relationships between ENLACE's priority projects. It's important to note that if ENLACE's task dependencies between relocations, budgets, and timelines become particularly complex, then Mavenlink may be the preferred software due to its more user-friendly dependency tracking features.

If additional assistance is required outside of the Studio's tutorial, then Tableau offers a suite of online training videos, in addition to live educational webinars and in-person training sessions. Tableau users have also uploaded numerous training videos to streaming websites such as YouTube, and users on Tableau's forum often answer software-related questions. Paid tutorial subscription services such as Lynda.com also offer a robust array of online training videos in Tableau. Overall, the studio believes that Tableau will effectively meet ENLACE's stated project management needs, and its ability to integrate with the software's data visualization capabilities makes it a uniquely holistic tool.

Gantt Chart Creation User Guide

1. Create Excel sheet with columns for 'Project Name', 'Project Phase', 'Start Date', 'End Date', and other columns for other necessary information such as 'Budget.'

2. Once this spreadsheet is created, go into Tableau, and use this spreadsheet as your data source for a new workbook.

3. Make sure that under Marks, Gantt chart is chosen from the drop down menu.

4. When creating a Gantt chart in Tableau, remember the following: The date provides the axis; the dimensions provide the breakdowns you want to visualize and/or the encoding of the Gantt bars; the measures create the length of the Gantt bars and/or their encoding.

5. Drag the 'Start Date' field to the columns, and drag the 'Project Name' and 'Project Phase' fields to the rows.

6. Now, what Tableau has done is place a Gantt mark at the start date of each 'Project Phase'.

7. To extend the Gantt bars to illustrate task duration, you need to size each mark by the number of days in each respective project. You may have a field for duration in the Excel spreadsheet, but it can also be created in Tableau with a calculated field:

    a. To create the calculated field, select Analysis > Create Calculated Field

    b. In this case, the duration formula to use in the calculated field would simply be [End Date] – [Start Date].

    c. Name this calculated field 'Duration'

8. Placing the 'Duration' field on the Size Marks Card will extend the Gantt marks so that 'Project Phases' with longer durations will have longer bars and 'Project Phases' with shorter durations will have shorter bars.

9. At this point, a usable Gantt chart has been created, but there is still room to add a lot of value in Tableau through formatting, encoding, and reference lines. For example, the following additions can be made:

    a. The bars can be colored by project phase by adding the 'Project Phase' dimension to the Color Marks Card.

    b. Extra information such as 'Budget' can be viewed when hovering over the project phase bar by adding the 'Budget' field to the Detail Marks Card.

    c. Choosing the date format of the Gantt chart can be done by clicking the small arrow on the 'Start Date' field, and from there different date formats are listed in the drop-down menu.

10. To update the Gantt chart, simply change the necessary information in your linked Excel spreadsheet, save your changes in Excel, and then click 'Refresh Data Source' in your Tableau workbook that contains the Gantt chart.

11. Further resources for Gantt chart creation in Tableau can be found at the following links:

- https://www.tableau.com/about/blog/2017/6/using-gantt-charts-tableau-manage-project-72429
- https://onlinehelp.tableau.com/current/pro/desktop/en-us/buildexamples_gantt.htm
- https://www.evolytics.com/blog/tableau-201-make-gantt-chart/
- https://www.tutorialgateway.org/gantt-chart-in-tableau/

Task Dependency Creation Guide

1. To create 'Finish to Start' (i.e. Project A must finish before Project B can begin) relationships between ENLACE's projects or project phases, first create your Excel workbook as mentioned in Step 1 of the Gantt Chart Creation Guide.

2. When linking two projects, the end date of Project A should be the start date of Project B. This should be reflected in the Excel formula. For example, if the end of Project A is 1/1/2019, located in cell E2, then the Start Date of Project B should be '=E2'

3. Next, you need to ensure that a change in the Start Date of a project changes the End date of the same project.

    a. First, determine the duration of the project by subtracting the End Date from the Start Date.

    b. Then, populate the corresponding End Date cell with the Start Date cell number + the project duration in days.

    c. For example, if Project A is in cell D2, has a Start Date of 1/1/2018, and an End Date of 1/1/2019, then in the End Date cell you would enter '=D2+365'

4. This way, changing the dates of a project will automatically update the dates of all linked projects so that Project C won't start until Project B finishes, which won't start until Project A finishes, and so on.

5. In the Excel spreadsheet that the Studio sent over, Finish to Start dependencies have been created between the 'Diseño', 'Subasta', and 'Construcción' project phases within each project.

6. Link between Tableau map and Gantt Chart

    a. The Gantt Chart and Relocations have been color-coded to match the Project Boundary colors on the Tableau map.

    b. In 'Dashboard' view, custom dashboards can be created that combine different workbooks to illustrate the connection between the Gantt chart and the Project Boundary map.

    c. Here's an example of a dashboard combining the Tableau Gantt chart and Project Boundary map: [Insert GanttChart_Map.png here]

Data

Introduction

Since ENLACE was established, the organization has collected, organized, and analyzed a wealth of data as presented in El Plan de Desarrollo Integral del Caño Martín Peña, published in 2004. Through the collection of community surveys, management of properties and lots owned by the Fideicomiso de la Tierra (Community Land Trust), aggregation of U.S. Census Data, and understanding of environmental data, ENLACE has been able to manage and study the community thoroughly. This data is used to inform how the priority infrastructure projects will move forward, especially the Paseo del Caño, which will require the rehousing of numerous households.

While ENLACE has successfully collected, managed, analyzed, and communicated data since its creation, they presented several needs and desires to better manage and analyze data more efficiently and thoroughly through the use of new technologies and analyses. Improving data management within the organization, as well as the sister organizations of the G-8 and Fideicomiso, can result in more efficient and valuable outcomes in the following areas:

1. Project timelines can be better tracked and adjusted. Integrating data into project management and visualization can lead to more efficient and evidence-based processes.
2. Grant applications can be supported by compelling data. Funding streams, including government grants, philanthropic donations, and competitive grants, can be better informed with data that shows the needs of the community and how the money will be useful to meet those needs and improve the community.
3. Communities can focus on projects of highest impact. The communities around Caño Martín Peña have unique needs and opportunities, evident through the community's history, data, and culture, that make it a great candidate for data-informed grant resources. Having reliable data can reinforce existing projects and help communities pick projects that will lead to the highest benefit.

Data Needs and Desires
The Studio's discussions with the organizations of the Caño revealed multiple data needs and desires as to how they can better manage, visualize, analyze, and track data. The specific goals of the deliverables to meet these needs and desires are discussed further within subsequent sections of this report.

ENLACE initially requested a Community Data Dashboard to help organize and visualize the data they already have and intend to collect and aggregate in the future. They hoped to use this dashboard to facilitate easier connections with funding applications. They had also put out an RFP for surveying services that would collect data on existing infrastructure and conduct a tree inventory. In response to these needs, the Studio created a Community Data Dashboard to help visualize and organize data using Tableau software. This Dashboard was supplemented with information on how to aggregate and analyze the data. The Studio also created an introductory how-to guide for conducting a tree inventory at a low cost and the benefits of collecting this data.

The Fideicomiso requested a data management tool, specifically for property management, that can be used to track current projects, parcels, and families, as well as track the progress of long-term, future projects. In response to this need, the Studio created a map-enabled visualization in Tableau that is fed by existing Excel data and connected to the project management GANTT chart. While this visualization does not meet all of the desires the Fideicomiso had for a tool, it meets many of the immediate needs at a low cost and user-friendly interface.

The following subsections of the Data chapter discuss the research the Studio conducted on data and data sources, the specific goals of the client's needs, and a detailed description of the Studio's deliverables and how they meet those needs:

I. Research on Data Sources and Spatial Scales
II. Community Demographic Profile--Demographic visualizations and analyses at the neighborhood, community, and city-wide levels
III. Tree Inventory Information
IV. Data Management and Property Visualization Tool Recommendations

Research on Data Sources and Spatial Scales

In order to fully understand the unique challenges faced by Puerto Rico, the communities that comprise El Caño Martín Peña, and ENLACE as an organization, the Studio began by conducting research and literature reviews regarding the state of planning on the island, both pre- and post-hurricane Maria. Students divided into groups of two or three along the four following topics:

- Informal housing
- Transportation
- Service infrastructure
- Economic development

Each of these groups met once a month to present their findings to the Studio leads. Analyzing scholarly literature, news articles, geospatial data, and other data sources, each team produced a final presentation and report that informed the beginning of the full Studio class that began in January. Students produced various basemaps that aligned with these topics as well, adding maps on building types, floodplains, and threat of sea level rise.

From there, the studio explored several data sources that would inform both the Community Data Dashboard sought by ENLACE and the property management and visualization sought by the Fideicomiso.

Community Data Dashboard
Goal(s):
- to paint an approximate picture of the state of the community's demographics that can be easily updated when new data becomes available
- to demonstrate the status of the community in comparison to the rest of the Municipio de San Juan
- to make the case to funders how this community stands to benefit from sustained investment

Methods:
- download and aggregate raw data into meaningful geographic classifications
- compare data between El Caño Martín Peña and the Municipio de San Juan through percent differences
- visualize these data for clarity and legibility

Recommended Property Management Tool
Goal(s):
- to streamline the rehousing process for community members affected by priority projects undertaken by ENLACE
- to organize and visualize parcel, property, landowner, and tenant information
- to display different combinations of data based on access needs and security concerns

Methods:
- acquire parcel data and property information, including properties owned by the Fideicomiso de la Tierra
- investigate visualization options accounting for visual clarity, easy end-user experience, and secure data terms of service
- construct a visualization demo with user guide

The Studio explored several data sources, briefly described below:

The United States Census. Collected every ten years by the United States Census Bureau, these data capture the demographics of a community most accurately. The Census Bureau is the United States' primary data collection agency and has connections with many other governmental agencies which supply information on their clients. Using a mixture of data collected by the bureau and data from other sources, the bureau is able to aggregate information on population demographics, employment, program enrollment, transportation, education, and many other factors. (Census Bureau, n.d.)

The American Communities Survey. This program, also managed by the Census Bureau, surveys United States citizens every year during periods between censuses. Beginning in 2005, surveys across periods of 1, 3, and 5 years are combined to generate estimates. These estimates imbue the data with a higher degree of statistical confidence. 1-year estimates are available for areas with population greater than 65,000, while 5-year estimates are available for all areas. 3-year estimates have been discontinued since 2013 (Census Bureau, n.d.).

GIS Data. The Studio explored several GIS data portals, including from the Puerto Rican government and El Centro de Recaudación de Ingresos Municipales (CRIM), the agency responsible for tax assessment and management. Students also brought several data sources with them, from previous work done by Georgia Tech academics and other university centers, including the Center for Puerto Rican Studies at Hunter College. The Studio had significant difficulty accessing spatial data due to lack of access or availability. These challenges are recounted in Table x.x.

Client data. Both ENLACE and the Community Land Trust provided the Studio with data that was important for understanding the scope, goals, and character of the Caño Martín Peña community. ENLACE provided PDF maps generated for the 2004 plan, while the Community Land Trust provided spatial shapes and information that assisted in the development of the property visualization tool.

Community member interviews. During the Studio's trip to San Juan, Puerto Rico, students interviewed community members and staff of ENLACE, the G-8, and the Fideicomiso to better understand community and staff data needs. The need for a better-integrated property management tool was discovered during these interviews, along with the Fideicomiso's process for rehousing people affected by ENLACE's priority projects.

Source	Type	Smallest Spatial Level	Availability	Accessibility	Ease of Use
Census	Numerical or spatial	Census block group	High	High	Medium
American Community Survey	Numerical or spatial	Census block group	High	High	Medium
PR Government Data Portal	Spatial	City or community	High	Medium	Medium
CRIM	Spatial	Parcel	Medium	Very low	Low
EJScreen	Spatial (environment)	City or community	High	Medium	Very low
Open Street Map	Spatial	Parcel and building	High	High	Low

ABOVE Data sources explored for the Studio by availability, accessibility, and ease of use.

The Studio utilized many of these data sources for the deliverables sought by the client.

Census data from 2010, 2014, and 2017. For a demonstration of the Community Data Dashboard, students downloaded data from the 2010 Census and the 2014 and 2017 American Communities Surveys (5-year estimates). A list of data categories can be found on pg. Xx. The students felt that these three years, for a demonstration, were enough to provide a brief yet thorough glimpse into how community level data can be interpreted against municipal data, and how data can be analyzed over time.

GIS data from El Gobierno de Puerto Rico. Students were able to use neighborhood boundaries, topographical features, and supplemental shapes like streets and service infrastructure from the Puerto Rican government.

Client data. Students utilized parcel data provided by the Fideicomiso for the property visualization tool, explained in more detail in the following sections.

Data Categories:
- Age
- Race
- Households by household type
- Household units by household size
- Population in households by household type and relationship
- Educational attainment for population 25 years and over
- School enrollment for population 3 years and over
- Employment status for total population 16 years and over
- Unemployment rate for civilian population in labor force 16 years and over

- Occupation for employed civilian population 16 years and over
- Household income (in 2017 inflation adjusted dollars)
- Median household income (in 2017 inflation adjusted dollars)
- Housing units
- Tenure
- Occupancy status
- Gross rent (housing units with cash rent)
- Monthly housing cost (renter-occupied housing units)
- Poverty status in of families by family type by presence of children under 18 years

Challenges and Gaps in Data Collection and Management
The Studio experienced many challenges with data collection and management. While many data were very easily accessible, as the table on page 69 shows, other sources were blocked by login screens or not downloadable. Additionally, the reliability of the data is in question, due to the latest data being sourced from 2017, before Hurricane Maria hit Puerto Rico. Below is a brief description of the challenges faced during the data collection process, in order of most problematic to least.

1. *Accessibility.* Overall, data were publicly available through online sources, including the Census Bureau, Social Explorer, and the Puerto Rican Open Data Portal. Additionally, due to Puerto Rico's political status as a territory of the United States, the format of the data was also very familiar to United States students. However, it became clear that some vital data sources were not publicly available, including citywide parcel level data. This could be viewed through an online portal made available by the CRIM, but technical errors made it impossible to download even a partial dataset. Another challenge included the availability of data specific to the clients. While the 2004 plan and the maps contained within it provided valuable insight for project goals, finding this data in formats that could be easily manipulated for a data demonstration was difficult.

2. *Reliability.* It should be noted that the last year accounted for by the Studio is 2017, the year that Hurricanes Irma and Maria hit. These massive storms likely changed the landscape of Puerto Rican demographics, employment, and homeownership status. Because data takes time to update, it is likely that the data sets acquired by the students are either not complete or inaccurate.

3. *Completeness.* One challenge facing the Caño Martín Peña community is the proliferation of informal housing, or housing that falls outside the sanctioned permitting and construction process. This results in data that is incomplete, duplicative, or redundant. For example, existing parcel data contain more than three different parcel and cadastre numbering schemes, while some parcels are missing owners, addresses, titles, or all three. In the Caño Martín Peña project area, updating these data is a goal held by the Fideicomiso, G-8, and ENLACE.

Many planning efforts, including this Studio, are committed to addressing these data challenges, especially those related to how the hurricanes have affected the data accuracy. By visualizing the data in a clean, user-friendly format, ENLACE and the Fideicomiso can get a better sense for what is missing, what needs to be gathered, and how that missing data can help streamline their project and property management processes. Other organizations are seeking to fill data gaps at the island scale. The planning department at the University of Puerto Rico is attempting to measure data through advanced GIS and imaging techniques, including aerial drone photography. The Center for Puerto Rican studies at Hunter College is also attempting to measure how many Puerto Ricans were displaced by Hurricane Maria (Meléndez and Hinojosa, 2017). Lastly, various planning efforts, including Reimagine Puerto Rico, are also filling data gaps and strengthening systems to incorporate resilient strategies into data management (Resilient Puerto Rico Advisory Commission, 2018).

Tree Inventory Information

*Introduction: The Urban Forest & Ecosystem Services*
The trees and vegetative materials around us, especially within an urban setting, provide us with many benefits. Often referred to as the "urban forest," trees provide numerous ecosystem services that can be divided into four categories:

- *Provisioning,* or raw materials we get from natural resource such as lumber and water
- *Regulating,* which refers to trees' ability to control temperatures, mitigate flooding, clean water, filter air, and store carbon emissions
- *Cultural,* which refers to educational, recreational, aesthetic, and spiritual benefits that we mentally and emotionally gain from natural resources
- *Supporting,* which is how parts of the ecosystem work together to sustain themselves long-term through biodiversity, soil formation, and habitat creation

By conducting an urban forest inventory, we can better understand these services, particularly the regulating services, as well as the ecosystem structure and value of the urban forest. Ultimately, this information can be used to create urban forest and natural resource management plans in order to increase the longevity of the resources, prepare for disasters, and mitigate the effects of urban development on resources.

Urban Trees
It was long believed that in a high-traffic urban setting with lots of impervious cover, such as concrete, the average lifespan of a tree is 10-13 years, compared to an average of 150 years in a rural setting (Herwitz, 2001; Skiera & Moll, 1992). However, a more recent study shows that high-traffic urban trees can live up to 19-28 years since planting with proper placement, care, and maintenance (Roman & Scatena, 2011). The trees along El Caño are not close to busy arterial streets, however, they are very close to the neighborhoods' development and impervious cover which has effects on the trees' ability to grow.
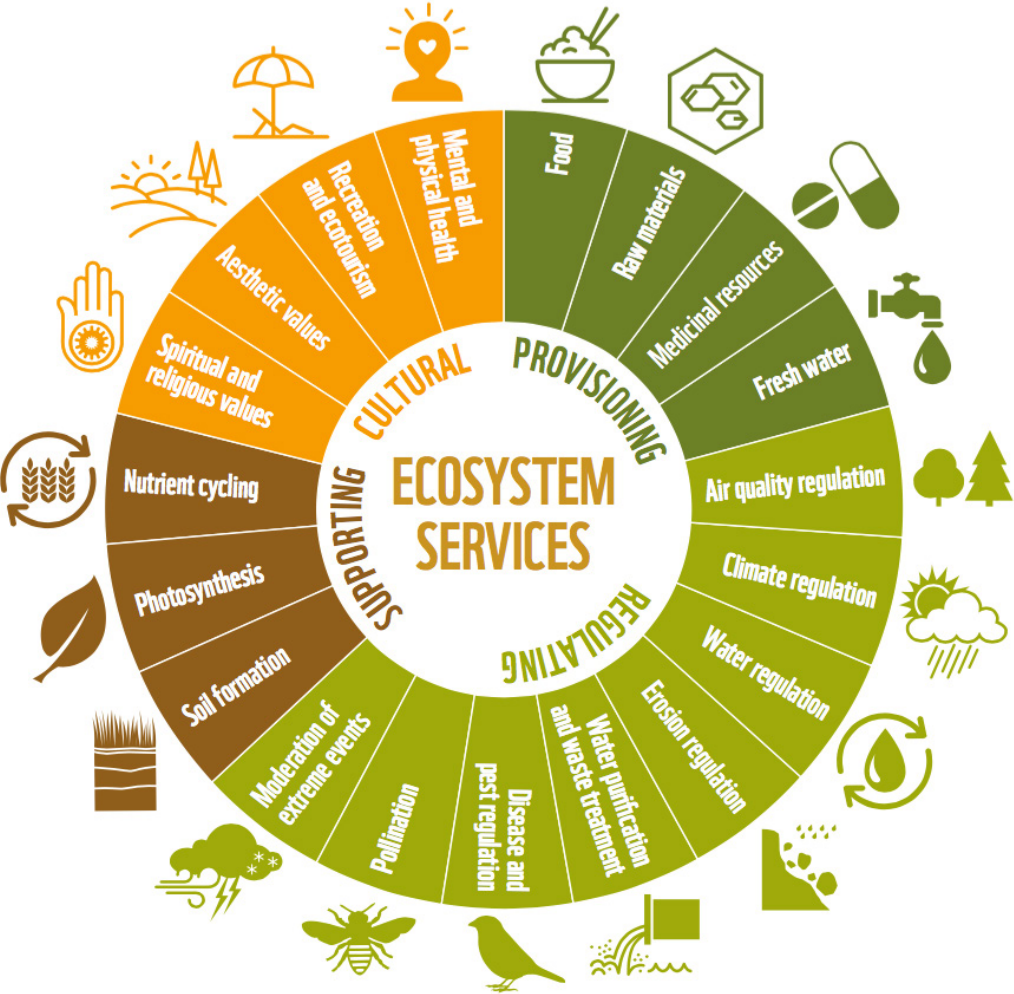
ABOVE Diagram of the types of Ecosystem Services (WWF Living Planet Report, 2016)

Trees & Heat Mitigation

Cities can be as much as 36°F hotter than surrounding rural areas on a cloudless, hot day (Akbari et al., 2001). Known as the urban heat island effect, cities are hotter due to urban materials, lack of moisture, and waste heat generated by mechanical objects (King & Davis, 2004). Trees, however, have a big impact in mitigating this heat effect through evapotranspiration, which is when moisture in the leaves is evaporated by solar energy and cools the surrounding air. In an area with lots of asphalt, shade trees were found to reduce surface temperatures by 31°F (NASA, 1997). By maximizing tree cover and tree lifespan in El Caño, especially after the channel is dredged and many trees are removed, the heat island can be mitigated and lead to energy savings, less frequent and severe weather phenomena, and increased comfort for residents.

Stormwater Management

The urban heat island effect also contributes to irregular rainfall patterns as temperature differences between rural and urban areas mix in the atmosphere (Wolf, 2004). As impervious cover increases in San Juan and other urban areas, there will be an increase in stormwater runoff and risk of flooding, as the Caño has experienced regularly. Trees are able to intercept rainfall, reducing the amount of stormwater and slow rainfall, increasing the opportunity for soil penetration and absorption. Additionally, trees are able to filter the pollutants that urban stormwater runoff carries and improve water quality flowing into El Caño and downstream. With a better understanding of the value the trees currently have in mitigating stormwater runoff, this asset can be planned for and optimized.

ABOVE The Urban Heat Island Effect (Adhikari, 2018)
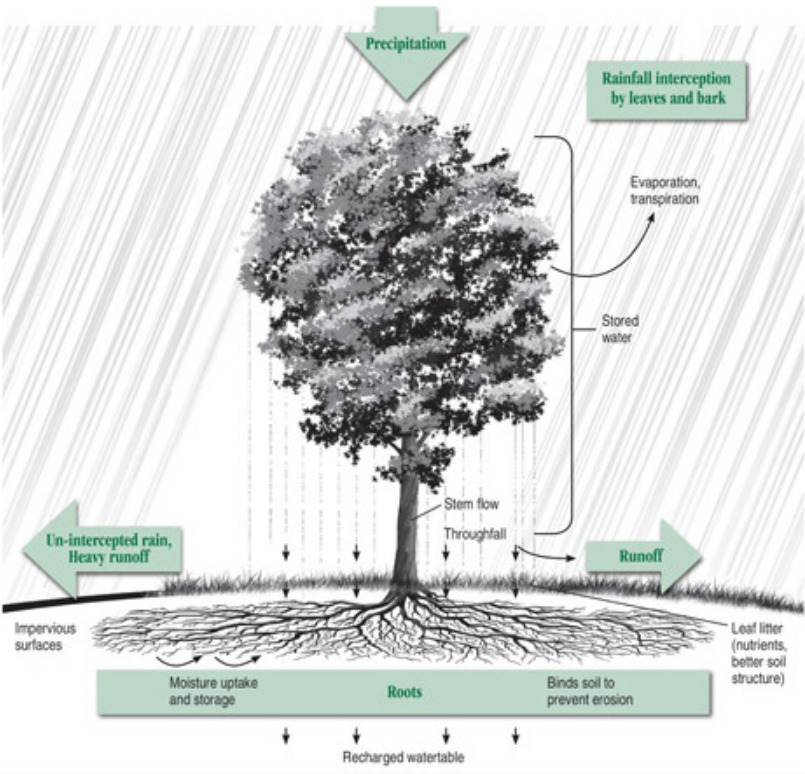
ABOVE How Trees Manage Stormwater (Arbor Day Foundation, n.d.)

Inventory Information: How-To-Guide
A tree inventory is a relatively simple study to conduct with the proper preparation. It requires trained professionals knowledgeable in tree identification, tree measurements, equipment, data analysis, and beginner computational skills. The area of El Caño Martin Peña is not very large but the trees are very dense, especially right along the water line, which will take longer to measure accurately.

Firstly, there are two types of inventories: a complete inventory or a sample inventory. A complete inventory is typically used for a smaller area, such as a single site, and enables the user to know the location and condition of every single tree. This can be very time consuming in a large or dense area and is not recommended for El Caño.

A sample inventory is much more time and cost-effective. By creating sample plots with a fixed radius, models are used to aggregate the representative sample data for the entire area with typically a 10% standard error. Due to the high-density of trees and vegetation along the waterline, this is the recommended method. Typically circular plots are set to an area of 1/10 acre, or radius of 37.2 feet, but this can be changed by the user.

There are also two ways to select plots within the study area: stratified or unstratified. An stratified sample is representative of different land use types within the study area. For example, if 30% of an area is a residential land use, 30% of the plots will be selected randomly within this land use. El Caño is predominantly of residential land use so a stratified sample is not very necessary. An unstratified sample simply selects plots randomly all throughout the study area.

i-Tree Eco Software & Modeling
The industry leader in urban forest inventory software is i-Tree Eco, a free tool developed in collaboration by the U.S. Forest Service, International Society of Arboriculture, and professionals. The software is very user-friendly and makes it easy to select plots, collect and input data, and automatically runs peer-reviewed models to produce outputs. i-Tree also has extensive support materials on their website including how-to guides, forums with troubleshooting, and fast-responding customer service technicians. They are able to answer tree information questions around species or difficult sites, as well as technical software questions.

The models that i-Tree Eco uses requires many inputs and therefore many measurements in the field. Some of these measurements require extensive knowledge of trees, as stated previously, so it is important to ensure the data collection field crew is properly prepared and trained. However, these inputs are required to produce the data with the utmost accuracy.

Required Measurements & Equipment
There are separate sets of measurements required for each plot and each tree, as shown below. i-Tree Eco has a mobile app so the data can be entered via the app while in the field, or entered after data collection on a computer. The measurements provide information about ground cover and shrubs, as well as tree size and condition.

| **Per Plot**	**Per Tree**
Zoned land use	Species
Status (planted or natural growth)	Size
Land cover	Height
% impervious	Diameter at breast height (DBH)
% vegetation	Street tree or non-street tree
% grass	Publicly-owned tree or privately-owned tree
% water	Canopy width
Shrub Information	East-West
List of species	North-South
% cover of each species	Canopy height
Distance of center point to each tree	Canopy condition
Measure each stem >1" at breast	% dieback
height as a tree	% missing
	Ground cover beneath canopy
	% impervious
	% shrub
	Distance and orientation of trees to buildings
	Crown light exposure
	Maintenance needs
	Maintenance recommended
	Maintenance task
	Sidewalk conflict
	Utility conflict

The equipment required for a tree inventory is not extensive nor expensive. Below is a list of the tools that are needed to collect the measurements.

- Crew
    - ◊ At least 2-3 people
    - ◊ Trained in identifying tree species, measurements, and visual estimates
- For Safety & Efficiency
    - ◊ Clipboards
    - ◊ Neon vests
- Navigation
    - ◊ Compass
    - ◊ GPS
- For Plots
    - ◊ Flags to mark plots and plot points during measurement
    - ◊ Tape measure
- For Trees
    - ◊ Clinometer or hypsometer (height)
    - ◊ DBH tape (diameter)
- For Data & Analysis
    - ◊ Tablets (for mobile data entry)
    - ◊ Computer with Excel, Mapping software, and i-Tree Eco software

Data Outputs
i-Tree Eco produces three categories of data: urban forest structure, urban forest condition, and value of the ecosystem services that the urban forest produces. The forest structure data uses the sample plot data to aggregate estimates of the entire urban forest, including the number of trees, species diversity, size distribution, tree density, canopy coverage, and ground cover. These values are useful to understand the biodiversity within the community, amount of invasive species, and amount of tree coverage relative to the entire area. The size distribution informs how long trees are likely to live in the community, as there is typically a large number of small trees

and smaller number of large trees in an urban setting. The urban forest condition is described through maintenance needs and tree health, showing the presence of disease or likelihood of dieback on trees. Finally, i-Tree Eco uses models to estimate a dollar value for the ecosystem services that the trees provide through energy savings, avoided carbon emissions, air pollution capture, avoided health care costs, and avoided stormwater treatment costs. All of this information is useful to understand how to maximize certain ecosystem services in El Caño, especially after some land clearing and channel dredging takes place. An example of some of these data outputs are shown below from an urban forest inventory in Gainesville, Florida (Andreu et al., 2017).
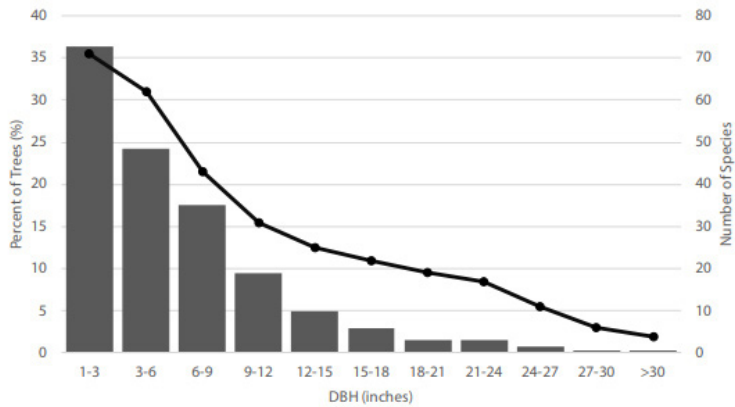
Diameter Distribution of Urban Forest

Pollutant Removal of Urban Forest & Associated Value

Pollutant	Removal (short ton)	Value ($)
O_3	692	$1,310,010
NO_2	102	$22,930
SO_2	26	$2,090
$PM_{2.5}$	22	$1,324,400
CO	4	$6,176
Total	**846**	**$2,665,600**

ABOVE Examples of Data Outputs from Study in Gainesville, FL

Associated Costs

This type of study is more labor and time intensive than it is costly, as the equipment is relatively cheap. We recommend that ENLACE hires trained AmeriCorps Vista crew members to collect the data, which would significantly reduce the cost. Urban forestry students from the University of Puerto Rico would also be able to provide cheap labor. The total cost of the equipment is approximately $655, and there are often grants available for this type of study. If 2 UPR students were hired for 2 months, that would bring the total cost to about $8,232. It may also be helpful for ENLACE to enlist the help of a professor at UPR that is knowledgeable of urban forestry to help with understanding and analyzing the data and how to move forward. The next step would be to create an urban forest management plan, which in El Caño, should include tree hazard mitigation strategies to prepare for disasters, a post-dredging replanting plan, and other prudent action items that the data may inform such as eradication of invasive species.

Possible Challenges

An urban forest inventory is not a difficult task, however there are potential challenges that ENLACE may face. Firstly, this study is very technical in that it requires trained knowledge in tree maintenance, species identification, and tree measurements in order to collect the data. Additionally, while i-Tree Eco software is pretty user-friendly and includes extensive support, there is a small learning curve when setting up the study and navigating the software. Secondly, an urban forest inventory can take a lot of time. Especially in densely-covered areas, such as along El Caño, a single plot can take several hours to an entire day's worth of work time. It is difficult to predict how long the study will take so it is best to set a long timeline for the project. For an idea of the time it takes, just the data collection for the City of Gainesville, Florida took about 6 months in total. 177 plots were measured across the entire city, which is 63.49 square miles, so each plot represented approximately 200 acres. El Caño is a much smaller area in total, however, so it is not likely to take as long. Finally, after the study is conducted, it may be difficult to interpret what the results mean and what to do with the data. It is best to look to other cities or small areas that have conducted an urban forest inventory and look at how they analyzed the data to create urban forest management plans. Additionally, a consultant could be hired using urban forest grant money to aid ENLACE on how to move forward with the results and optimize their use.

OPPOSITE Image of Cano Martin Pena. Photo courtesy of Laura Geronimo.

Community Data Dashboard

As mentioned in the previous section, the goals of creating a Community Data Dashboard for ENLACE, the G-8, and the Fideicomiso include to paint a picture of the community's demographic makeup, to compare the community's experience to the Municipio of San Juan more broadly, and to make the case to funding agencies for sustained investment in the community.

Process for Data Analysis
The Studio's data analysis process is captured by the figure to the left.

1. First, the students aggregated demographic data, captured at the block group level, to geographic levels that have more meaning -- in this case, neighborhoods within the community. Dividing data by neighborhood, though not the end goal, will also be useful for ENLACE to measure which of the neighborhoods they serve are in the most need of services. Our tract to neighborhood data key can be found in the table to the right.

2. Second, in order for data comparisons with the municipality to be meaningful, this neighborhood level data was aggregated up to the community level. This provides a more robust comparison baseline.

3. Next, students compared the state of the community with the state of the municipality through use of percentage comparisons and percentage differences. Some sample results are listed in the table on page 85.

4. Finally, students compared change over time across some key demographics.

Block Group	Neighborhood
36.1	Barrio Obrero San Ciprian
36.2	Barrio Obrero San Ciprian
37.1	Buena Vista Santurce
37.2	Buena Vista Santurce
37.3	Barrio Obrero Sector La Marina
37.5	Barrio Obrero Sector La Marina
38.1	Barrio Obrero Oeste
38.2	Barrio Obrero Oeste
44.1	Las Monjas
44.2	Las Monjas
44.3	Parada 27
45.1	Buena Vista Hato Rey
45.2	Buena Vista Hato Rey
45.3	Israel Bitumul
46.1	Israel Bitumul
46.2	Israel Bitumul
46.3	Israel Bitumul
46.4	Israel Bitumul
46.5	Israel Bitumul

ABOVE The table above is a block group to neighborhood aggregation key.

To assemble a demographic snapshot of the communities comprising El Caño Martín Peña, the Studio relied on three different methods of analysis, described briefly below:

1. Comparative analysis between the CMP community and the Municipio of San Juan (SJM). The process for this analysis is captured through the steps above. The process of aggregating each category of data is slightly different depending on the unit analyzed. We calculated four "total" numbers to use as the basis for our percentage calculations:

    a. Total population (age, race, and other general population statistics)

    b. Total population 16+ (education level, employment, and other education and labor force statistics)

    c. Total households (people per household, household income, and other household statistics)

    d. Total housing units (owners vs. renters, occupancy, and other housing statistics)

Percentages could then be drawn based on the basis numbers for both CMP and SJM.

2. Time series descriptive analysis between 2010 and 2017. For a few demographic categories, students also graphed trends over time. This type of analysis will be the easiest to update with the availability of new data. It should be noted that trend lines can be automatically drawn in Tableau with summary statistics (p-value, R2) included, though users should be cautious about trusting these numbers.

3. Spatial analysis. Through Tableau, the Studio was able to represent these data pictorially (Figures x.x-x.x). Described in later sections, the spatial representation of these data will enable ENLACE to view priority projects, parcels, and demographic information on one screen through the use of overlays and filters.

Sample Statistics

Throughout the course of this analysis, the Studio compiled some sample statistics that (1) satisfied the needs of the demonstration, (2) applied to various funding source application processes, and (3) showed interesting or unexpected trends. Many of these categories are components of social vulnerability, which include "the conditions and social factors that limit a person's abilities to cope with daily life and also make them vulnerable to the effects of disasters" (Blaikie et al., 2004; Wolkin et al., 2015, p. 810). Flanagan et al. (2011) sort these conditions and social factors into four categories:

- Socioeconomic status
- Household composition/disability
- Minority status/language
- Housing/transportation

Measure	2014 CMP	2014 SJM	2017 CMP	2017 SJM
Socioeconomic Status				
Less than high school education	32.0%	15.1%	32.4%	13.7%
Unemployment	13.0%	8.1%	12.2%	7.5%
Income <20,000 [1]	64.2%	48.3%	67.7%	46.9%
Median Household Income	$12,973	$27,950	$12,876	$25,804
Families with children in poverty	56.0%	36.5%	54.3%	37.7%
Household composition/disability				
Population 65+	15.9%	18.3%	19.2%	20.3%
Living Alone	12.3%	13.6%	15.4%	15.1%
6+ People per household	3.7%	1.9%	3.8%	1.6%
Minority Status				
Race: African-American[2]	22.4%	14.6%	19.6%	12.3%
Housing				
% Renting	35.4%	35.9%	37.2%	34.9%
% Vacant	24.1%	21.6%	26.4%	24.2%
Renter's cost-burden	38.3%	39.5%	37.9%	38.9%

ABOVE The table shows vital community-based characteristics delineated by these categories.
[1] Median household income for Puerto Rico is calculated at about $20,000 (DataUSA, 2016)
[2] Race classifications conducted by the Census Bureau, which rely on self-reporting and United States conceptions of race based on purity or lack thereof (i.e. the "one-drop rule"), may not capture the full scope of racial identities held by community members. This is especially true in the Caño Martín Peña, where racial identities of its Puerto Rican and, in many cases, Dominican inhabitants are much more complex (Torres-Saillant, 1998)

A few of these findings are useful for ENLACE to communicate to a variety of audiences, including potential funders, politicians, and the general public.

- *A significant difference in median household income.* By no means are the majority of Puerto Ricans or San Juan residents wealthy by U.S. standards; yet, residents of El Caño Martín Peña have much lower economic earning power.
- *A significant difference in education.* Residents of El Caño Martín Peña are twice as likely to have not completed high school than the average San Juan resident. This remains steady between 2014 and 2017.
- *A high percentage of older individuals, and many who live alone.* A crucial measure of social vulnerability in post-disaster contexts is the ability to rely on other individuals for support. Older residents and those who live alone (or who fit both criteria) are more vulnerable during natural disasters.
- *A high percentage of cost-burdened individuals.* Though residents of El Caño Martín Peña have rates of cost-burdened rentership that are on par with those of San Juan more generally, it is notable that they have a much lower income overall and thus perhaps a higher cost-burden in real purchasing power.

These demographic statistics and qualities can be leveraged to demonstrate need for sustained investment from various governmental and philanthropic sources. As explored further in the Funding Streams chapter of this report, these data in raw form and visualized can help make the case for ENLACE, the G-8, and the Fideicomiso to a wide audience of funders and supporters.

Gaps and Further Analysis
While Table x.x. shows a sample set of statistics that can be acquired through the Census Bureau, there are certainly more data available that the studio did not identify, compile, or analyze. The students identified a number of gaps remaining in data analysis, enumerated below:

Identification of more data points and categories. To conduct a full time series analysis, more data points are necessary, arguably dating back to the beginning of the ACS 5-year estimate analyses. As new data points come available (i.e. the 2018 and 2019 ACS), these will further illuminate challenges faced by the Caño Martín Peña post-hurricane.

Measurement of statistical significance of differences. The statistics compiled by the studio are descriptive and have not undergone rigorous scrutiny regarding their significance from a statistical perspective. Conducting this type of analysis will help determine the effects of country-wide phenomena, such as the effects of PROMESA or Hurricane Maria.

Challenges of scale. The smallest scale of data collected for this analysis is at the block group level. This gives a fairly accurate portrait of the community but is still prone to noticeable degrees of error. This data should be used as guidelines, but should be corroborated by on-the-ground accounts and surveys.

Data Management &
Property Visualization Tool

Current Data Management Methods

Currently, the Fideicomiso uses multiple Excel files located on individual machines to manage data and QGIS, a free GIS application, to visualize and map the data. These tools currently do not serve all of their needs, however, because they are tied to individual machines. The functions of these two software are limited, as they are not able to easily visualize the progress of projects, track rents and households, or how the property data ties into funding applications and ENLACE's data. Additionally, the staff at the Fideicomiso do not all know how to use QGIS, which has been a barrier to efficient data management and use. They recently got Amazon Web Services (AWS), a cloud-computing service, and are in the process of moving over to this new system which will help data sharing between local computers.

Specific Needs and Desires

The Fideicomiso requested a data management tool that could be used to track property management, project progress, and other relevant information at the parcel and household levels. The Studio received an RFP that they had put together describing the required functions of the tool, including:

- Map data connected to a cloud-based or backed up database
- Track leases, rent collection, and due dates
- Keep maintenance records, work orders, and costs
- Order and sort legal and ownership documentation
- Create reports, or import and export other data compatible with other software solutions
- Query data through a map or search functions
- Advanced search functions
- Creation, addition, and editing of new properties and related data
- Track demographics and individual information for each household
- Track survey data
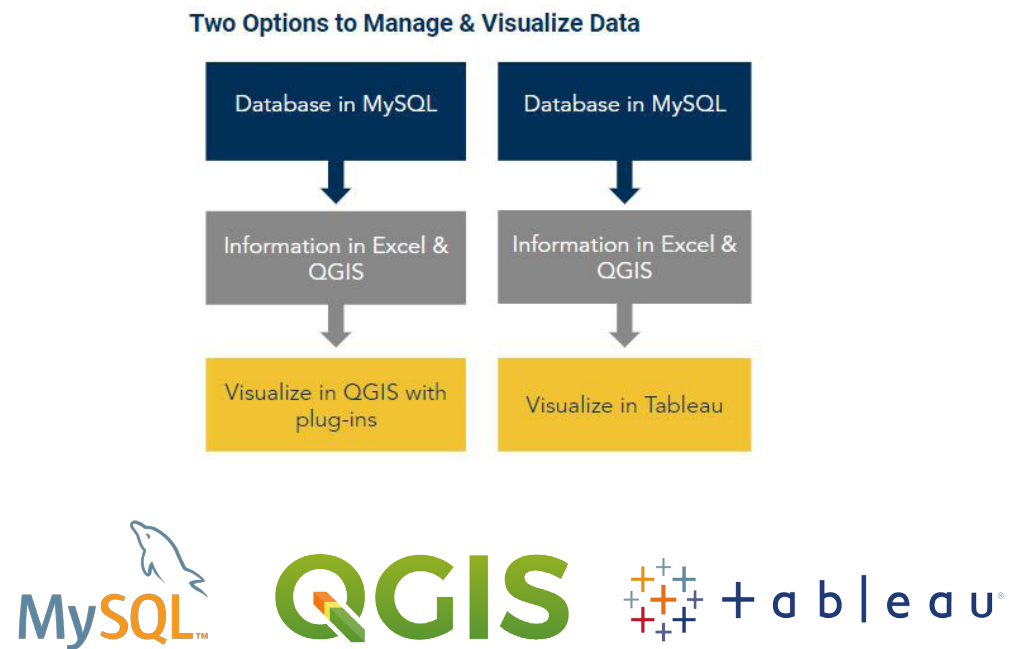- Itemize purchase funding sources, including grants and other income

The selection of recommended tools was limited by cost constraints, as well as ease of use. The Fideicomiso requested the Studio find a software that meets all or most of the above functions with minimal cost, as the quote they received for the formal RFP was $200,000. With QGIS already being a barrier to user-friendliness, it was crucial for the tool to be relatively easy to use with minimal training. It was also the duty of the Studio to provide as much guidance as possible with a User Guide document and video tutorials for how it specifically applies to ENLACE and the Fideicomiso, in addition to the software's own technical support online.

ABOVE Image from the ENLACE presentations. Photo courtesy of Carson Cooper.

Recommended Tools

The Studio presented two recommended tool options to ENLACE and the Fideicomiso to meet their priority needs for data management and visualization. The first is to use MySQL to set up a cloud-based database that supports existing Excel data files, visualize the data in maps using QGIS (which they currently use), and visualize the data in more complex ways using QGIS plug-ins. The second is to use MySQL to support the existing Excel data and QGIS shapefiles, then visualize the data in multiple ways in Tableau. The use of a MySQL database will ensure the data is updated within the cloud for all machines, and make it possible to easily search for information through a query, rather than within an Excel file. The tools are compared below.

Two Options to Manage & Visualize Data

Database in MySQL	Database in MySQL
Information in Excel & QGIS	Information in Excel & QGIS
Visualize in QGIS with plug-ins	Visualize in Tableau

Comparison of the Tools

The Studio recommends that ENLACE and the Fideicomiso install a MySQL database with either option, as it allows for the query function, shares and updates the data on all machines in the cloud, and further backs up the data through the cloud. For data management, both options will require the continued use of Excel to organize, input, and update data. For spatial data and shapefiles, both options also require the continued use of QGIS if shapefiles need to be manipulated or new shapefiles need to be created. The key difference between these two options is how the data is visualized.

The first option--visualizing the data in QGIS with data plug-ins--is advantageous as it is already being used by the Fideicomiso and it is free. However, not many people know how to use QGIS and will also have to learn how to use the plug-ins to create more engaging visualizations than simple maps. It is also more difficult to connect the QGIS visualizations with project management progress tracking, especially Mavenlink is selected as the final project management tool for ENLACE.

Visualize in QGIS with plug-ins

Advantages:
- Fideicomiso already uses QGIS
- Free

Disadvantages:
- QGIS is difficult to learn
- Does not integrate well with the project management tool (if Mavenlink is chosen)

Visualize in Tableau

Advantages:
- Easier to manage
- Integrates better with project management tool (if Tableau is chosen)

Disadvantages:
- Cost
- Will take some time to learn

The second option--visualizing the data in Tableau--is advantageous as it is easy to visualize and integrate multiple types of data and is relatively user-friendly. Tableau is fed by Excel data, connects to shapefiles, and easily updates through a 'Refresh' function as it is linked to the source files. It also allows for hovering functions, so that the visualizations are interactive. This option integrates well with tracking ENLACE's infrastructure projects if Tableau is selected as the final project management tool for ENLACE. However, Tableau is not a free software and while it is relatively user-friendly, it will require some training.

Recommended Tool Option

The Studio recommends that the Fideicomiso uses Tableau to visualize data, while updating and managing the data in Excel. Tableau makes it easy to visualize spatial, demographic, or informational data and updates easily through the linked 'Refresh' function. As long as shapefile shapes or points do not need to be edited, all information linked to each parcel can simply be updated in Excel then updated in the Tableau map with the click of a button. If shapefile polygons or point data needs to be manipulated or a new shapefile needs to be created, this will have to be done in QGIS, but will not be necessary for daily project updating and tracking. The User Guide and video tutorials will give detailed descriptions on how to use Tableau and the process for creating maps and data visualizations specific to property management at the parcel level.

OPPOSITE Demonstration of Tableau Links and Mapping in Tableau
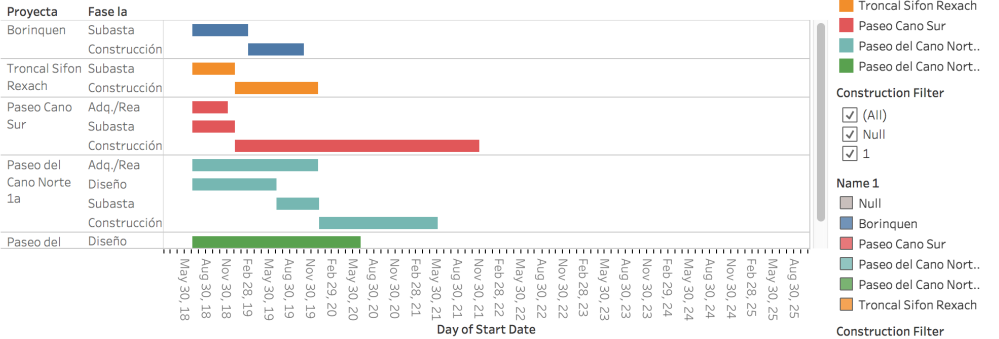
Funding Streams

Introduction

ENLACE highlighted funding as an organizational need and thus, a focus area for the studio. Specifically, ENLACE tasked the studio team with two objectives: first, enable ENLACE and its partner organizations to apply for grants and second, identify possible revenue streams less vulnerable to political influence. Before discussing the proposals to meet this objective, this report first discusses the existing challenges and political context that pose barriers to funding for ENLACE. Then, the funding portion of this report offers a review of relevant literature and plans. The next section provides the methodology used to conduct research and inform recommendations. Finally, the funding streams portion discusses financial recommendations, findings, and conclusions.

OPPOSITE Image of the ENLACE meeting and presentations. Photo courtesy of Jennifer Johnson.

Barriers to Funding

ENLACE and the Caño Martín Peña communities face several barriers to accessing critical funds to not only rebuild after Hurricanes Maria and Irma, but also to build basic infrastructure, ecologically restore the channel, and relocate families. The following paragraphs touch on some of these challenges. Specifically, this section discusses the challenge of Caño Martín Peña communities' location in a floodplain, ENLACE's status as a government agency, and political attitudes and perceptions about ENLACE.

Over 50% of the Caño Martín Peña communities exist in a floodplain. Some individual neighborhoods within the Caño Martín Peña communities lie in areas that are 90% floodplain, such as Buena Vista Santurce and Barrio Obrero Marina. Because of their location, the communities face flooding during major rain events as well as during hurricanes. This predicament poses barriers to funding opportunities, particularly federal financial assistance post-hurricane. The Puerto Rican government stated that it will only allocate federal financial assistance to rebuild outside flood- prone areas post Hurricane Maria and Irma (Kusisto and Campo-Flores, 2018). Those currently in chronically flooded areas are eligible to receive assistance but on the condition that they relocate to safer areas.

Part of ENLACE's mission is to retain existing residents within the geographic bounds of the eight Caño Martín Peña neighborhoods. Residents in these communities have expressed their desire to remain as well. The communities are very densely populated, and only 48.3% of ENLACE's district remains outside the floodplain. Because of these conditions, there is little room for these families to move both outside the floodplain but within ENLACE's jurisdiction. ENLACE and the residents within its purview are thus not competitive for these federal recovery funds distributed through the Puerto Rican government. Specifically, Vivienda, or the Municipality of San Juan's housing department will not allocate CDBG-DR funds or CDBG Entitlement funds to the Caño Martín Peña communities for housing reconstruction and infrastructure repair.

In addition to the communities' location in a floodplain, ENLACE's status as government agency poses barriers to accessing financial resources. Specifically, ENLACE is an independent government organization established under Puerto Rican law. Because it is not a nonprofit, it cannot accept donations and does not qualify for some grants that specifically target nonprofit entities. The G8 and the Fideicomiso can capture some of these opportunities because they are nonprofits under Puerto Rican law. However,

they are not 501(c)(3) nonprofits which poses some limitations to their funding and resource opportunities. The 501(c)(3) designation allows nonprofits to exempt federal taxes as well as allows their donors to write off donations (Foundation Group, 2019). The lack of 501(c)(3) status limits their donations from sources outside the island motivated by tax write-offs.

Another barrier to funding includes political attitudes about ENLACE and their perceived resources and capacity. The public and private sectors perceive that ENLACE receives sufficient funding, and thus, the city and other entities should not allocate additional money to the organization. A few reasons may prompt these attitudes. Unlike comparable organizations, ENLACE has a steady budget allocated to it by the Municipality of San Juan. In addition to this budget, the organization has the expertise and technical capacity that many similar entities do not have. For example, ENLACE's director Lyvia Rodríguez Del Valle is a former planning professor at UPR and provides the organization with years of planning experience and knowledge. Many community-based organizations in Puerto Rico do not have access to similar planning expertise. Finally, ENLACE and its partner organizations have garnered international attention. For example, the Caño Martín Peña Fideicomiso won a World Habitat Award in 2015 (World Habitat Awards, 2015). Overall, the public and private sector widely believe that ENLACE has sufficient resources because of its steady budget, planning expertise, and international attention. Despite these attitudes, ENLACE still struggles to fund its operations.

In addition to the barriers to accessing funds, ENLACE and its partner organizations encounter other issues once awarded financial support. These issues include but are not limited to rising construction costs post-hurricane, coordination between other government agencies, and timing of funds. While it is important to note these issues, this report largely addresses accessing funds and creating revenue streams.

Literature Review

The funding streams team first reviewed relevant plans to understand ENLACE's priorities and to identify existing funding sources and recommendations. Specifically, the team examined ENLACE's 2004 Comprehensive Development Plan, the 2015 EPA Urban Water Location Work Plan , the 2017 EPA Smart Growth Implementation Assistance Plan (2017), and finally, the Memorial de Presupuesto: Año Fiscal 2016-2017.

Overall the plan review provided the funding streams group valuable context about the Caño Martín Peña communities. Through the plan review, the funding streams group identified existing grant, government assistance, and other funding opportunities that ENLACE has pursued. Furthermore, this plan review provided critical context on infrastructure project costs, relocation costs, etc.

In addition to the plan review, the team conducted land trust case studies focusing on financing of housing and infrastructure. These case studies include Dudley Neighbors, Inc. (DNI) in Boston, Massachusetts, Maria Auxiliadora Community Land Trust in Cochabamba, Bolivia, and Cooperative UFAMA al SUR in Montevideo, Uruguay. The team examined looked at land trusts models in the continental United States to understand its relationship with federal and state government financing mechanisms. Bolivian and Uruguayan land trusts were considered to provide Latin American context to this study. While ENLACE is not a land trust, its relationship with the Fideicomiso de la Tierra del Caño Martín Peña and the G8 may present similar funding opportunities.

The DNI is a land trust that presides over 1,300 parcels of land in the Dudley Triangle neighborhood of Boston. Many consider DNI an incredibly successful community land trust that promotes development without displacement (DNI, 2019). DNI specifically leases community controlled vacant land to to both private and nonprofit developers for the sole purpose of building affordable housing. This housing must be consistent with the Dudley neighborhood's community master plan. The funding streams team studied this land trust to provide the context of how other land trusts and related organizations interact with the United States federal government. However, Dudley Neighbors mostly operates outside of federal sources of funding. In fact, the community land trust formed during a time of diminishing federal resources for affordable housing (Dwyer, 2015). Despite limited interaction with federal resources, the DNI's lease model informed the funding group's recommendations.

The Maria Auxiliadora Community established a community land trust for an informal settlement in Latin America much like ENLACE's eight communities. While the Maria Auxiliadora Community did not locate near a water body, their community is still subject to the effects of climate change via flash flooding, etc. (ECPA, 3013). Furthermore, the community raised funds to connect formal water/wastewater and power infrastructure to their informal community. ENLACE coordinates infrastructure projects for the Caño Martín Peña communities, so the resources used by the Maria Auxiliadora community may be applicable to their projects.

Another pertinent example is the Cooperative UFAMA al SUR in MonteVideo, Uruguay. The cooperative assisted low-income afro women-headed households by providing them social housing units. Their housing solutions focused in rehabilitating and transforming a small-scale abandoned building into 36 housing units. LIkewise, the provision of houses is not only a way ENLACE or the Fideicomiso can assist the Caño Martín Peña, but also a necessary step to carry out their priority projects. In order to construct necessary infrastructure, ENLACE needs to relocate families in the way of construction. The Cooperative's rehabilitation model is a low cost solution to creating affordable housing that ENLACE and the Fideicomiso can use to relocate families. The funding mechanism used by the UFAMA al SUR project is also relevant to ENLACE's projects. The UFAMA al SUR project acquired the buildings through the municipality, sourced construction equipment from an embassy, and used housing loans and resident labor to renovate the building. Some of these strategies may be applicable to fund housing projects in CMP considering that CMP is also a low-income marginalized urban community.

Overall, the plan review and case studies provided relevant context to the funding group's research. The funding streams group pulled relevant grants, financing mechanisms, and partnerships from these case studies and integrated them into the final deliverables.

Methodology

The studio team spent considerable time familiarizing itself with relevant planning documents and identifying case studies of community-driven initiatives carried out in similar contexts. To supplement this literature review and test the soundness of its scope and breadth, the team also conducted expert interviews with professionals working in relevant fields (see Research Approach in the figure below and list of early interview in the table to the right). These disciplines included property development (for-profit and non-profit, affordable and market-rate); climate adaptation and resilience planning; and federal grants administration.

Recommendations gathered from discussions with practitioners fell roughly into five categories of guidance:

1. Strategies for layering a variety of funding sources to make a multifamily or mixed-use development viable
2. Land value capture, exactions, and community benefits
3. Accessing federal tax credit programs, namely Low Income Housing Tax Credits (LIHTC), Opportunity Zones, and New Markets Tax Credits (NMTC)
4. Government grants that fit the unique needs and circumstances of the CMP communities and operational capacity of our client, ENLACE; and,
5. Streamlining the procurement process.

Plan Literature Review	Latin American Case Studies	Interviews
- **Comprehensive Development Plan (2004)** - **Urban Water Location Work Plan** (2015) - **EPA Smart Growth Implementation Assistance Plan** (2017) - **Memorial de Presupuesto: Año Fiscal 2016-2017**	- **Maria Auxiliadora Land Trust**, Cochabama, Boliva - **Cooperative UFAMA al SUR**, Montevideo Uruguay	- **Private developers** - **Non-profit affordable housing experts** - **ENLACE** - **Fideicomiso** - **G-8** - **Vivienda** - **EPA**

ABOVE Funding Streams Research Approach.

The expert interviews – most of which were conducted in the first half of the semester – were critical in refining the group's scope of work and steering its focus toward innovative funding strategies that might have otherwise been overlooked. The conversation with EPA staff, in particular, led the team to de-emphasize certain grants that the client had either already accessed or could more easily pursue with EPA assistance by virtue of their well-established relationship with Evelyn Huertas of the EPA Region 2 San Juan Bay Estuary Program. Interviews with real estate development professionals focused the team's attention on tax credit programs, particularly Opportunity Zones, which seemed capable of unlocking vast reserves of private finance without the administrative hurdles or concept limitations of LIHTC (namely, that LIHTC's emphasis on rental housing was at odds with the community land trust model). These practitioners also provided first-hand insights into strategies for partnering with profit-motivated developers in ways that ensured resources reached less lucrative areas and activities, e.g., to fund critical infrastructure serving residents outside of the immediate area of development.

Name	Affiliation	Title	Expertise	Interview Date
Richard Porter	Georgia Tech; Richport Properties	Director, Master of Real Estate Development, School of Building Construction; President	Private sector real estate development	2.18.2019
Gates Dunaway	Gates Dunaway Group	Managing Director	Non-profit affordable housing development	2.25.2019
Jason Bernagros	EPA	Water Quality Implementation Team Leader, Chesapeake Bay Program	Landscape architecture and water resources planning	3.1.2019
Evelyn Huertas	EPA	Manager, Region 2 San Juan Bay Estuary Program	Environmental science and grants administration	3.1.2019
Maureen Krudner	EPA	Region 2 Green Infrastructure Coordinator	Environmental science and green infrastructure	3.1.2019
Carlos Olmedo	Vivienda (HUD)	Deputy Director of Planning, CDBG-DR Program	Grant administration strategy, resilience planning	3.20.2019

ABOVE List of interviews.

Once familiar with the client's past work, current challenges, and having developed a scope informed by relevant communities of practice, the studio team considered how best to structure its funding streams deliverables. Its fundamental objective was to develop impactful, durable resources that could both immediately assist client decision making – e.g. regarding which grants to pursue – and ultimately identify strategies for long-term change that would benefit ENLACE and its community partners' ability to fund key projects. Consequently, the team sought structure deliverables that were intuitively organized, accessible to a variety of users in terms of their content, and had practical utility. The team wanted to avoid handing off a cumbersome academic paper or "just another plan" destined to collect dust on a shelf. At the same time, the studio team remained mindful of the need to produce something substantive and rigorously researched that would meet expectations for a professional city planning exercise.

By mid-March, as the team prepared preliminary findings to present to the client at the beginning of its week-long visit to San Juan, the funding streams work seemed to be logically coalescing around three principle deliverables. The team envisioned: specific funding streams for priority projects presented graphically and providing for multiple scenarios; a tabular "opportunity database" that included grants as well as other funding sources and partnerships (across governmental, philanthropic, and private sectors); and recommendations on innovative funding strategies, presented in a format to be determined.

Each deliverable was designed to complement the others, together providing a holistic view of funding prospects and their potential interactions over timelines most relevant to the client's project timeline. The "funding maps" scenario planning exercise involved schematic representations of how ENLACE might piece together diverse type of support – from federal grants to tax credits, linkage fees, or technical support – to fully fund a priority project over its lifespan. The studio team had hoped that these maps could provide a logic tree of mutually dependent variables that would undergird an iterative project management software.

The opportunity database was compiled as a collaborative Google Sheet that identified key grants from the federal government (e.g., EPA, FEMA, HUD, and USDOT) as well as non-governmental or non-grant sources (e.g., PR-based and external foundations, private companies, federal tax credit programs, technical assistance providers). The rationale behind this tabular database structure – rather than something more aesthetically pleasing – was that it would preserve options for integrating the database into a project management tool. The team employed a grant identification strategy that focused on meeting the needs of three selected ENLACE priority projects (e.g., sewerage, green streets, parks) and community needs (e.g., economic development and existing business retention). Prospective funding opportunities were then screened for potentially problematic eligibility restrictions (parcels in flood plains were often ineligible for federal redevelopment dollars, for example), funding levels, application deadlines, community sensitivities, among other criteria. Grants were initially identified through EPA's Water Finance Clearinghouse; local foundations and philanthropic funders were identified through Fundación Flamboyán's 2015 "Directorio de Fundaciones de Puerto Rico."

Findings & Recommendations

The following sections present the funding team's final deliverables and how they evolved after a week of field work in Puerto Rico. Notably, the proposed scenario planning exercise for ENLACE's priority projects, which was intended to identify and inter-relate applicable grants and financing mechanisms across a several-year time horizon, was eliminated for reasons explained below. The opportunity database was further populated and refined to highlight grants, partnerships, and other funding possibilities outside of the priority projects initially identified by ENLACE; several of the most promising of these were elaborated into dedicated fact sheets. Finally, the recommendations section highlights additional fact sheets on innovative funding strategies, a housing financing case study, procurement recommendations, and conclusion to the funding streams section of this report.

The week in Puerto Rico addressed critical gaps in data and communication that had hampered the research process earlier in the semester. For example, shortly after arriving in San Juan, a kickoff meeting at the ENLACE office fundamentally reoriented the studio team's approach to its funding streams research. Early scoping and research had been organized around the individual key projects identified by ENLACE, all of which focused on extending sewerage, water service, and green infrastructure for stormwater management – particularly greenways – throughout the eight communities. However, in their first in-person presentation to the Georgia Tech group after it arrived in San Juan, ENLACE and Land Trust staff emphasized that housing and housing and relocation was their primary focus. Removing this constraint on project activity scope, which had limited the pool of potential funding sources under consideration to EPA and USDOT grants, for the most part, allowed the studio team to expand its search to include incentives and grants for housing and economic development. Other key lessons from the week in Puerto Rico that reshaped the funding streams deliverables included the following topics on the right.

Legal status: the team had been aware of ENLACE's role as a government corporation; however, insights into the status of the G-8 and Land Trust – non-profits in the eyes of Puerto Rican law but not federally designated 401(c)(3)s – helped clarify grant eligibility;

Urban design: the CMP communities' unique demographic characteristics (bifurcated age structure skewed toward older adults and the young children they were raising) and the acute stigma in San Juan attached to any physical forms reminiscent of public housing demanded sensitive treatment. Innovative design typologies for housing and examples of intergenerational planned communities became much more important;

Grant compliance: because of the client's relatively small staff size and limited technical capacity, burdensome reporting requirements over the life cycle of a grant was a potential deal-breaker and would likely disquality certain grants from consideration;

Land value capture: Puerto Rico's ongoing fiscal crisis, staff observed, would make implementation of tax increment financing a very difficult political "sell" to the revenue-starved San Juan government;

Master planning: the studio team had been unaware that ENLACE was preparing an RFP for a master plan that would update the 2004 comprehensive plan to reflect latest science and best practices around climate adaptation and green infrastructure.

Scenario Planning for Priority Projects

During the Puerto Rico trip, ENLACE leadership had expressed enthusiasm about the prospect of incorporating funding scenarios into the emerging program management tool. After returning to Atlanta and evaluation feasibility, however, it became clear that this feature went beyond the natural capabilities of Tableau, the newly selected software platform for the tool. Only the most superficial information on funding time-lines could be integrated, the team concluded, without highly bespoke workarounds that would likely fail over time without periodic reconfiguration.

Opportunity Database

To address the team's first task, the funding group created an opportunity database to enable ENLACE and its partner organizations to apply for grants. The database offers various grants, partnerships, and other funding mechanisms into one convenient, master excel file. The file includes information on the opportunity name, its administrator, and a brief description. Furthermore, the database includes application details, funding levels, and pros and cons. Finally, the excel sheet provides space to indicate if ENLACE has pursued this opportunity. Originally, the funding streams group created the database in google sheets. However, during the trip to Puerto Rico, the team learned that ENLACE primarily uses Microsoft OneDrive. With this information, the funding group converted the file to a Microsoft excel spreadsheet. The funding streams group turned over this excel file to ENLACE after the completion of the studio.

On the right you will find line-item examples of how the group presented the information. Overall, the excel sheet contains 35 governmental grants. In addition to these governmental sources, the excel sheet contains 30 other forms of support. These forms include philanthropic foundation grants, tax incentives, technical assistance programs, and potential partnerships. The funding streams group intends for ENLACE to update and manipulate the Opportunity Database. Specifically, the group hopes that the ENLACE staff member responsible for grant research will find it useful.

PROGRAM NAME	ADMINISTERED BY	DESCRIPTION	HOW TO APPLY
Community Development Block Grants (CDBG)	HUD (via Vivienda)	"Eligible to fund stormwater and green infrastructure because these projects can create jobs, increase economic activity, and increase property values" (EPA Water Infrastructure and Resiliency Finance Center 2017).	
CDBG Section 108 Loan Guarantee Program	HUD	Allows future CDBG allocations to be used to guarantee loans for neighborhood revitalization projects, including construction and installation of public facilities and infrastructure. Section 108-guaranteed projects can incorporate green infrastructure into their design and construction. The Section 108 Loan Guarantee Program (Section 108) provides communities with a source of financing for economic development, housing rehabilitation, public facilities, and other physical development projects, including improvements to increase their resilience against natural disasters	More information at -https://www.hudexchange.info/programs/section-108/ -https://www.hudexchange.info/programs/section-108/section-108-program-eligibility-requirements/#section-108-loan-requirements-and-underwriting - application opened year long

FUNDING LEVELS	PRO's	CON's	PRIORITY PROJECTS
$6,993,886.00 disbursed to San Juan in 2018; $6,313,768.00 in 2017 (https://www.hudexchange.info/grantees/san-juan-pr/)	Can be used for acquisition of real property; relocation and demolition; rehabilitation of residential and non-residential structures; construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers; activities relating to energy conservation and renewable energy resources, among other activities.	Construction of new housing is typically ineligible	Paseo el Caño Sur and Norte
- Loans typically range from $500,000 to $140 million, depending on the scale of the project or program - The maximum repayment period for a Section 108 loan is twenty years	- public entities can apply - the loan can be used to fund acquisition of property, Housing rehabilitation eligible under CDBG Construction, reconstruction, or installation of public facilities (including street, sidewalk, and other site improvements), related relocation, clearance, site improvements, Finance fees public works and site improvements in colonias, in limited circumstances, housing	- ENLACE would need to have a reimbursement plan	Paseo el Caño Sur and Norte

ABOVE ENLACE Project Inventory and Funding Streams Checklist google spreadsheet.

Fact Sheets on Major Grants

To showcase certain grants housed in the Opportunity Database, the funding streams group presented a few choice opportunities in fact sheet format. The purpose is to express the capabilities of the grant in an accessible, visual format. Furthermore, the fact sheets offer a quick summary of the grant and its context in Puerto Rico. The fact sheets also tease out more details about the pros and cons of pursuing the grant as well as general details about grant type, time horizon, etc.

The funding group chose to showcase the following grants: CDBG & CDBG-DR, grants for aging communities, and EPA Brownfields grants. These opportunities are the most applicable to ENLACEs situation. For example, over 30% of the Caño Martín Peña communities are over the age of 55. Given this statistic, ENLACE or its partner organizations may be eligible for grant opportunities that assist elderly communities. The fact sheets can be found in the appendix on pages 124-141.

Innovative Funding

For the sake of simplicity, standardization, and to distill seemingly incongruous program structures into something digestible and directly comparable, the studio team also chose to use the fact sheet format for its alternative funding strategy recommendations. The team considered a wide spectrum of programs, tools, and potential partnerships, drawing from the Opportunity Database. Ultimately, it selected options to highlight based on applicability to the client's community circumstances and the broader Puerto Rican context, potential scale of funding and flexibility in eligible activities, community sensitivities and compatibility with community identity (e.g., its emphasis on homeownership), and institutional barriers such as elaborate legal structures or reporting requirements. The team also sought to include recommendations that covered a range of time horizons from the immediate to the long-term (e.g., an estimated 10 years for building institutional capacity building and marshalling political will at the municipal or territorial level). This selection process led to fact sheets on Opportunity Zones, New Market Tax Credits, and tax increment financing (TIF), and more specifically resulted in the following recommendations:

> 1. Build capacity to participate in tax credit programs: spin off Community Development Entity that can compete for New Markets Tax Credit allocations and engage with Enterprise and National Equity Fund to determine whether CMP projects could become recipients of their Qualified Opportunity Funds investment;

> 2. Begin studying long-term feasibility of TIF that includes high-value adjacent parcels in its geography; this may require a nexus study to demonstrate and quantify development impact from these parcels;

> 3. Engage promising private sector partners Cocal-Cola and Fundación Banco Popular, both of which could support the client's work through foundation investment that would align closely with their corporate social responsibility platform and compliance requirements under the Community Reinvestment Act, respectively.

Other Recommendations

Case Study - Incremental Houses (half houses)
To respond to the need of low-income households, several developing countries, with limited financial capacities, have built incremental housing which consist of a fist construction phase led by the state, and in a second phase the household expands the house. One specific example the studio team examines is the Incremental Houses in Quinta Monroy in Chile, a community facing similar objectives of the neighborhoods of the Caño Martín Peña. Some of the objectives includes addressing many issues brought by the nature of informal urbanization, keeping the family in the same neighborhood, and developing a land too small for single family units.To achieve these goals in the first phase of the project, the chilean housing agency built half houses that meet all legal requirements and construction standards, and provided a subsidy of $7,500 dollars per units - for a total of 100 units- which cover the land acquisition, the architectural design, and the construction costs. The households also played a more critical role in the achievement of the second phase of the houses as they lead progressively the expansion of house with their own financial resources and the state technical assistance.

In addition to fact sheets on funding opportunities, the studio group prepared for the Community Land Trust a list of developers that had demonstrated success in demonstrated success in smaller-scale or context-sensitive affordable housing development. In order to streamline the procurement process and more effectively reach appropriate candidates, the team advised the Land Trust to consider soliciting proposals for affordable housing projects from these firms through an invited bid rather than their customary RFP or RFQ. In identifying and evaluating potential candidates to recommend, the studio team considered criteria including experience in: Puerto Rico; Latin America; mixed-Use development; neighborhood commercial and small-scale business incubation; and housing rehab. The team also focused its attention on firms that appeared to place an emphasis on high-quality, context-sensitive urban form rather than those that simply succeeded in financing the proliferation of aesthetically sterile, low-cost construction. These criteria led to the following recommendations:

- CRC Companies (based on multigenerational housing rehab of the El Rancho Verde development in San Jose, California and workforce housing in Honduras);

- Elemental (based on incremental housing case studies in the Chilean communities of Quinta Monroy and Villa Verde);

- Enterprise Homes (based on townhome and "middle housing" case studies of MetroTowns, Renaissance Square, and Wheeler Creek – all in the mid-Atlantic region);

- Barrett Studio Architects (based on intentional mixed-income communities Kestrel and Holiday Urban Neighborhoods in Colorado); and,

- DPZ Partners (based on Blue Water in the Florida Keys, workforce housing composed of interlocking, single-story courtyard homes).

Conclusions

During the San Juan meetings, ENLACE project managers had expressed enthusiasm at the idea of the Studio's final deliverables including any additional guidance on its long-awaited RFP for a new master plan. To this end, the team also included a brief profile of one planning firm with experience outside of Puerto Rico that appeared to be a good candidate for this work, along with broader observations about qualities that would make an RFP respondent a particularly good fit. The team recommended that ENLACE's selection committee target its master planning RFP to reach firms with experience with: Latin America and the Caribbean (or, at the least, in developing economies outside of the United States); vernacular design; tropical contexts; and contexts experiencing capacity challenges and less-developed infrastructure. The accompanying one-pager highlighted California-based firm Opticos and its internationally recognized work on the master plan for Akanda, Uganda, which included a new form-based code and guidelines for tropical building design and sustainability.

The final deliverables described above provide a foundation for future studio work that addresses in more granular detail the client's long-term funding prospects. There are two notable limitations this studio team encountered that should be mitigated (or accounted for in initial scoping) in future iterations: lapses in communication with the client (and excessive "gatekeeping" that inhibited deeper collaboration); and the limited time period and back-loaded nature of the spring academic semester. One possible tactic for addressing the latter issue would be to conduct the studio in the fall semester and schedule the trip to Puerto Rico at the end of the summer. In-person collaboration with client and UPR colleagues is the most fruitful opportunity for idea generation and confirmation of scope of work, and holding this trip as early as possible would help guide studio work with greater purpose and certainty for the duration of the semester.

Regarding communication, it is obviously difficult for any client – especially for a small, community-focused public entity such as ENLACE – to devote staff time and resources to management of a student project. However, the small number of meaningful touch points over the semester and lack of access to programmatic staff engaged in day-to-day project details imposed a relatively low ceiling on the depth of analysis the studio team was able to apply. The team often worked on inference and communication with third-party partners, like the client's EPA region manager, rather than through more efficient direct exchange with the client. By the end of the semester, for example, the studio team had still failed to secure a single meeting with ENLACE's grant manager, despite repeated outreach, which likely limited the relevance and specificity of the funding streams work. In future studio iterations, it would be helpful to establish and adhere to a standing weekly meeting with the client and to ensure remote access to programmatic staff rather than to leadership alone.

OPPOSITE Image taken on the bicicaño tour. Photo courtesy of Mirit Friedman.

References

Akbari, H., Pomerantz, M., Taha, H. (2001). Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. Solar Energy, 70. (3). 295-310.

Akkermans, H., & Van Helden, K. (2002). Vicious and virtuous cycles in ERP implementation: A case study of interrelations between critical success factors. *European Journal of Information Systems*, 11(1), 35–46. https://doi.org/10.1057/palgrave. ejis.3000418

Algoed, L.; Hernández Torrales, M.E.; & Rodríguez Del Valle, L. (2018). El Fideicomiso de la Tierra del Canþo Martiìn Penþa Instrumento Notable de Regularizacioìn de Suelo en Asentamientos Informales. Retrieved from the Lincoln Institute of Land Use website: https://www.lincolninst.edu/sites/default/files/pubfiles/algoed_ wp18la1sp.pdf

Andreu, M. G., Fox, D., Landry S., Northrop, R., and Hament, C. (2017). Urban Forest Ecological Analysis. Report to the City of Gainesville, March 2017. City of Gainesville, Florida.

Blaikie, P., Cannon, T., Davis, I., and Wisner, B. (2004). At risk: Natural hazards, people's vulnerability and disasters. New York, NY: Routledge.

Brindley, D. (2018, March 20). Months After Hurricane Maria, Puerto Rico Still Struggling. Retrieved April 17, 2019, from Magazine website: https://www.nationalgeographic.com/magazine/2018/03/puerto-rico-after-hurricane-maria-dispatches/

Brodine, M. (2017). Proyecto ENLACE del Caño Martín Peña: Restoring an Ecosystem and Building Resilient Communities in Puerto Rico. Retrieved April 8, 2019, from Urban Waters Learning Network website: http://www.urbanwaterslearningnetwork. org/resources/proyecto-enlace-del-cano-martin-pena-restoring-ecosystem-building-resilient-communities-puerto-rico/

DataUSA (2016). Puerto Rico. Retrieved from https://datausa.io/profile/geo/puerto-rico/

Dooling, D. (1997). Hot 'Lanta (NASA, school kids team to study how trees help cities keep their cool). National Aeronautic Space Association. Retrieved from https://science.nasa.gov/science-news/science-at-nasa/1997/essd08may97_1

Dwyer, L. A. (2015) Mapping Impact: An Analysis of the Dudley Street Neighborhood Initiative Land Trust [PDF File]. Retrieved from https://dusp.mit.edu/sites/dusp.mit. edu/files/attachments/news/Dwyer_Thesis_FINAL.compressed.pdf

El Gobierno de Puerto Rico. (2019). Puerto Rico Open Data Interconnection Portal. Retrieved from https://data.pr.gov/en/

EPA. (2015, July 30). Urban Waters and the Caño Martín Peña (Martín Peña Channel, Puerto Rico) [Overviews and Factsheets]. Retrieved March 26, 2019, from US EPA

website: https://www.epa.gov/urbanwaterspartners/urban-waters-and-cano-martin-pena-martin-pena-channel-puerto-rico

Flanagan, B. E., Gregory, E. W., Hallisey, E. J., Heitgerd, J. L., & Lewis, B. (2011). A social vulnerability index for disaster management. Journal of Homeland Security and Emergency Management, 8(1), 1-22.

Flyvbjerg, B. (2007). Policy and planning for large-infrastructure projects: Problems, causes, cures. *Environment and Planning B: Planning and Design, 34*(4), 578–597. https://doi.org/10.1068/b32111

Foundation Group. (2019) What is a 501(c)(3)? Retrieved from https://www.501c3. org/

Fuller Marvel, L. (2008) Listen to What they Say: An Approach to Social Planning in Puerto Rico. San Juan, Puerto Rico: La Editorial, Universidad de Puerto Rico.

Giezen, M. (2012). Keeping it simple? A case study into the advantages and disadvantages of reducing complexity in mega project planning. *International Journal of Project Management*, 30(7), 781–790. https://doi.org/10.1016/j.ijproman.2012.01.010

Government of Puerto Rico. (2019). Puerto Rico: Disaster Recovery Action Plan. Retrieved April 17, 2019, from http://www.cdbg-dr.pr.gov/wp-content/uploads/2019/03/111618_PRDOH-Action-Plan_Substantial-Amendment_030819_Approved.pdf

Herwitz, E. (2001). Trees at Risk: Reclaiming an Urban Forest. Worcester, MA :Chandler House Press.

i-Tree. (n.d.). Retrieved from https://www.itreetools.org/

King, V. & Davis, C. (2004). Final Report: Isolating and Managing Urban Heat Islands in Selected Southeastern Cities. Greensboro, NC: The James E. Clyburn University Transportation Center, North Carolina Agricultural and Technical State University.

Kusisto, L. & Campo-Flores, A. (2018, Sep 17) Puerto rico to hurricane-hit homeowners: Move if you want aid. Dow Jones Institutional News. Retrieved from https:// www.dowjones.com/

Mazzei, P. (2018, November 28). Protest in Puerto Rico Over Austerity Measures Ends in Tear Gas. The New York Times. Retrieved from https://www.nytimes. com/2018/05/01/us/puerto-rico-protests.html

Meléndez, E. & Hinojosa, J. (2017, October). Estimates of post-Hurricane Maria exodus from Puerto Rico. Retrieved from https://centropr.hunter.cuny.edu/sites/default/ files/RB2017-01-POST-MARIA%20EXODUS_V2.pdf

Meléndez, E., & Martínez, V. (2017). Conflict of Interest Shadows Members of the FOB | Centro de Estudios Puertorriqueños. Retrieved April 17, 2019, from https://centropr.hunter.cuny.edu/events-news/puerto-rico-news/fiscal-oversight-board/conflict-interest-shadows-members-fob

Montoya-Galvez, C., & Begnaud, D. (2019). Lawmakers introduce Puerto Rico statehood bill: "It's time to end 120 years of colonialism." Retrieved April 19, 2019, from https://www.cbsnews.com/news/statehood-for-puerto-rico-lawmakers-to-introduce-bill-granting-puerto-rico-statehood-bypassing-any-referendum/

NASA. (2018). Landsat Image Gallery - Recovering from Hurricane Maria. Retrieved April 22, 2019, from https://landsat.visibleearth.nasa.gov/view.php?id=92789

NOAA. (2017). Extremely active 2017 Atlantic hurricane season finally ends | National Oceanic and Atmospheric Administration. Retrieved January 24, 2018, from http://www.noaa.gov/media-release/extremely-active-2017-atlantic-hurricane-season-finally-ends

Proyecto Enlace del Caño (2004). Plan de desarrollo integral y usos del terreno del distrito de planificación especial del Caño Martín Peña.

Resilient Puerto Rico Advisory Commission (2018). Reimagina Puerto Rico.

Retamal, H. (2017). Track storms as they travel through the Pacific and Atlantic Oceans. Retrieved April 22, 2019, from WSJ website: https://www.wsj.com/graphics/hurricane-tracker/

Rodriguez, L. (2017). ENLACE Caño Martín Peña: A Restoration and Resiliency Project. Retrieved from https://docs.house.gov/meetings/IF/IF18/20171114/106623/HHRG-115-IF18-Wstate-RodrguezDelValleL-20171114.pdf

Roman, L. & Scatena, F. (2011). Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA. Urban Forestry & Urban Greening, 10. 269-274.

Skiera, B. & Moll, G. (1992). The sad state of city trees. American Forests. 61-64.

Sullivan, E. (2018). Nearly A Year After Maria, Puerto Rico Officials Claim Power Is Totally Restored. Retrieved April 17, 2019, from NPR.org website: https://www.npr.org/2018/08/15/638739819/nearly-a-year-after-maria-puerto-rico-officials-claim-power-totally-restored

Sutter, J. (2018). Leptospirosis: Puerto Rico's hidden bacterial disease "outbreak" - CNN. Retrieved December 1, 2018, from https://www.cnn.com/2018/07/03/health/sutter-leptospirosis-outbreak-puerto-rico-invs/index.html

Texas A&M. (2019). The Role of Universities - Hazard Mitigation Corps. Retrieved March 26, 2019, from Coastal Resilience website: https://coastalresilience.tamu.edu/home/introduction-to-coastal-resilience/adapting-to-climate-change-and-population-growth-2/facilitating-resiliency/role-of-universities/

TMR OnQ Framework Template. (2017). State of Queensland Department of Transport and Main Roads.

Torres-Saillant, S. (1998). The tribulations of Blackness: Stages in Dominican racial identity. Latin American Perspectives, 25(3), 126-146. https://www.jstor.org/stable/2634170

United Nations. (2018). Special Committee on Decolonization Refers to Post-Hurricane Plight of Puerto Ricans as It Approves Annual Self-Determination Text | Meetings Coverage and Press Releases. Retrieved April 19, 2019, from https://www.un.org/press/en/2018/gacol3324.doc.htm

United States Census Bureau. (n.d.). About the bureau. Retrieved from https://www.census.gov/about/what/admin-data.html

United States Census Bureau. (2014). American Communities Survey [Data file and maps]. Available from Social Explorer web site: https://www.socialexplorer.com/explore-maps

United States Census Bureau. (2017). American Communities Survey [Data file and maps]. Available from Social Explorer web site: https://www.socialexplorer.com/explore-maps

United States Census Bureau. (2010). Decennial census [Data file and maps]. Available from Social Explorer web site: https://www.socialexplorer.com/explore-maps

Walker, S. Y. J. (2002). Project understanding, planning, flexibility of management action and construction time performance: Two Australian case studies. Construction Management and Economics, 20(1), 31–44. https://doi.org/10.1080/01446190110089691

Wolf, K. L. (2004). Trees, Parking and Green Law: Strategies for Sustainability. Stone Mountain, GA: Georgia Forestry Commission, Urban and Community Forestry.

Wolkin, A., Patterson, J. R., Harris, S., Soler, E., Burrer, S., McGeehin, M., & Greene, S. (2015). Reducing public health risk during disasters: Identifying social vulnerabilities. Journal of Homeland Security and Emergency Management, 12(4), 809-822. https://doi.org/10.1515/jhsem-2014-0104

World Habitat Awards. (2015) Caño Martín Peña Community Land Trust. Retrieved from https://www.world-habitat.org/

Appendix

FUNDING STRATEGIES
FINAL RECOMMENDATIONS

To showcase certain grants housed in the Opportunity Database, the studio team have included a few choice opportunities in fact sheet format. The purpose is to express the capabilities of the grant in an accessible, visual format.

The fact sheets offer a quick summary of the grant and its context in Puerto Rico. They also tease out more details about the "pros and cons" of pursuing the grant as well as general details about grant type, time horizon, etc.

GOVERNMENTAL GRANTS

- CDBG (p.2)
- CDBG-DR (p.3)
- HUD Section 202 Program (p.4-5)

The studio team has also produced fact sheets on alternative funding strategy recommendations. The team considered a wide spectrum of programs, tools, and potential partnerships, drawing from the Opportunity Database.

Criteria for selection included applicability to the client's community circumstances and the broader Puerto Rican context, potential scale of funding and flexibility in eligible activities, community sensitivities and compatibility with community identity (e.g., its emphasis on homeownership), and institutional barriers such as elaborate legal structures or reporting requirements.

ALTERNATIVE FUNDING STRATEGIES

- Tax increment financing (TIF, p.6-7)
- Opportunity Zones (p.8-9)

CDBG

DESCRIPTION

The community development block grant (CDBG) program provides funding to improve affordable housing, infrastructure, and economic opportunities in low to moderate income communities.

Grantees can use funds for property acquisition including relocation and demolition of property as well as rehabilitation of structures. The grant may also fund the construction of public infrastructure such as water/wastewater systems and streets. Furthermore, the CDBG can fund enewable energy and energy conservation projects. Finally, the grantee may use the funds tooster economic development and job-creation.

PUERTO RICO CONTEXT

The Municipality of San Juan received nearly $7 million in CDBG funds in 2018.

PROS
- Many ENLACE projects fit the description of eligble CDBG activities.

CONS
- Construction of new housing is typically ineligible.

TYPE
Affordable Housing, Infrastructure, Economic Development

ADMINISTERED BY
HUD (via Vivienda)

APPLICANT(S)
ENLACE

PROJECTS
Paseo del Caño Sur/Norte, Water/Sewer Systems, Housing Relocation and Construction

FUNDING LEVELS
Municipality of San Juan has $7 to allocate.

HOW TO APPLY
Contact Carmen Caraballo at ccaraballo@sanjuanciudadpatria.com for more information.

CDBG-DR

DESCRIPTION

The Community Development Block Grant program also provides funding for disaster recovery. Funds can be used for a variety of community development activities that benefit low and moderate-income individuals, reduce blight, or address an urgent community need. In rehabilitating housing and constructing public amenities, cities may be able to incorporate green infrastructure techniques) in street design.

Housing programs include Home Repair, Reconstruction, or Relocation Program, which will provide assistance to eligible homeowners to repair damaged homes or rebuild substantially damaged homes in non-hazard areas. Eligible homeowners with damaged homes in a hazard zone (areas situated in the floodplain, floodway, or areas vulnerable to landslide) will be offered relocation assistance.

PROS

- May cover relocation and housing if moved outside the floodplain or out of the CMP

- ENLACE projects comply with the Affirmatively Furthering Fair Housing act, a requirement.

CONS

- CDBG-DR will not cover the development of new infrastructure.

- Housing construction, rehabilitation and relocation cannot be done in a designated floodplain .

TYPE

Disaster Recovery, Affordable Housing, Infrastructure, Economic Development

ADMINISTERED BY

HUD (via Vivienda)

APPLICANT(S)

ENLACE

FUNDING LEVELS

$1.5 billion of $20 billion CDBG-DR funds dispersed to PR.

RESTRICTIONS

Cannot fund relocation in FEMA-designated flood zones.

HOW TO APPLY

Application opens in May 2019. Proposal must address a disaster-related impact, be a CDBG eligible activity, and meet a CDBG national objective.

AGING COMMUNITIES GRANTS

With over 30% of the population 55 years and older, the CMP communities can benefit from programs catered to aging populations. This fact sheet offers information on two grant programs that offer funds specifically to aging communities.

HUD SECTION 202 PROGRAM
SUPPORTIVE HOUSING FOR THE ELDERLY

DESCRIPTION

HUD's Section 202 Program offers a capital advance to construct and operate affordable rental housing for the elderly so that they can age in place with supportive services. Both the capital and operating funding streams are allocated to nonprofits and municipalities.

PUERTO RICO CONTEXT

Puerto Rico has benefited from this program in the past. The facing page offers a case study from Hormigueros, Puerto Rico.

TYPE

Affordable Housing

ADMINISTERED BY

HUD (Atlanta Hub)

FUNDING LEVELS

$2.5 Mi to $11.5 Million

AARP COMMUNITY CHALLENGE

DESCRIPTION

The AARP Community Challenge offers a yearly grant to improve livability for people of all ages. The 2019 challenge provided funds to non-profits and government entities for community-based "quick-action" projects related to housing, transportation, smart cities and public spaces.

PUERTO RICO CONTEXT

The San Patricio community in Puerto Rico received this grant in 2018 for street crossing improvements.

TYPE

Community-Based "Quick-Action Projects

ADMINISTERED BY

AARP

FUNDING LEVELS

Median grant amount is $50,000

TAX INCREMENT FINANCING

DESCRIPTION

Tax Increment Financing (TIF) is a value capture mechanism that uses the future increased tax value of a development to fund reinvestment.

PUERTO RICO CONTEXT

The Puerto Rican government passed enabling legislation for TIFs in 2014. This legislation allows TIF to use 50% of the State Sales and Use Tax revenues to fund redevelopment. Thus far, the San Juan Convention Center District is the only TIF district in Puerto Rico. This district uses TIF to fund large-scale downtown redevelopment projects. Outside of Puerto Rico, there are several examples where TIF is used for smaller-scale redevelopment more suited to the CMP communities. An example of this smaller-scale redevelopment financed by TIFs is on the facing page.

TYPE

Economic Development

APPROVED BY

Municipality of San Juan and Government of the Commonwealth of Puerto Rico

ADMINISTERED BY

Municipality of San Juan

TIME HORIZON

50 Years

SECTION 202 CASE STUDY

HORMIGUEROS, PR

In 1995, Section 202 awarded Estancias Presbiterianas del Angel a capital advance of $11,305,033 to build affordable senior housing in Hormigueros, Puerto Rico.

The development consisted of 5 connected buildings ranging in scale from 1 to 4 floors. The design alluded to local cultural heritage and architecture. Furthermore, the property featured accessibility specific to the elderly and disabled residents including color-coded floors, ramps, wide hallways, etc.

PROS

- Can be used to fund infrastructure, street improvements, parks, etc.

- Long-term revenue stream

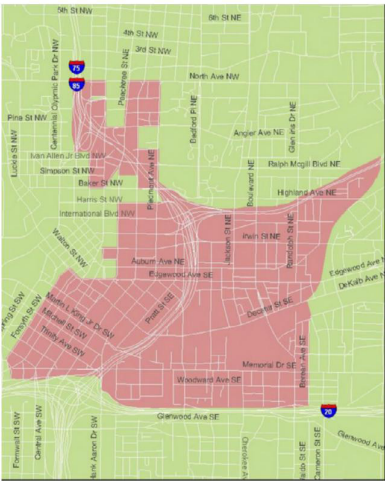- Territorial taxes are already very low; prime for TIF

CONS

- Limited Puerto Rican precedents

- Municipal governments may fight against any scheme that takes tax revenue

- TIF boundary may expand into other communities with competing priorities

- TIF can significantly constrain an organizations ability to generate tax revenues

OPPORTUNITY ZONES

DESCRIPTION

Opportunity Zones (OZs) are eligible Census Tracts designated by Federal government in an effort to attract private investment to historically disinvested communities. There are 8,760 OZs nationwide, of which 863 are in Puerto Rico – covering virtually the entire island including the Caño Martín Peña communities.

PUERTO RICO CONTEXT

There are 8,760 OZs nationwide, of which 863 are in Puerto Rico – covering virtually the entire island including the Caño Martín Peña communities.

Investors are reportedly waiting to see the outcome of a bill pending in the territorial legislature – which would ensure the same capital gains benefits as those on the mainland – before investing in Puerto Rican OZs.

TYPE

Private investment (incentivized by tax credit)

APPROVED BY

Requires project adoption by Qualified Opportunity Fund

ADMINISTERED BY

Puerto Rico Department of Treasury

TIME HORIZON

Immediate to 10 years

TIF CASE STUDY

ATLANTA EASTSIDE TAD

The City of Atlanta established TIF in the eastside downtown neighborhoods to fund streetscape improvements, mixed-income residential development, retail development, and adaptive reuse of vacant buildings. Through TIF, the tax increment funds a grant program designed to provide gap financing to "property owners and/or developers seeking to develop small to medium-scale catalytic real estate projects."[1] If similarly set up, a TIF in the CMP communities can invite investment but retain the character and scale of the area.

---

1   Invest Atlanta. "2019 Eastside and Westside TAD Program Guidelines," February 2019.

PROS

- Can potentially unlock orders of magnitude more capital for community projects

- Very few restrictions on userelatively few reporting requirements because money is private rather than public

- Eligible uses include affordable housing, mixed-use, and brownfield redevelopment

CONS

- Specific details around the program have been murky, Federal gov't has been slow to release policy guidance

- Investment must be in the form of equity rather than debt (e.g., investor must take partial ownership of enterprise)

- Requires participation of a third-party Qualified Opportunity Fund

Credit: Carver Neighborhood Market; Google

OZ CASE STUDY

SOUTH ATLANTA

There are 26 designated Opportunity Zones in the City of Atlanta, and local officials promoted at least one projext in each in an April 2019 "Opportunity Zone Prospectus."

These projects range in scope and type from very large – like the redevelopment of a dying urban mall in the West End – to very modest and neighborhood scale. In this latter group is a project by a faith-based community non-profit to adapt an abandoned gas station and nearby storefront into small businesses in the underserved South Atlanta community.

The group's previous project, seen above, became South Atlanta's first coffee shop and grocery selling fresh produce.

PROCUREMENT STRATEGIES
FINAL RECOMMENDATIONS

In addition to fact sheets on grants and other funding opportunities, the studio group prepared a brief set of tailored recommendations regarding procurement of third-party planning and development services.

The ENLACE recommendations relate to its plans to issue an RFP for a comprehensive master plan; Fideicomiso recommendations focus on design and development firms, and reflect its greater legal flexibility in procurement practices.

In identifying and evaluating potential candidates to recommend, the studio team considered criteria including experience in: Puerto Rico; Latin America; mixed-Use development; neighborhood commercial and small-scale business incubation; and housing rehab. The team also focused its attention on firms that appeared to place an emphasis on high-quality, context-sensitive design.

FIDEICOMISO

Pages 11-17 highlight real estate development firms that have demonstrated success in smaller-scale and/or context-sensitive affordable housing development.

In order to streamline the procurement process and more effectively reach appropriate candidates, the team advises the Fideicomiso to consider soliciting proposals for affordable housing projects from these firms through an invited bid rather than their customary RFP or RFQ.

ENLACE

Page 18 highlights California-based firm Opticos and its internationally recognized work on the master plan for Akanda, Uganda, which included a new form-based code and guidelines for tropical building design and sustainability.

The team recommends that ENLACE target its master planning RFP to reach firms with experience: working in Latin America and the Caribbean; with vernacular design; with tropical contexts; and dealing with infrastructure challenges.

CRC COMPANIES

DESCRIPTION

The CRC group of firms focus on planning, design, engineering, budgeting, construction, financing, operations, and asset management. It builds market-rate, mixed-income, and affordable housing.

CRC Companies is based in Northern Virginia and has a strong presence in military communities, as it specializes in public-private partnerships to build family housing on military bases.

However, the group has also demonstrated an ability to rehabilitate existing affordable housing projects, including those with a focus on acommodating intergenerational households. They have also built a large workforce housing development in Honduras.

SPECIALTY

Mixed-use; family housing

LOCATION

Arlington, Virginia

EXPERIENCE IN...

Puerto Rico	❌
Latin America	✅
Mixed-Use	✅
Small Commercial	❌
Housing Rehab	✅

STRENGTHS

- Versatility of form: mixed-use high rises in urban center and lower-density single-family and multifamily

- Workforce housing in a lower-income Latin American country

- Full service firm with finance shop

- Collaboration with local development partners

UNKNOWNS

- Limited portfolio in Latin America

- Possibly more focused on market-rate and LIHTC projects

- Familiarity with social housing, land trusts, and informal communities

DEVELOPMENT CASE STUDY

EL RANCHO VERDE

SAN JOSE, CALIFORNIA

700-Unit Affordable Housing Community with Multi-Generational Resident Programming

- Mix of 2- and 3-BR units

- 80% of units affordable at 50% AMI

- 19 units/acre

- Amenities include two pools, multipurpose room, childcare, learning center

- Capital stack included LIHTC credits

LOS CASTAÑOS DE CHOLOMA

CHOLOMA, HONDURAS

3,629-Unit, Low-Income Workforce Housing

- Developed with support from Overseas Private Investment Corporation (OPIC)

- 27-year financing model enables families to buy a basic, 380-square-foot home

- Amenities include elementary school, daycare center, soccer fields, community police station, and bus terminal

- CRC sold stake to local development partner after several years

ELEMENTAL

DESCRIPTION

Elemental is a "Do Tank" founded in 2001, focusing on projects of public interest and social impact. A hallmark of the firm is a participatory design process in which the architects work closely with the public and end users. Elemental has built work in Chile, the United States, Mexico, China, and Switzerland.

STRENGTHS

- Post-disaster experience
- Community engagement
- Cost-effective design
- Intergenerational households
- Informal communities

UNKNOWNS

- No mixed-use typologies
- Finance focus and experience

SPECIALTY

Social housing, incremental

LOCATION

Santiago, Chile

EXPERIENCE IN...

Puerto Rico	❌
Latin America	✅
Mixed-Use	❌
Small Commercial	❌
Housing Rehab	❌

DEVELOPMENT CASE STUDY

QUINTA MONROY

IQUIQUE, CHILE

Social housing project to rehouse informal community in urban center

- "Half-a-house" rowhouse concept in which families built out homes over time
- Approximately 78 units per acre without going above three stories
- Completed with gov't subsidy of only $7,500/unit
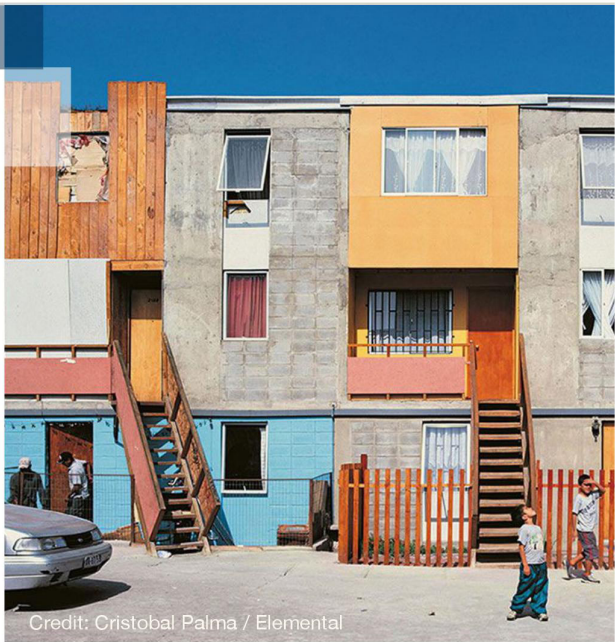
Credit: Cristobal Palma / Elemental

BARRETT STUDIO

DESCRIPTION

Barrett Studio Architects was founded in Boulder, Colorado in 1977. The firm practices "living architecture" and maintains a focus on ecology and sustainability. Most of their work is confined to Colorado, although their portfolio includes projects in Venezuela and Tajikistan.

SPECIALTY

Social housing, incremental

LOCATION

Santiago, Chile

EXPERIENCE IN...

Puerto Rico	✗
Latin America	✗
Mixed-Use	✓
Small Commercial	✗
Housing Rehab	✗

STRENGTHS

- High-quality architecture
- Designing human-scale planned communities
- Affordable multifamily and senior housing

UNKNOWNS

- Small firm
- Little experience with Latin American contexts
- Focused on Colorado

DEVELOPMENT CASE STUDY

KESTREL

LOUISVILLE, COLORADO

Affordable housing for seniors and families supported by CDBG-DR

- Built in response to severe need for affordable senior and multi-family housing in area
- Targets 40-60% AMI
- Layers LIHTC credits and CDBG-DR funds (following 2013 floods)

Credit: Olsson

ENTERPRISE HOMES, INC.

DESCRIPTION

Enterprise Homes, Inc. has completed more than 5,000 affordable and market-rate homes and rental residences in communities throughout the Mid-Atlantic region. Enterprise collaborates with nonprofit and for-profit housing organizations, community groups, as well as city and county agencies. It is affiliated with Enterprise Community Partners, a leader in affordable housing capital.

SPECIALTY

Affordable rental and for-sale, mixed-income

LOCATION

Columbia, Maryland

EXPERIENCE IN...

Puerto Rico	✗
Latin America	✗
Mixed-Use	✓
Small Commercial	✓
Housing Rehab	✓

STRENGTHS

- Social impact focus
- Experience with rental and homeownership
- Finance expertise in house
- Small-scale designs (e.g., townhomes)

UNKNOWNS

- Focused on Mid-Atlantic region
- Limited experience outside continental U.S.

DEVELOPMENT CASE STUDY

METROTOWNS

WASHINGTON, D.C.

Mixed-income workforce housing with 83 for-sale and 42 rental homes

- Infill development that replaced dilapidated public housing projexct
- One-, two-, and three-bedroom homes
- Amenities include community green and playground

Credit: Enterprise Homes

DPZ PARTNERS

DESCRIPTION

DPZ was founded in 1980 by Andres Duany and Elizabeth Plater-Zyberk, who would also found the non-profit Congress for the New Urbanism (CNU). The firm reports holding record for most New Urbanist projects designed and built. It has produced master plans for developments in Mexico and Brazil, as well as Southeast Asia and the Middle East.

STRENGTHS

- Vernacular, human-scale neighborhood design
- Participatory design
- Presence in Florida and Gulf Coast

UNKNOWNS

- Focus on mastered-planned rather than incremental development
- Small size, cost unkown
- Highly sought after

SPECIALTY

New Urbanism, form-based codes, vernacular design

LOCATION

Miami, Florida

EXPERIENCE IN...

Puerto Rico	✖
Latin America	✔
Mixed-Use	✔
Small Commercial	✔
Housing Rehab	✖

DEVELOPMENT CASE STUDY

BLUE WATER

TAVERNIER KEY, FLORIDA

Workforce housing project achieves density with single-story courtyard homes

- 36 units on just 2.7 acres (13.3 du/acre) using interlocking structure
- Unit types range from 1BR/1BA to 4BR/2BA
- Each unit has private outdoor courtyard; community shares a playground

Credit: DMBC

OPTICOS DESIGN, INC.

DESCRIPTION

Opticos is a small, California-based urban design and architecture firm founded in 2000. It is a certified "B Corporation" committed to social and environmental impact, which seeks to "help cities evolve, [celebrate] the existing character while avoiding unwanted gentrification." Founder Daniel Parolek pioneered the "Missing Middle Housing" concept.

STRENGTHS

- Housing typologies
- Tropical contexts
- Coastal planning and climate adaptation
- Experience with capacity challenges

UNKNOWNS

- Small size; often works as subconsultant
- More focued on urban design than planning
- Knowledge of green infrastructure practices

SPECIALTY

Form-based codes "Missing Middle" housing Vernacular design

LOCATION

Berkeley, California

EXPERIENCE IN...

Puerto Rico	✖
Tropical Climate	✔
Coastal Adaptation	✔
Master Plans	✔
Design Typologies	✔

PLANNING CASE STUDY

AKANDA MASTER PLAN

LIBREVILLE, GABON

Master plan for 2,500-acre growth area in Ugandan capital

- Opticos led effort on new form-based code and Tropical Building Design Guidelines
- Urban design consultant on master plan
- Focus on ease of use and implementation, recognizing local unfamiliarity with land regulations

Credit: Opticos