

SPRING
2023

INFRASTRUCTURES OF AUTONOMY

BUILDING A SUSTAINABLE CULEBRA IN THE FACE OF CLIMATE CHANGE

JOINT ARCHITECTURE & PLANNING STUDIO

COLUMBIA
GSAPP



Figure 1: Members of the studio team at Playa Flamenco.
Picture taken by Claudia Kohn Avila.

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Figure 2: Members of the studio team at San Ildelfonso de la Culebra. Picture taken by Ubaldo Escalante.

Acknowledgments

We would like to express our sincere gratitude to all those who have supported us in the production of this studio report.

Firstly, we would like to thank our client, Mujeres de Islas, for their invaluable guidance and support throughout the research process and for their trust in us. The organization provided us with the initial direction for our projects and helped us define research questions and objectives. The team also facilitated our access to local communities, organizations, and government officials in Culebra, which was essential for our research. Their dedication to promoting sustainable and equitable development in Culebra is an inspiration, and we hope that our proposals will contribute to their efforts.

We extend our deepest appreciation to the Culebrenses for their openness and willingness to be vulnerable to share their stories of combating colonialism. Your insights and experiences were essential in providing us with the qualitative data necessary for our research and in shaping our continued exploration of these issues. We are humbled by the hospitality and warmth that they showed us during our visit, and we are grateful for the time and effort that they put into helping us understand the challenges and opportunities facing their community.

Thank you all for your invaluable contributions to our studio report. We hope that our work will serve as a tribute to the resilience and autonomy of the Culebrenses, and that the recommendations provided in this report will help contribute to the sustainable and equitable development of Culebra.

Reconocimientos

Nos gustaría expresar nuestrx sincero agradecimiento a todos aquellos que nos han apoyado durante la producción de este documento.

En primer lugar, nos gustaría agradecer a nuestro cliente, Mujeres de Islas, por su apoyo durante este proceso de investigación y por su confianza en nosotrxs. Su dedicación a promover el desarrollo sostenible y equitativo en Culebra es una inspiración, y esperamos que nuestras propuestas contribuyan a sus esfuerzos.

El equipo de Mujeres de isla nos guió en la creación de nuestros proyectos y nos ayudó a definir los objetivos de investigación. Durante nuestra visita a la Isla de Culebra, el equipo nos facilitó los encuentros con la comunidad, organizaciones locales, y funcionarios del municipio, lo que fue esencial para nuestra investigación.

Extendemos nuestro agradecimiento a los Culebrenses por su apertura, mostrar vulnerabilidad y disposición para compartir sus historias de lucha en contra del colonialismo.

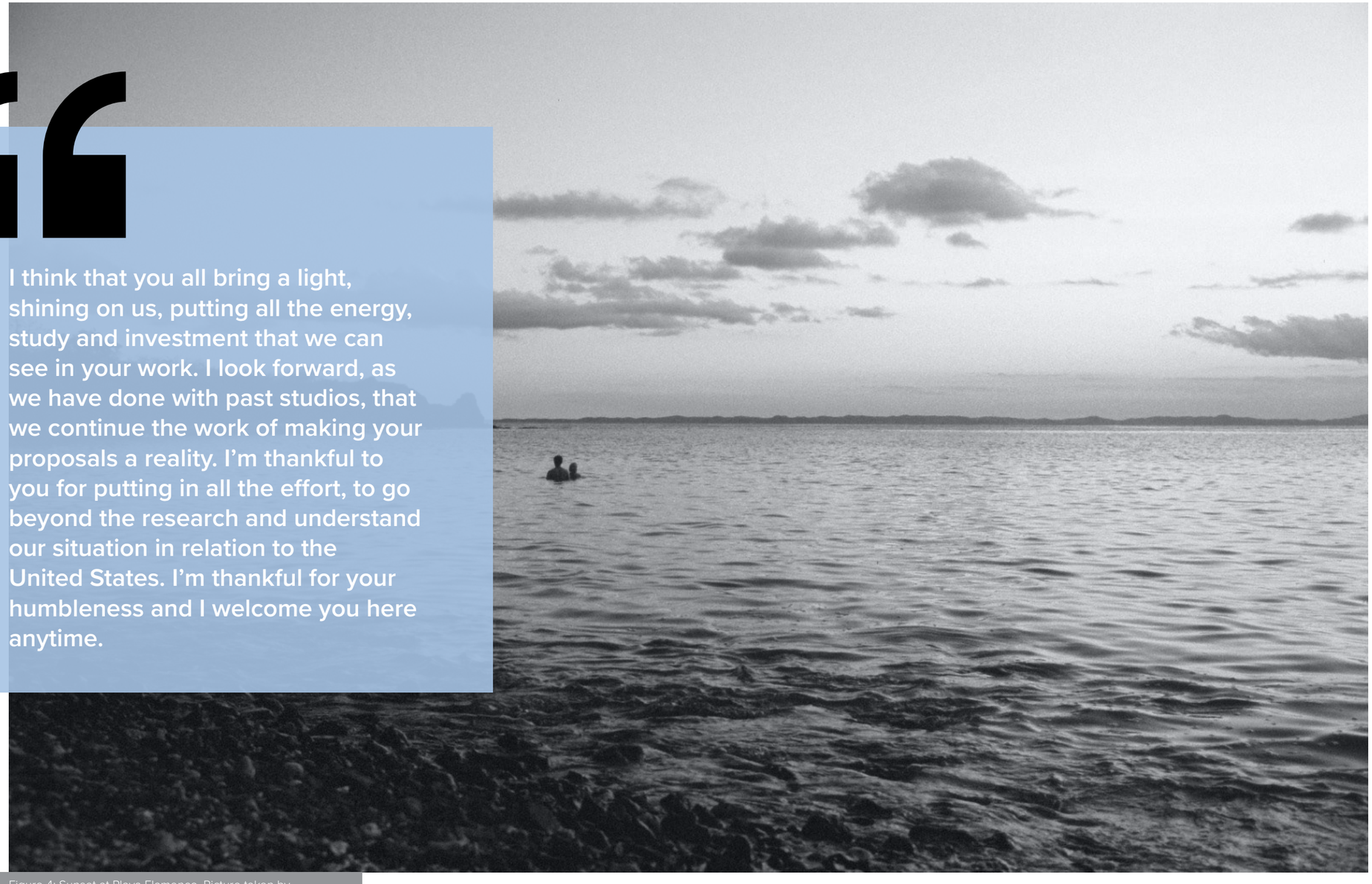
Sus ideas y experiencias fueron esenciales para la recolección de datos cualitativos, los cuales fueron cruciales para el desarrollo de las propuestas. Nos sentimos honrados por la hospitalidad que nos mostraron durante nuestra visita, y estamos agradecidos por el tiempo y el esfuerzo que dedicaron para ayudarnos a comprender los desafíos y oportunidades que enfrenta su comunidad.

Estamos agradecidos con todos las personas que contribuyeron al reporte. Esperamos que nuestro trabajo sirva como un homenaje a la resiliencia y autonomía de los Culebrenses, y que las recomendaciones proporcionadas contribuyan al desarrollo sostenible y equitativo de Culebra.



Figure 3: View from Villa Muñeco. Picture taken by Camila Botero Echeverri.

Message From Mujeres De Islas



> I think that you all bring a light, shining on us, putting all the energy, study and investment that we can see in your work. I look forward, as we have done with past studios, that we continue the work of making your proposals a reality. I'm thankful to you for putting in all the effort, to go beyond the research and understand our situation in relation to the United States. I'm thankful for your humbleness and I welcome you here anytime.

Figure 4: Sunset at Playa Flamenco. Picture taken by Chris Kumaradjaja.

Thinking about this third visit by students from Columbia University to our Island of Culebra, my heart swells and hope arises in my soul.

I appreciate the inquiries, the inclusion of our perspectives, the interest in genuinely supporting us, and the recognition of the wisdom of our community. Watching the students being curious, decisive, dreaming with us, and wanting to be immersed in the stories/memories, homes, and feelings with such sincerity and genuineness, is an extreme delight.

Listening to them present their proposals, we feel that it responds to the attentive listening that they maintained from the beginning and that they still maintain. This attitude of respect assures us that the process will result in ideas, views, and manifestations that will reflect our desires with dignity to achieve a sustainable and self-determined Culebra.

I wish to continue in communication and always with that openness to propose, work and move forward not for the communities but with the communities.

We await your next visit to Culebra!

- Dulce María del Río-Pineda,
Co-Founder & Coordinator
of Mujeres de Islas

Mensaje De Mujeres De Islas

Al pensar en esta tercera visita de estudiantes de Columbia University a nuestra Isla de Culebra el corazón se hincha y la esperanza aflora en mi ser.

Agradezco las consultas, la inclusión de nuestras perspectivas, el interés por genuinamente apoyarnos y el reconocimiento a la sabiduría de nuestra comunidad. Viéndoles curiosxs, decidxs, soñando con nosotrxs, deseando estar inmersos en las historias/memorias, viviendas, sentires, sabores con tanta sinceridad, extremadamente genuinos es un deleite.

Escuchándoles presentar sus propuestas sentimos que responden a la atenta escucha que mantuvieron desde el inicio y que aún mantienen. Esta actitud de respeto nos asegura que el proceso redundará en ideas, miradas y manifestaciones que recogen con dignidad nuestros deseos para alcanzar una Culebra sostenible y autodeterminada.

Deseo continúen en comunicación y siempre con esa apertura de proponer, trabajar y moverse hacia adelante no para las comunidades sino con las comunidades.

¡En Culebra les esperamos!

- Dulce María del Río-Pineda
Co Fundadora y Coordinadora
de Mujeres de Islas

Creo que todos traen una luz, que nos iluminan, que ponen toda la energía, el compromiso y la inversión que podemos ver en su trabajo. Espero, como hemos hecho con estudios anteriores, que continuemos con el trabajo de hacer realidad sus propuestas. Estoy agradecida por todo el esfuerzo, ir más allá de la investigación y comprender nuestra situación en relación con Estados Unidos. Estoy agradecida por su humildad y les doy la bienvenida aquí siempre.



Figure 5: View from Villa Muñeco. Picture taken by Chris Kumaradjaja.

Executive Summary



Figure 6: Pictured here are Doris, Nathania, and Paulino. Picture taken by Chris Kumaradjaja.



Figure 7: Render of the public market. Render by Teonna Cooksey

This studio report is a collaborative effort between architects and urban planners working with the community of Culebra, towards envisioning a sustainable, autonomous, and climate-prepared future for the island. According to the U.S. Census Bureau, Culebra is a small island with a population of 1,700 people, with a median age of 46 years, and a poverty rate of 23%. It is heavily dependent on tourism, transportation, and education to sustain its economy.

In order to achieve a more autonomous and climate-prepared community, the studio team working on this project has adopted a bottom-up, community-led approach to design, challenging traditional, centric models of urban development. The project is organized around five themes: Memory, Coastal Resilience, Housing, Energy, and Food, with the goal of creating a more autonomous and climate-prepared community.

The proposed solutions include leveraging existing resources, creating inclusive, equitable, and sustainable spaces, and identifying and meeting community-wide challenges. The studio is taking into account the history of colonialism in Culebra and the ongoing impacts on communities and the built environment. The report highlights the need to preserve Culebra's history and local identity, the importance of coastal resilience in the face of environmental challenges, the need for more affordable housing, reducing dependency on the mainland for energy, and addressing food insecurity.

The report shows that colonialism's impact is still present in Culebra, but the community's resilience and solidarity inspire a sustainable, autonomous, and climate-prepared future. The studio's proposals aim to further support these efforts.

Resumen Ejecutivo



Figure 8: Members of the studio team and Mujeres De Islas. Picture taken by Ubaldo Escalante

Este informe es un esfuerzo colaborativo entre arquitectos y planeadores urbanos que trabajaron con la comunidad de Culebra para imaginar un futuro sostenible, autónomo y preparado para el cambio climático en la isla. Según la Oficina del Censo de EE. UU., Culebra es una pequeña isla con una población de 1,700 personas, una mediana de edad de 46 años y una tasa de pobreza del 23%. Depende en gran medida del turismo, el transporte y la educación para mantener su economía.

Con el fin de lograr una comunidad más autónoma y preparada para el cambio climático, el equipo de este estudio ha adoptado un enfoque bottom-up y liderado por la comunidad para el diseño, desafiando los modelos tradicionales y centrados del desarrollo urbano. El proyecto se organiza en torno a cinco temas: Memoria, Resiliencia Costera, Vivienda, Energía y Alimentación, con el objetivo de crear una comunidad más autónoma y preparada para el clima.

Las soluciones propuestas incluyen aprovechar los recursos existentes, crear espacios inclusivos, equitativos y sostenibles, e identificar y satisfacer los desafíos de toda la comunidad. El estudio tiene en cuenta la historia del colonialismo en Culebra y sus impactos continuos en las comunidades y el medio ambiente construido. El informe destaca la necesidad de preservar la historia y la identidad local de Culebra, la importancia de la resiliencia costera ante los desafíos ambientales, la necesidad de viviendas más asequibles, reducir la dependencia del continente para la energía y abordar la inseguridad alimentaria.

El informe muestra que el impacto del colonialismo sigue presente en Culebra, pero la resiliencia y la solidaridad de la comunidad inspiran un futuro sostenible, autónomo y preparado para el clima. Las propuestas del estudio buscan apoyar aún más estos esfuerzos.

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Introduction

Historical Overview
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Focus Areas

01

This section will cover the historical overview, highlighting the enduring colonial influences that have shaped Culebra throughout history. It also introduces Culebra as the site of our proposals and studio visit. Furthermore, this section acknowledges past GSAPP studios and Culebra, underscoring the existing relationship. Mujeres De Islas, will be introduced as well. The organization works based on pillars that reflect its mission, which has served as starting points for the focus areas and helped elaborate the studio's proposals.

Key Takeaways From This Chapter

Unincorporated Territory
Puerto Rico is an unincorporated territory of the United States, a status that has given rise to challenges related to colonialism and autonomy

Joint Studio
Architects and urban planners are working collectively to deconstruct western-centric practices and create community-led designs

Mujeres De Islas
This studio builds upon past GSAPP engagement to address the ongoing impacts of colonialism on the community and environment

Research Areas
The studio team has narrowed research and proposals into five areas to further create an autonomous, empowered, and climate-prepared community



Figure 9: Navy on Playa Sardinas in 1914. Picture sourced from the Naval History and Heritage Comman.

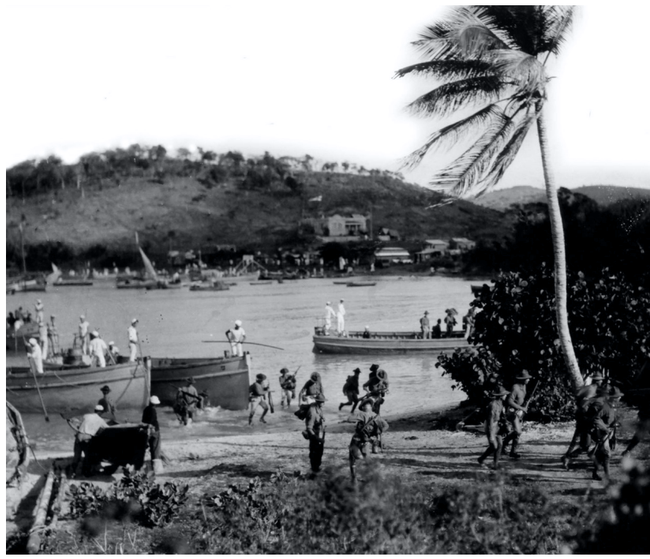


Figure 10: Early 20th-century picture of the Marine Corps on Culebra's beaches. Picture sourced from the U.S. Naval Institute.



Figure 11: Artwork located in community activist Benjamin's house. Picture taken by Claudia Kohn Avila.

Historical Overview



The island was first inhabited by the Tainos, the native tribe that lived in the Caribbean and Florida. The Tainos lived from agricultural practices and lived in small villages. The Tainos call Puerto Rico's Island "Borinquen. " However, in 1493, Christopher Colombus and his crew arrived in Puerto Rico.

It was in the 1880s that the Spanish went to Culebra. The Spanish settled in "San Ildefonso de la Culebra". The Spanish colonization brought significant changes to the island, including introducing Christianity and the Spanish language.

In 1898, Culebra's history took another turn with the Spanish American War. After the Spanish defeat, the island was turned over to the US government with the promise that property titles given by the Spanish would be honored and titled land would not be confiscated by the Military.

In 1901, the US Military arrived in Culebra to establish a base that could serve as a firing range and hold marine exercises. It gave the Culebrenses 24 hours to abandon their houses so that a base for the South Atlantic fleet could be built.

Then in 1903, US President Theodore Roosevelt established the Culebra Naval Reservation, but with the outbreak of the Second World War in 1939, the Culebra Archipelago became the primary gunnery and bombing practice site for the Navy. Culebrenses were removed from their homes with only 24-hour notice.

In 1975, the culebrenses came together with help of the people of the main island and successfully expelled the military from the island. Then, in 1989 Hurricane Hugo destroyed Culebra and severely damaged wooden infrastructure and corrals. The road to recovery was long.

In 1996 the beautiful landscape of Culebra caught the attention of international newspapers, and Culebra was listed among the best beaches in the world. That moment marked the history of Culebras tourism.

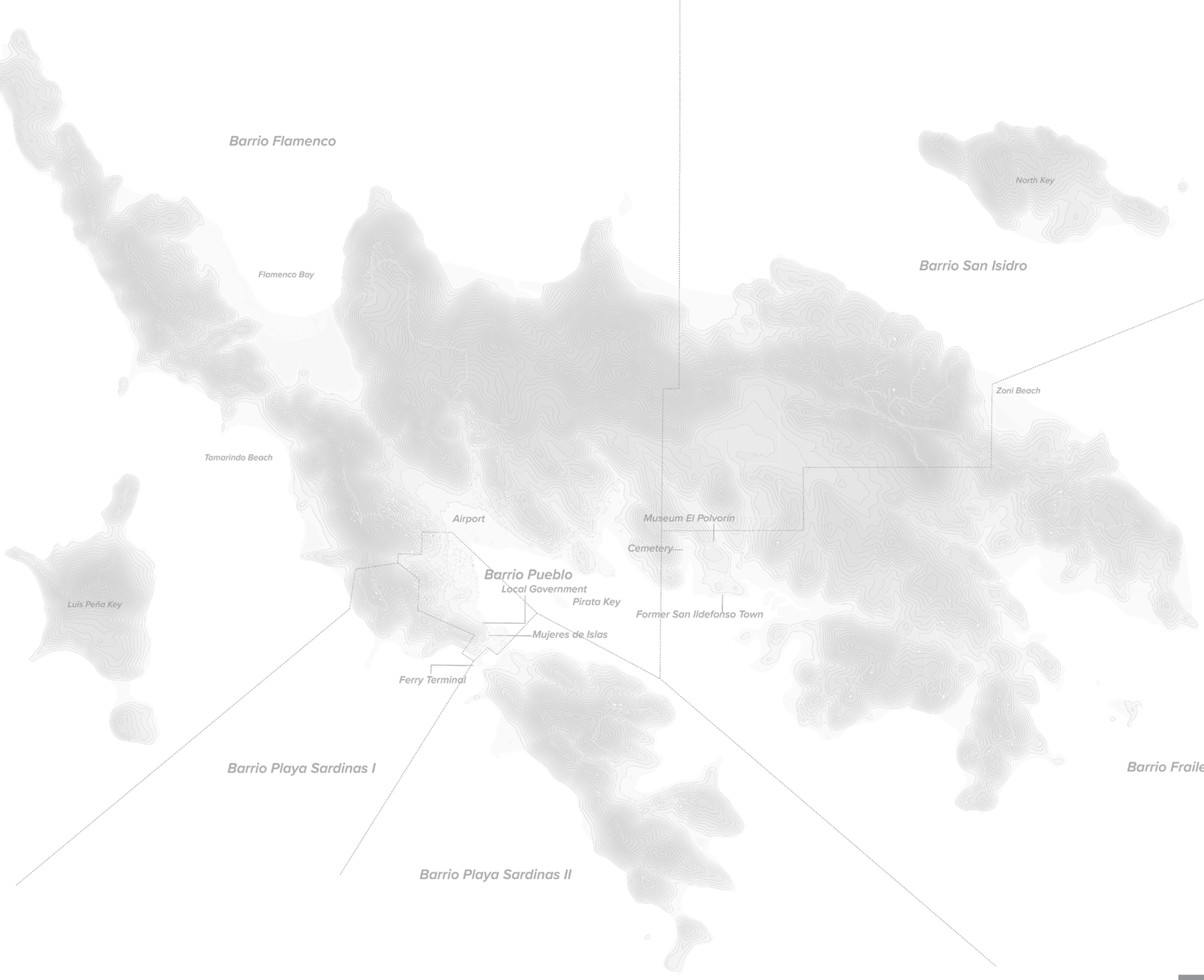
In recent years Culebra has faced many challenges, in 2017 Hurricane Maria and Irma devastated the island. The disaster highlighted the complex relation between Puerto Rico and the United States.

Figure 12: Historical timeline of Culebra.

Introducing Culebra

1792
population
(U.S. Census Bureau, 2022)

46.5
median age
(U.S. Census Bureau, 2022)



23.4%
poverty rate
(U.S. Census Bureau, 2021)

25,104
median household income (U.S. Census Bureau, 2022)

The primary economic activity on the island is office and administrative support, including tourism, transportation, and education
(US Census Bureau, 2022)

LEGEND

- Culebra Municipal Boundaries
- Buildings
- Roadway
- Barrios

N 0 0.5 1 2 2.5mi

Figure 13: Contextualizing map of Culebra with the barrios.

Introducing The Studio

Architecture & Urban Planning
Architects and urban planners have worked jointly in this studio to produce context-appropriate proposals for the Culebrense community. To clarify the differences between these two professions, architecture is a micro-scale spatial and creative response to people's needs, while urban planning is a macro-scale comprehensive and analytical approach to identifying and meeting community-wide challenges.

Architecture typically deals with the composition of spaces and structures, deconstructing colonialism by challenging power structures that have shaped the built environment, and creating spaces that are more inclusive, equitable, and sustainable. At the same time, urban planning typically analyzes the built environment, the people that inhabit the land, and the enabling factors including policies and strategies.

Historically, the two professions have been known to take a top-down colonialistic approach to developing the built environment. This has been challenged in recent decades with professionals now starting to take a bottom-up community-led approach to design with people, rather than for them. The bottom-up approach involves community engagement, participatory design, surveying the community's lived realities, and more. The professionals in this studio have used these methods to better connect with and learn about the Culebrense community, using local expertise to inform their designs and strategies.

Figure 14: Studio members with the Mujeres de Islas team. Picture taken by Chris Kumaradjaja.

Introducing The Studio

Our studio envisions a future Culebra that **leverages existing resources** to create an **autonomous, empowered,** and **climate-prepared** community.

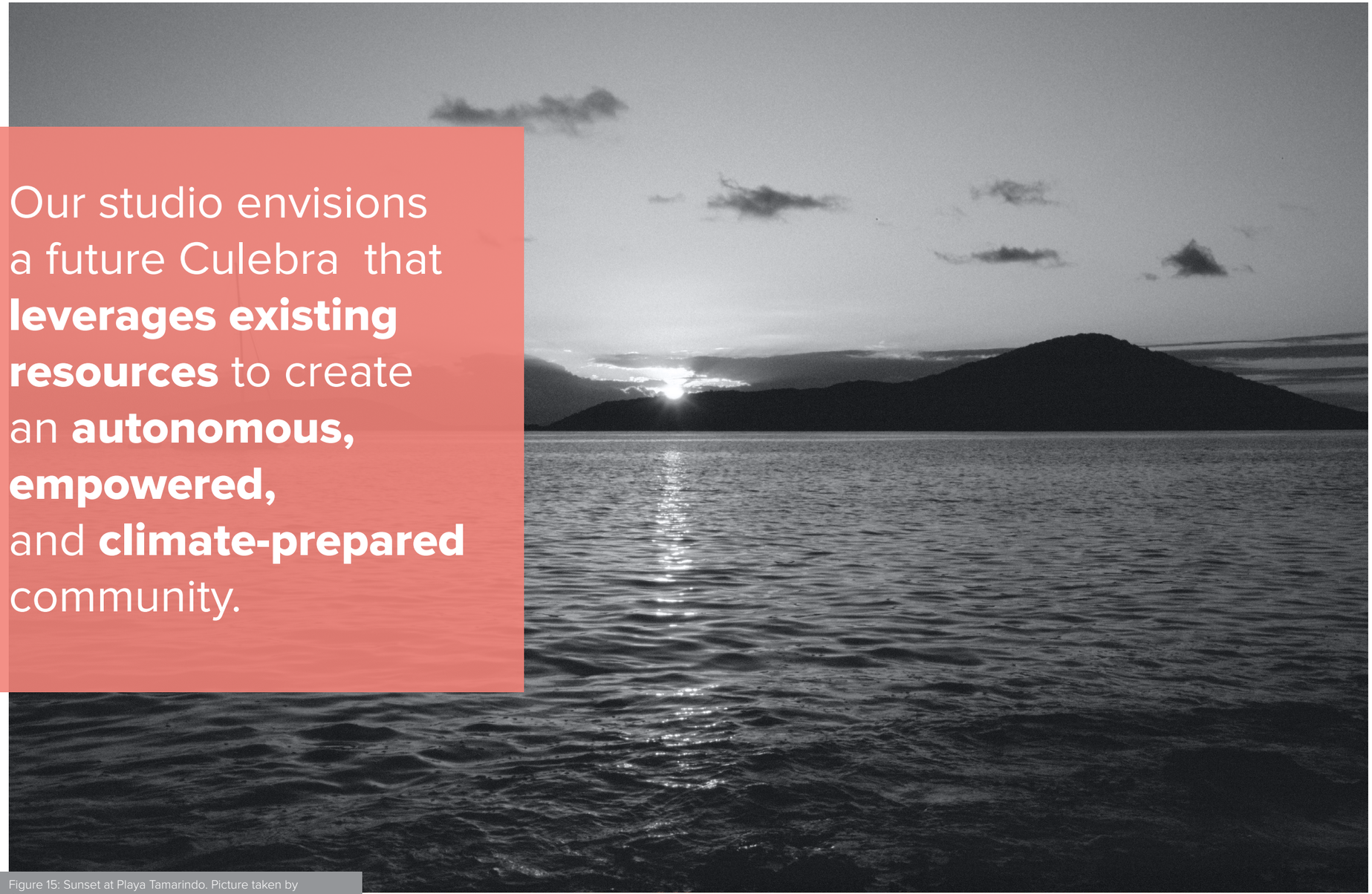


Figure 15: Sunset at Playa Tamarindo. Picture taken by Chris Kumaradjaja.

Studio Vision

Taking into account Culebra's historical legacy of colonialism, architects and planners have worked collectively towards developing tools that will help the local community achieve autonomy. To inform these proposals, the team's collective studio vision aims to challenge western-centric models of design and urban development, alongside addressing the ongoing impacts of colonialism on communities and the built environment.

Introducing Our Client

About The Client
The community organization Mujeres de Islas was founded in 2010 by Dulce del Rio-Pineda in response to the economic challenges faced by many residents of Culebra. The team has since grown and is dedicated to contributing to the sustainable development of the island, particularly in making it more autonomous and climate-prepared. Their guiding mission is to identify resources, strengthen initiatives, and create projects that contribute to sustainable development through the culture of peace and transformative education, having an impact on emotional health, culture, and environmental and socio-economic development of Culebra. Mujeres de Islas has been a client to previous GSAPP studios.

Mujeres De Islas Initiatives
The team shared some of the past projects that have helped them achieve their goals. One such project involved training youth in agricultural practices to encourage healthy eating. They recognized the importance of promoting healthy eating habits among young people and providing them with the skills and knowledge needed to grow their own food.

Another project involved supporting local businesses through workshops in developing business models and plans. The team recognized that small businesses are a key part of the island's economy and that providing support to these businesses can help to build a more sustainable future for Culebra.

The Mujeres De Islas team also highlighted their efforts to restore old school offices to host volunteers who come to serve Culebra. They recognize the importance of community involvement and collaboration, and the role that volunteers can play in helping to achieve their goals.

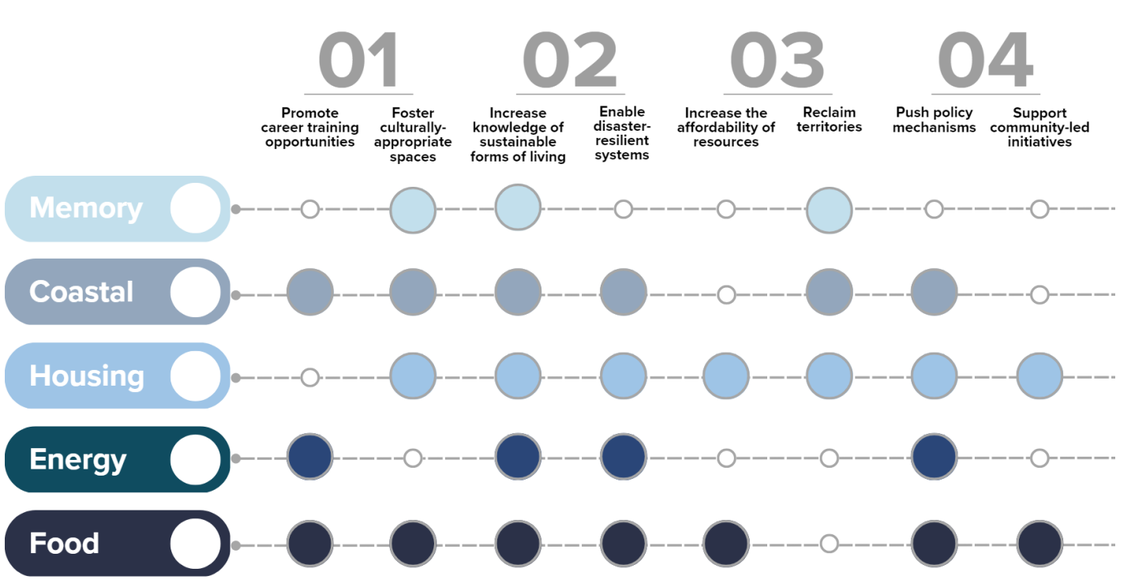


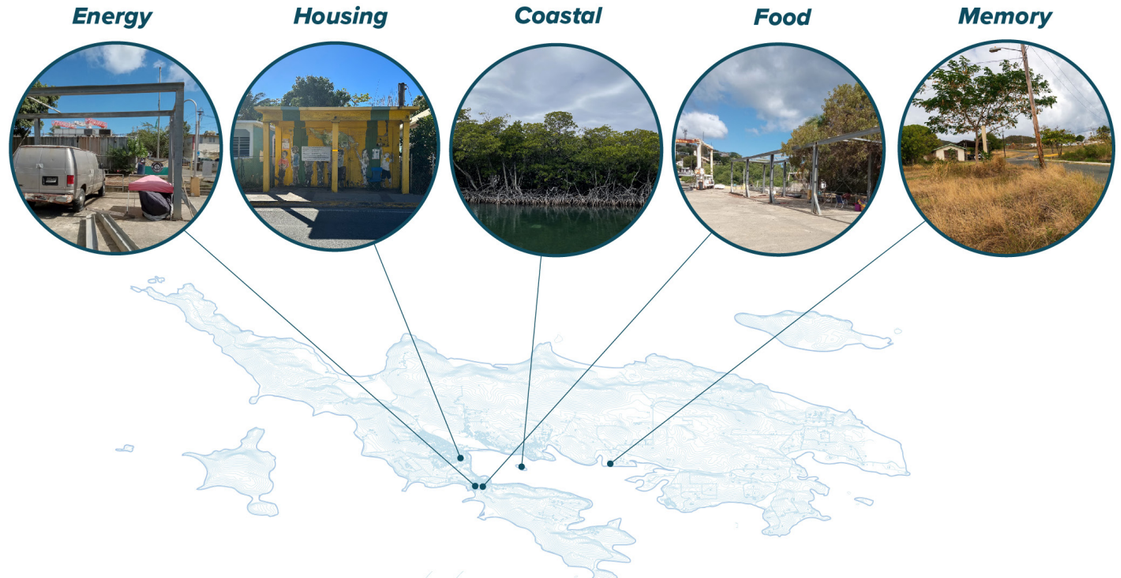
Finally, they spoke about the first solar kitchen in Puerto Rico that doubles over as a culinary arts school. This innovative project demonstrates the team's commitment to promoting sustainable practices and their recognition of the importance of education in building a sustainable future for Culebra.

Overall, the Mujeres De Islas team has shown a deep commitment to honoring the history of Culebra and its residents, while also working towards a sustainable and resilient future for the island. Through their various projects and initiatives, they have made significant strides towards achieving their goals, and continue to explore new and innovative ways to build a better future for Culebra.

Figure 16: Team members and volunteers of Mujeres De Islas, alongside local community activists.

Focus Areas





Identifying Outcomes
In order to achieve the previously stated studio vision, the architectural and planning proposals in this report respond to the following joint outcomes to enhance autonomy and sovereignty in Culebra:

Outcome 1
To strengthen technical skills and promote intergenerational knowledge sharing on the island, in order to reduce dependence on external parties, particularly during crises and natural disasters;

Outcome 2
To increase local climate preparedness by enhancing the ability of local infrastructure to adapt to climate change by being more disaster-resilient, alongside increasing knowledge of more sustainable forms of living;

Outcome 3
To create access to sovereign systems through enhancing resource affordability, empowering the local community, and promoting land reclamation;

Outcome 4
And, lastly, to reinforce infrastructure through policy mechanisms and community-led initiatives in order to decrease dependence on the big island and mainland United States by encouraging economic competitiveness, and improving disaster response.

Identifying Research Areas
Based on these identified outcomes, the studio team narrowed research and proposals into five areas to further create an autonomous, empowered, and climate-prepared community. Each of these areas has been negatively impacted by colonialism. They include:

Memory
This includes the negative impacts of colonialism on the preservation of the island's history and local Culebrense identity;

Coastal Resilience
This highlights the increase in environmental challenges, particularly those protect the island from the impacts of climate change;

Housing
This refers to the lack of opportunities on the island to find affordable housing;

Energy
This refers to the dependency on the mainland and Puerto Rican big island for fossil-fuel generated electricity, particularly during hurricane season;

Food
This highlights the impacts of the Jones Act on food security and food affordability amongst the population.

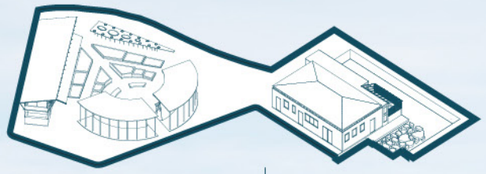
Figure 17: Outcomes matrix for all research area proposals.
Figure 18: Identifying research areas.

Focus Areas

Figure 19: Diagram outlining all the outcomes achieved by the various proposals.

Food

-Pesquera (fishery) Renovation/Market
-Dock Masterplan & Food tool kit



Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome02-A
Increase knowledge of sustainable forms of living

Outcome02-B
Disaster-resilient systems

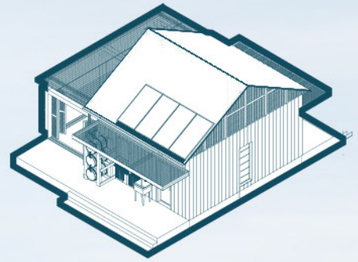
Outcome03-A
Increase the affordability of resources

Outcome04-A
Push policy mechanisms

Outcome04-B
Community-led initiatives

Housing

-Design Toolkit /Adaptation
-Hurricane Resilience Handbook
-Implementation of Land Bank



Outcome01-B
Foster culturally appropriate spaces

Outcome02-B
Disaster-resilient systems

Outcome03-B
Reclaim territories

Outcome02-A
Increase knowledge of sustainable forms of living

Outcome03-A
Increase the affordability of resources

Outcome04-A
Push policy mechanisms

Outcome04-B
Community-led initiatives



Outcome01-A
Promote career training opportunities

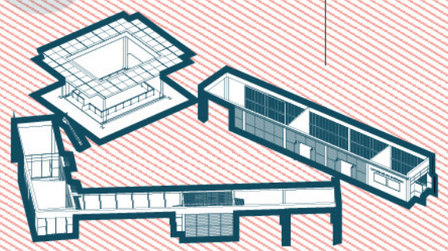
Outcome02-A
Increase knowledge of sustainable forms of living

Outcome02-B
Disaster-resilient systems

Outcome04-A
Push policy mechanisms

Energy

-Solar Hub
-Energy Masterplan



Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome02-A
Increase knowledge of sustainable forms of living

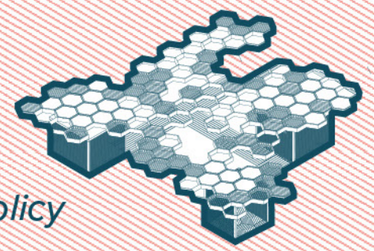
Outcome02-B
Disaster-resilient systems

Outcome03-B
Reclaim territories

Outcome04-A
Push policy mechanisms

Coastal

-Education center
-Coastal Ecosystem Policy



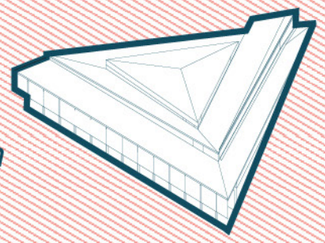
Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome03-B
Reclaim territories

Memory

-New Museum



Methodology

Summary
Municipal Priorities
Client Priorities
Past GSAPP Engagement
Common Limitations

02

This section outlines the methodological steps taken by the studio to identify priorities, analyze past proposals, conduct comprehensive analysis, engage with the community, identify common limitations, and design context-specific outcomes. The goal is to gain clarity on desired focus areas for investigation and design, assess lived realities, and understand the challenges and desires of the local population. The studio aims to create context-appropriate designs that address the five focus areas and lead to sustainable change.

Key Takeaways From This Chapter

Prioritization and Analysis
This studio prioritizes community-led design by identifying focus areas through analysis of past proposals and current policies

Comprehensive Analysis
This studio analyzes architecture and planning tools to inform proposals and understand colonialism's impact on the community

Community Engagement
This studio conducts community engagement and site visits to understand local challenges, desires, and limitations

Context-Specific Designs
This studio's focus is creating context-appropriate designs for sustainable change by using a bottom-up, community-led approach



Figure 20: Community activist, Benjamin, talking about his experiences during the U.S. Navy occupation. Picture taken by Chris Kumaradjaja.



Figure 21: Community activists Doris, Paulino, and Digna in conversation at Benjamin's house. Picture taken by Chris Kumaradjaja.



Figure 22: Studio professor in conversation with Muejres De Islas team member, Nathania. Picture taken by Chris Kumaradjaja.

Summary

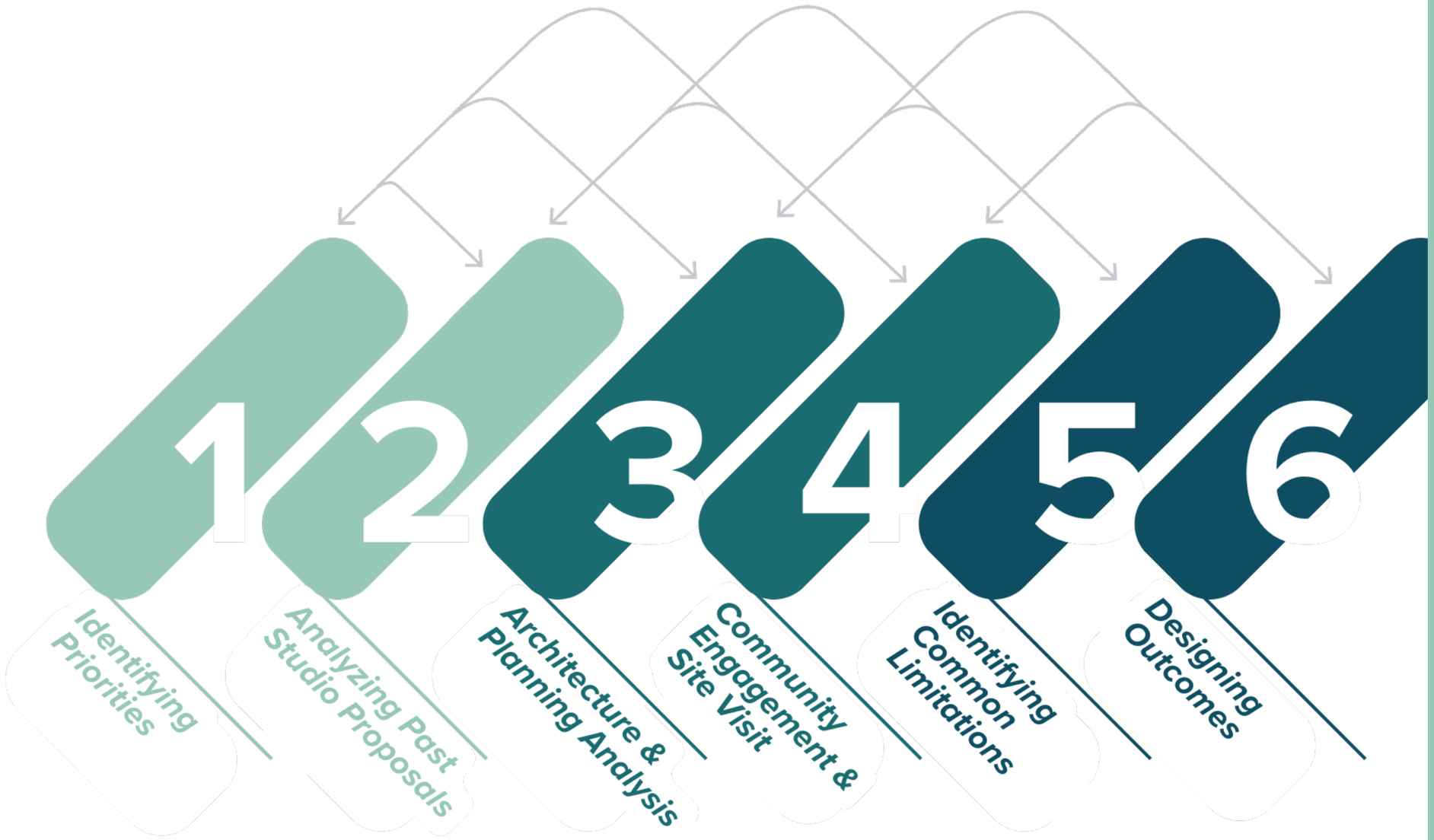


Figure 23: Methodological summary for the studio.

By combining architectural and urban planning tools, while also taking into account Culebra's current conditions, historical context, and GSAPP's ongoing relationship with the team and the island, this studio designed a methodology that is fitting to the studio vision. To summarize this methodology, the studio embarked on:

1. Identifying priorities, both municipal and the client's to gain clarity on the most desired focus areas for investigation and design;
2. Analyzing past studio proposals to get a sense of what projects have worked on the island and what research has already been captured;
3. Conducting a comprehensive architectural, planning, and policy analysis to use the two professions to assess lived realities and inform designs;
4. Conducting community engagement and site visits to gain qualitative data on the local population's challenges and desires;
5. Identifying common limitations to understand where the five focus areas interact;
6. And, lastly, but most importantly, designing our outcomes such that they're context-specific and context-appropriate for making change.

It's important to recognize that this methodology was not a straightforward, clean, and linear process. The team recognized the need for iteration and constantly found themselves going back and forth multiple times in order to arrive at their current state of progress. Embracing the iterative approach allowed the studio to refine and improve proposals incrementally. This involved revisiting and reevaluating previous steps, making adjustments, and exploring alternative avenues to achieve goals.

Some of the above methodological steps will not be covered in this section. As they are project-specific, they'll be covered in the following individual proposal sub-chapters.



Municipal Priorities

Figure 24: Member of the Mujeres De Islas team and studio team at the local municipality reviewing the Recovery Plan. Picture taken by Ubaldo Escalante.
Figure 25: Cover page of the Recovery Plan for the Municipality of Culebra for 2023.

In order to understand the priorities of the local municipality of Culebra, several conversations were held with the Land Use Planning Office Director. These conversations highlighted the Recovery Plan for the Municipality of Culebra for 2023, which identifies five key goals.

Housing
The first goal is to facilitate access to safe and accessible housing. This will be achieved by increasing the housing inventory for the residents of Culebra, regulating the development of housing through public policy tools, and continuing collaborations to respond to repair and reconstruct post-disaster needs.

Natural Resources
The second goal is to restore and protect natural resources. The municipality of Culebra aims to restore natural coastal barriers to mitigate natural hazards, use public policy mechanisms to protect natural resources and eradicate illegal practices, and enhance environmental education with a focus on tourism.

Citizen Participation
The third goal is to enable municipal resilience and citizen participation. This will be accomplished by developing citizen participation mechanisms and training on mitigation, recovery, and resiliency strategies, reducing municipal dependency on potable water and electric energy from the big island, and continuing collaborations with governmental entities to progress on existing efforts that will aid the Culebrenses' quality of life.

Physical Infrastructure
The fourth goal is to rehabilitate and strengthen physical infrastructure. The municipality of Culebra aims to improve and strengthen physical infrastructure for future disasters, enable safe and accessible shelters, and support the zero-waste programs like the Mujeres De Islas' composting program to extend the lifespan of the municipal landfill.

Economic Development
Finally, the fifth goal is to promote diverse, sustainable, economic development. This goal includes encouraging the production of local food to support economic development and food security, promoting the development of ecological and research projects, and establishing commercial development programs for the municipality of Culebra.

These goals reflect the municipality's commitment to promoting sustainable development, protecting natural resources, and improving the quality of life for its residents.

Client Priorities

> Youth Engagement

Mujeres De Islas emphasized the importance of involving youth in decision-making and empowering them to lead in the community. They view this as essential to achieving a sustainable future for Culebra, that balances economic development, environmental protection, and social justice.

> Waste Management

Mujeres De Islas consider waste management as a challenge and aims to find innovative solutions prioritizing sustainability and community involvement. One such project is their composting program that aims to reduce landfill waste and increase its lifespan.

> Tourism

Mujeres De Islas acknowledge tourism as a major economic driver for Culebra and aim to promote sustainable tourism practices respecting natural beauty and cultural heritage, while offering economic opportunities for locals. This is crucial to building a diverse and sustainable economy for the island.

> Public Transportation

Mujeres De Islas prioritized public transportation due to its crucial role in residents' well-being. They aim to improve transportation options for both residents and visitors by exploring sustainable solutions.

> Honoring History

The Mujeres De Islas team impressed the studio with their dedication to honoring Culebra's history and its people's memory. They aim to acknowledge the island's cultural heritage, colonialism's effects, ongoing autonomy struggles, and the community's resilience to natural disasters.

> Environmental Protection

The preservation of Culebra's ecological value and natural beauty is a significant priority for Mujeres De Islas. They aim to protect coral reefs, mangroves, promote sustainable agricultural and waste management practices, acknowledging their importance as assets for the island and future generations.

> Building Homes

Mujeres De Islas identified housing as another priority, aiming to provide safe and affordable housing for all residents, collaborating to respond to post-disaster needs. They are working on initiatives to increase inventory and regulate development through public policy tools.

> Energy Production

Energy production was identified as a priority for investigation. Mujeres De Islas recognizes that reliable energy infrastructure is critical to the well-being of residents due to the island's isolation and vulnerability to natural disasters. They aim to increase energy production from renewable sources, exploring sustainable options.

Figure 26: Former public dock that is not longer in use. Picture taken by Emily Padilla-Chicas.

Past GSAPP Engagement

It's important to acknowledge that this studio builds upon past Graduate School of Architecture, Planning, and Preservation (GSAPP) engagement with the Culebrense community and the Mujeres De Islas organization. Two GSAPP studios, in 2020 and 2021, were led by the architect Richard Plunz and urban planner Douglas Woodward.

The 2020 studio aimed to address the various challenges faced by the Culebrense community by proposing innovative infrastructural solutions. This involved engaging with community members, understanding their needs and aspirations, and devising strategies to enhance the island's overall infrastructure.

Building upon the outcomes and experiences of the preceding studio, the 2021 studio focused on the collection and spatial visualization of datasets. Recognizing the significance of data-driven decision-making, the studio aimed to gather relevant data and transform it into meaningful visual representations.

Grow Culebra, which aimed to boost local food production, encourage healthy eating and cooking habits, and promote citizen engagement in food policy and institutions



Figure 27: Render from the Grow Culebra proposal of 2020.
Render sourced from Ziwei Ling & Sarah Zamler

El Solárium, which sought to challenge traditional microgrids by developing a truly community-based renewable energy system and sustainable business plan

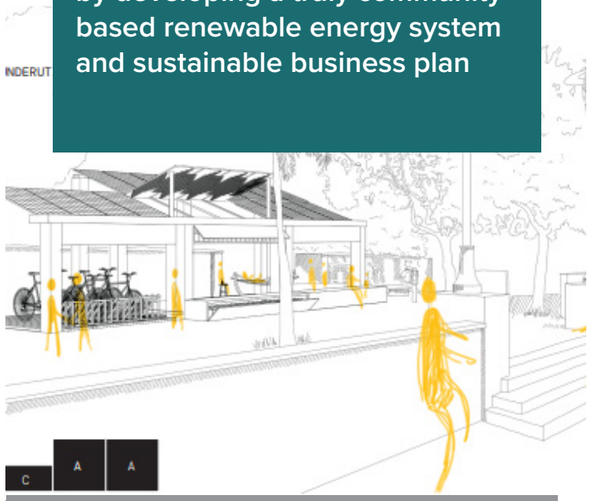


Figure 28: Render from the El Solárium proposal of 2020.
Render sourced from Regina Alcazar & Camille Esquivel.

Sargatopía, which proposed a starter kit that contained equipment needed to collect sargassum on beaches and turn the refined seaweed into sellable products



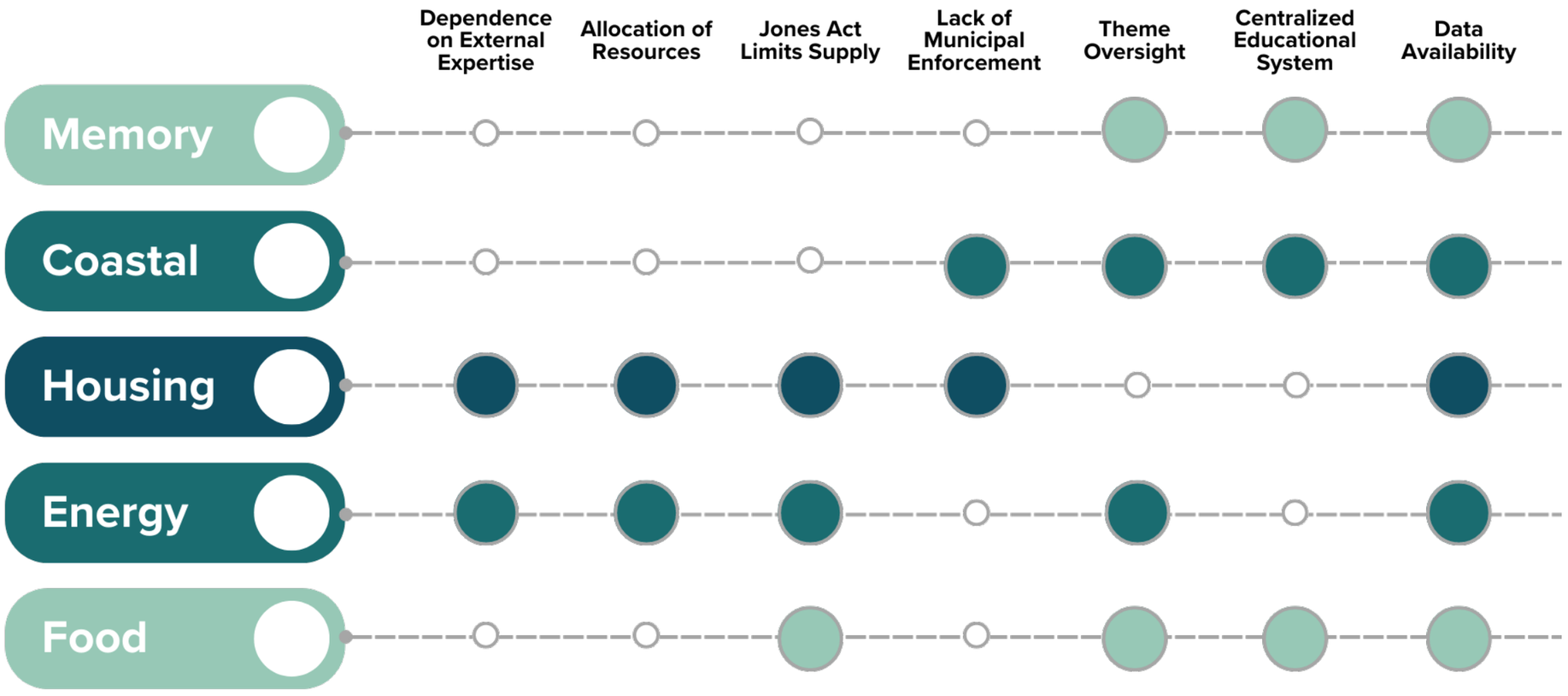
Figure 29: Render from the Sargatopía proposal of 2021.
Render sourced from Daniel Vanderhorst & Hanyin Zhang.

Sovereign Living, which addressed the lack of affordable housing on the island, due to the growing airbnb market and high cost of materials, through a Community Land Trust



Figure 30: Render from the Sovereign Living proposal of 2021.
Render sourced from Teonna Cooksey & Ryan Hansen.

Common Limitations



The studio's week-long in-person engagement in Culebra helped clarify how each research area is not only interconnected but is part of the bigger approach to developing autonomy and sovereignty for Culebra. Common limitations were made apparent from these visits and engagement for the five research areas. These are expanded upon below.

Technical Expertise
To enhance the collective expertise of Culebra's community, local experts should be brought together to refine technical skills and unlock advancements in locally identified groups of expertise. This can contribute to the island's overall growth and development by creating a valuable network of knowledge-sharing, collaboration, and mentorship for future leaders.

Resource Management
Federal funding from FEMA and organizations like EDF can benefit Culebra's community, but without a dedicated managerial body overseeing and guiding resource allocation, advantages may not be fully optimized. An effective managerial body can enhance strategic and efficient resource utilization, leading to better outcomes and long-term sustainability.

Jones Act
The Jones Act is known to limit the transportation of goods and materials to Puerto Rico, resulting in higher shipping costs, longer shipping times, and inflated prices of goods. This has visible impacts on the food industry, where food is no longer fresh when it reaches Puerto Rican ports, and ends up with inflated costs that locals cannot afford.

Municipal Regulation
The absence of effective enforcement mechanisms for municipal regulations has led to urban sprawl, substandard infrastructure, and a disregard for environmental and safety standards. Establishing robust enforcement measures are vital steps toward creating a more resilient and autonomous Culebra.

Oversight
Culebra locals wearing multiple professional hats can lead to oversight, missed opportunities, and inefficiencies due to juggling multiple roles and responsibilities, spreading individuals thin. Prioritizing research areas is necessary for community focus and efficiency.

Education
Puerto Rico's centralized educational system emphasizes US history over the island's own cultural and social heritage. This limits youth's understanding of their identity. However, elderly locals are preserving the island's history through writing and documentaries. The emphasis on US history is due to Puerto Rico's status as a US territory.

Data Availability
The availability of quantitative data from the U.S. Census Bureau and the American Community Survey has been limited in Culebra regarding demographic information and the five research areas. The lack of a means to spatially visualize data has been limiting to the teams. Additionally, on the information that is publicly available, it was made apparent through the trip that the actual conditions of the island are not reflected in the data from the U.S. Census Bureau. Community member and former Federal Fund and Land Use Planning Office Director, Roberto, highlighted that "data is weak and does not represent the reality of the Island."

Figure 31: Matrix of common limitations between the five identified research areas.

Proposals

Memoria
Resiliencia Costera
Casa
Energía
Alimento

03

This section will cover a range of projects from a team of architects and urban planners that support four overarching outcomes. These outcomes include strengthening technical skills and promoting intergenerational knowledge sharing, increasing local climate preparedness, creating access to sovereign systems, and, lastly, reinforcing infrastructure through policy mechanisms and community-led initiatives.

Key Takeaways From This Chapter

- **Strengthen technical skills**
  Proposals aim to reduce the dependence on external parties, particularly during crises and natural disasters
- **Increase Climate Preparedness**
  Proposals seek to enhance the ability of local infrastructure to adapt to climate change by being more disaster-resilient
- **Create access to sovereign systems**
  Proposals try to enhance resource affordability, empower the local community, and promote land reclamation
- **Reinforce infrastructure**
  Proposals seek to decrease external dependence by encouraging economic competitiveness, and improving disaster response



Figure 32: Plants growing at SEVA. Picture taken by Camila Botero Echeverri



Figure 33: Valentina lost her house during hurricanes Irma & Maria in 2017. Picture taken by Camila Botero Echeverri.



Figure 34: Public school Escuela Ecologica De Culebra with solar panels. Picture sourced from Dhwani Laddha.

Memoria

Project Team

- **Chris Kumaradjaja**
  M.Arch and M.S. Historic Preservation, GSAPP
  B.S. Civil Engineering, Columbia SEAS

Project Stakeholders

- **Fundación De Culebra**
  A non-profit organization, established in 1994, that has ran the Culebra Museum since 2008 alongside other projects
- **Museo Histórico de Culebra**
  “El Polvorín” allows visitors to learn about the island’s unique history, from the indigenous Taíno inhabitants to the U.S. Navy military occupation
- **Para La Naturaleza**
  An organization that sets up tours, workshops, and climate science events for those that want to contribute to Puerto Rico’s sustainable future

N

0 0.5 1 2 Miles

Proposal Vision



The Island of Culebra has experienced major traumas and redemptions. The people, who have witnessed colonization and military occupation, show a persistence and a resilience that have exemplified the Culebrenses throughout history. Their yearning and striving for freedom, and autonomy took on new and interesting forms with each historical challenge. The accessibility of history is a vital component to autonomy. The answers to the questions of “where do I come from?” and “what makes me?” bring greater and stronger connections to oneself and one’s community.

The answers to the questions of “where do I come from?” and “what makes me?” bring greater and stronger connections to oneself and one’s community.

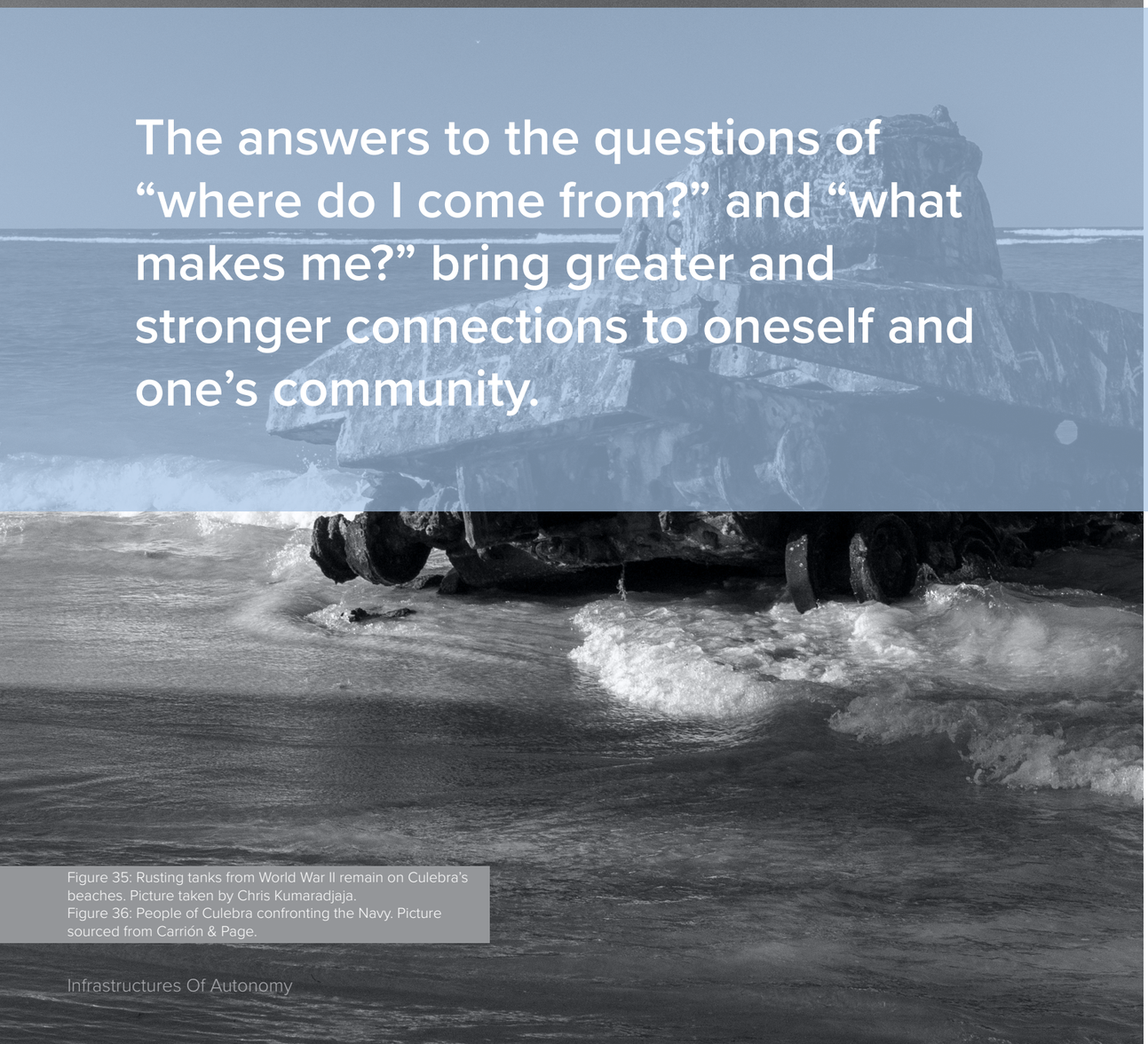


Figure 35: Rusting tanks from World War II remain on Culebra’s beaches. Picture taken by Chris Kumaradjaja.
Figure 36: People of Culebra confronting the Navy. Picture sourced from Carrión & Page.

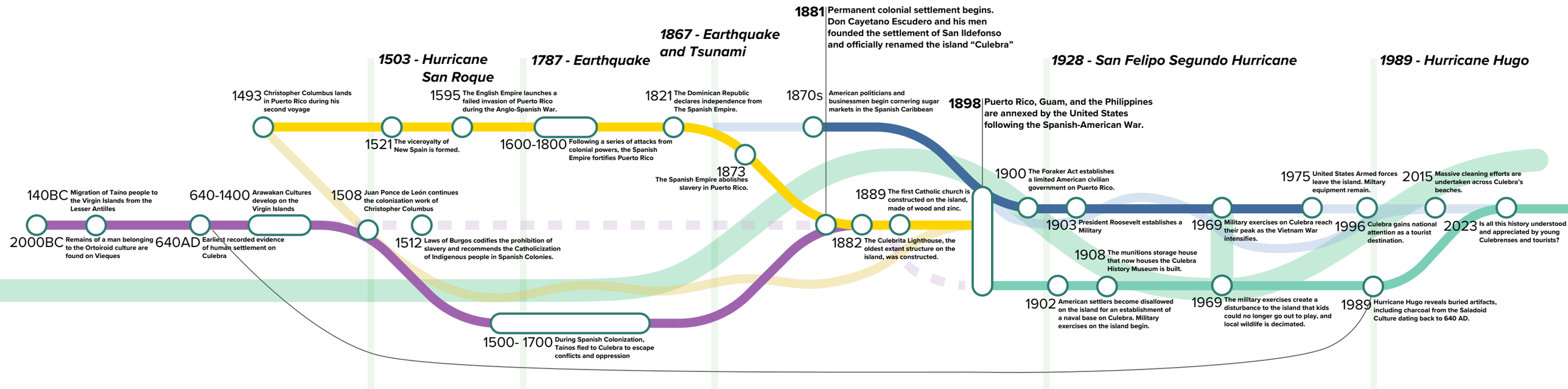
Key Objectives

- **Construct a space for oral histories and rehousing artifacts, giving a platform for the island’s elders to share their stories**
- **Constructing a solemn place of memory for the local Culebrenses**

Key Outcomes

- **Foster culturally-appropriate spaces**
  Creating spaces that are culturally-appropriate to house historical artifacts and privide a platform for elders to share their stories
- **Sustainable living**
  Increase knowledge of more sustainable forms of living from the past
- **Reclaim territories**
  Taking back land that was captured by the U.S. military for the housing of oral histories and historical artifacts

Historical Milestones



In truth, the timeline that has been outlined is not a single-dimensional one. Streams and narratives –or trails, dictating narratives of indigeneity, natural history, colonialism, and empire, overlap with one another and react with each other in a kind of historical chemistry that causes irreversible change. These layers of history mixed to create a unique culture. The people, who have witnessed colonization and military occupation, show a persistence and a resilience that have exemplified the Culebrenses throughout history. Their yearning and striving for freedom, and autonomy took on new and interesting forms with each historical challenge.

Figure 37: Historic timeline outlining how the narratives of indigeneity, natural history, colonialism, and empire, overlap with one another.

Current Conditions

San Ildefonso is the site on Culebra with arguably the most layers of history. San Ildefonso was known as the “First Town in Culebra”, regarded as as a “holy place” and a “historic area”. It was developed in 1880 as the first permanent settlement by Spanish settlers. A blueprint that was never realized shows the intentions of making San Ildefonso a traditional Spanish colonial town. Only recently, it was discovered that the indigenous Saladoid culture had occupied the area for nearly two millennia.

Once the United States annexed Puerto Rico and its surrounding islands in 1898, the United States Navy established a base on San Ildefonso, and commandeered the rest of the island for drills and target practice. Even though San Ildefonso was Culebra’s most populous settlement, the Navy expelled all the residents, giving them only 48 hours to relocate, and they moved to other parts of the island. Following a landmark resistance movement, the Navy withdrew from the island in 1975. Currently, the site is used for administration purposes, such as offices for the Natural Reserve. A few buildings, remaining from the Navy era and once used as munitions storage, are now administration buildings. The only extant structures from the colonial times are two brick cisterns.

When Hurricane Hugo struck Puerto Rico in 1989, repair efforts revealed remnants of a campsite that dates back to 640 BC. The Naval buildings were then restored, and a ferry terminal on Ensenada Honda was established. However, the ferry terminal is not in use.



Figures 38 and 39: Current site Conditions on San Ildefonso.
Picture taken by Chris Kumaradjaja.

Current Conditions



Currently, the museum dedicated to the entire history of the island is in an old munitions warehouse built by the US Navy. Through events brought on by both climate and empire, the past is constantly being revealed on a regular, but unpredictable basis. The layers of history that are around the island, that which is in “plain sight,” is not understood if it is not called out and contextualized.

The museum space is a single room of approximately 1,200 square feet. Pieces pertaining to different eras of history are juxtaposed without context. A video recounting the resistance is juxtaposed with trading scales and ledgers, while Taíno pottery is on display next to ammunition left by the US Navy.

The museum also has a wealth of literature written by Culebra’s elders, whose stories personify the layers of history and are testaments to the resilience of the island’s people. Much of the books written are in Spanish.





Figures 40, 41, and 42: Pictures from Museo Histórico de Culebra. Pictures taken by Chris Kumaradjaja.
Figure 43: An unrealized colonial plan of San Ildefonso. Pictures sourced from the Digital Archive of Culebra.
Figure 44: Map of Navy Base at San Ildefonso from 1940. Picture sourced from the Digital Archive of Culebra.

Community Engagement

Heritage is way beyond the physical. Self-actualization relies on the understanding of the histories that make a place. In this regard, the elders of any community provide the most valuable connections to this understanding. The resistance movements, including the Naval occupation prior, are still living memories for many Culebrenses.

Among Culebrenses, the leaders of this movement are living heroes. Their harrowing experiences and resilience serve as models for resolve and spiritual fitness. Apart from the lessons that their experiences can serve, these stories elevate the island to a hallowed place. Beaches on Culebra, such as the Playa Flamenco, were once inaccessible

Digna Feliciano runs a souvenir shop in the Barrio of Culebra. However, little do visitors know that she was a major figure in the resistance movement. During our visit, she retold of her own efforts to prevent the Navy from conducting missile tests that made it impossible to go outside, and decimated local wildlife. She, along with Benjamín Peréz Vega and many other Culebrenses-turned activists, mustered incredible bravery and courage to stand up for this cause. They have retold their stories in many books. However, Digna's books are an understated –and undersold– fixture in her shop, when they should be the centerpiece.

During our visit, Benjamín Peréz Vega invited us to his home. It was colorful, full of life, and a place where you felt like you could stay forever. The work that Benjamín put into his home, the paintings, the art, and even the swings, exemplifies the love that the Culebrenses have for their land. As we sat, Benjamín told us of his experience being the leader of the resistance movement. In the process, he was imprisoned for 88 days, but eventually his efforts resulted in success. He recalled that for many Culebrenses, like him, the island is the only place they know. And when the Navy had comandeered and abused their land to such an extent they were willing to sacrifice their lives to get their livelihoods back. The conversation quickly transitioned to a lesson of hope, a reminder to stand up for the people and land that you love.

Oral histories that Culebrenses have passed down through generations are a vehicle for this history that transcend physical artifacts. Currently, there is no a space on the island for individuals to tell their story, for people who lived during the navy occupation to tell about their childhood and resistance movements. This history is meant to be accessible to everyone, both Culebrenses and visitors. Perhaps, once visitors learn about the stories these beaches can tell, they can never *just* see these beaches as pretty objects, but a whole lot more.



Figure 45: Community Activist Digna in front of her sourvenir shop. Picture taken by Chris Kumaradjaja.

> We had to practice civil disobedience. We trespassed on the bombing range turning ourselves into targets so that they stopped bombing our lands.
>
> – Benjamín Peréz Vega, Community Activist

Figure 47: Community activists Doris and Paulino with Mujeres De Islas team member Nathania. Picture taken by Chris Kumaradjaja.



> They already had placed the explosives, to explode all the bombs. And we refused to move. They just kept running around trying to get us. They finally took a rope and pulled us out. And they exploded.
>
> –Digna Feliciano, Community Activist



Figure 46: Community activists Benjamín Peréz Vega and Dolly Camareno. Picture taken by Chris Kumaradjaja.

> And it was a success because President Nixon was on our side. He promised to end the bombings by 1972.
>
> – Paulino Espinosa Soto, Community Activist

Trails Of Memory

This proposal addresses these two aspects, the contextualization of both artifacts and oral histories, through a construction: a new home for the artifacts, and an oral history center. As mentioned, San Ildefonso has two hidden histories: the unrealized colonial settlement plan, and the traces of the Navy camp. In this site plan, they are dotted in orange and gray respectively. The structure's triangle shape is derived from the need to maintain circulatory and visual corridors from the ferry landing and the two existing historic Navy buildings. In this map, the History Museum is a ten-minute walk uphill. By moving the museum downhill, it remains contextual with the other nodes on the San Ildefonso campus. Although the ferry landing is not currently in use, the placement of the museum anticipates the ease of access that a ferry landing would bring.

We envision the timeline introduced above as a singular path inside the museum. Linearizing the timeline allows visitors to be "primed" for the stories to come. The entire museum is arranged in a gentle ramp, which provides a subtle ascent.

First, artifacts pertaining to the pre-Columbian era, such as the pottery and campsite remnants, are on display. After turning the corner, documents and pieces related to trade and empire, and stories relating to Spanish colonization are on display and told. However, as the history progresses, with the American annexation of Culebra, the corridor upon the next turn becomes darker and narrower, evoking the direness of being under occupation.

Once visitors are primed for the climax of this history, the path culminates in a dark room, where oral histories and documentaries are screened. This large space can also invite meetings and commemorative events, as it was sized to hold twenty people holding hands in a circle. Upon exiting the oral history room, history continues. What now? The large forces of gentrification and tourism make a complex future for Culebra. This last stretch is for those to reflect and to engage with the history that has been written, with the books by the elders on display to keep the stories alive.

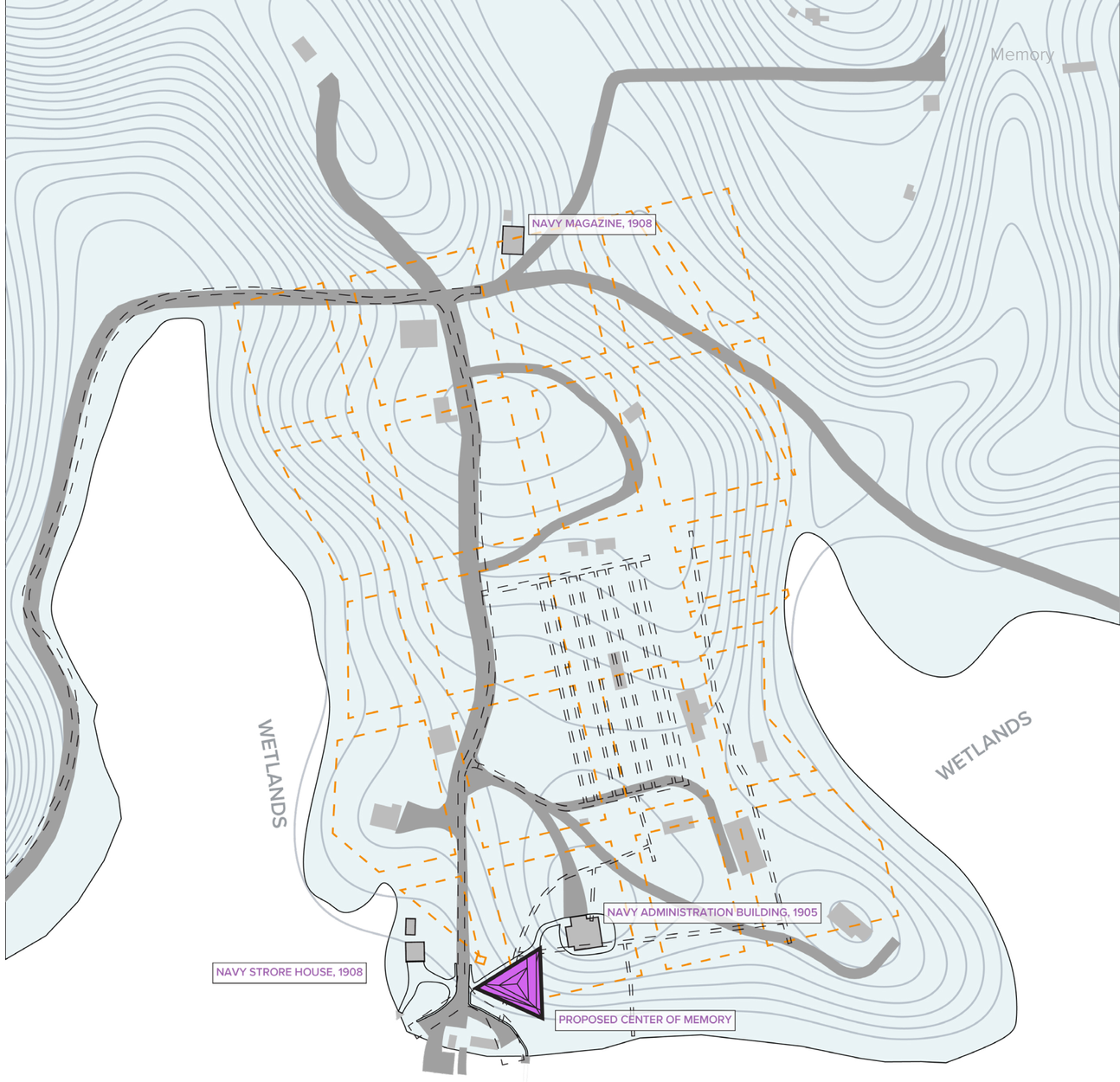


Figure 48: Site Plan

Purple: Proposed Museum
Orange: Colonial Plan
Black Dotted: Naval Plan

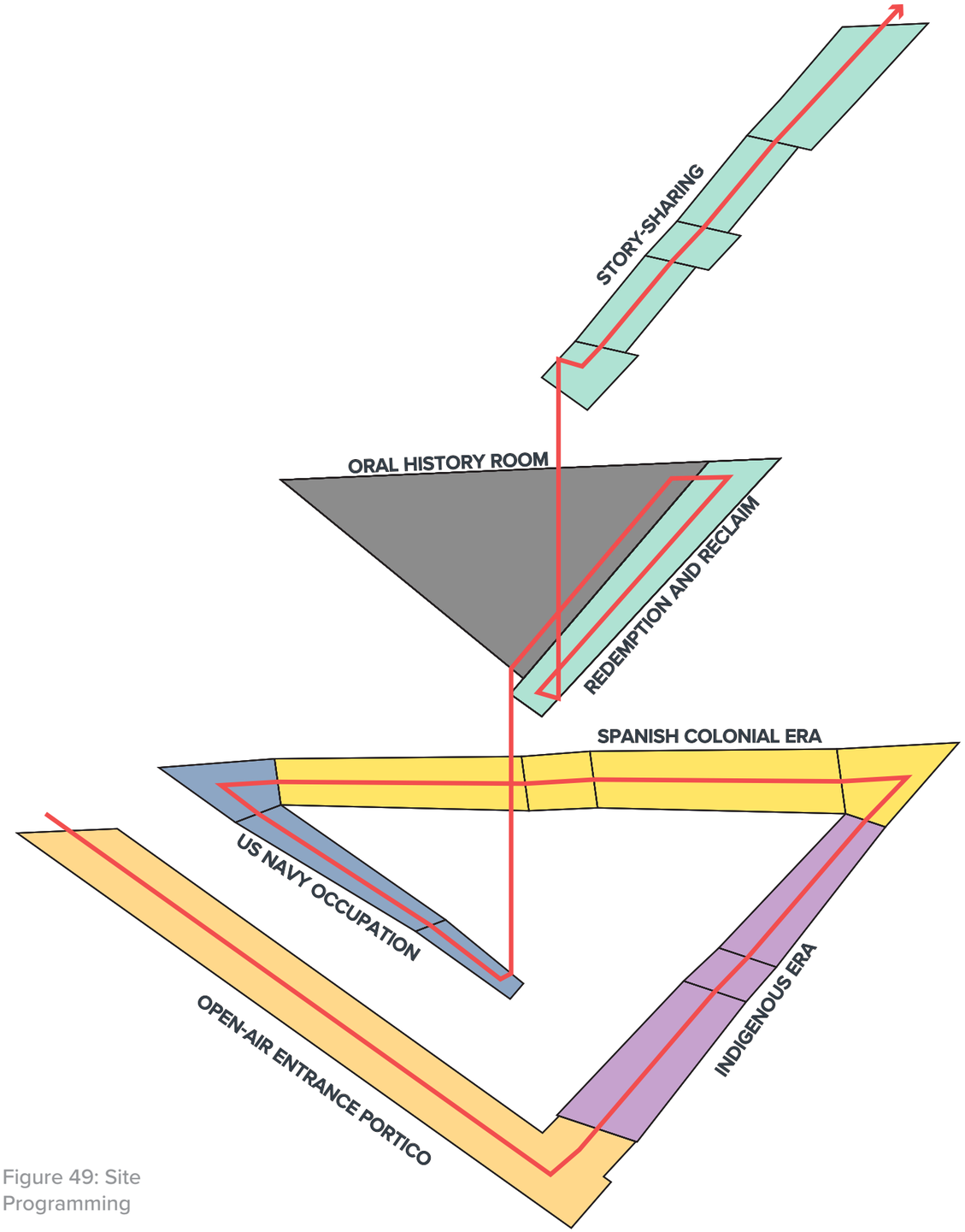


Figure 49: Site Programming

Figure 50: Plan Perspective

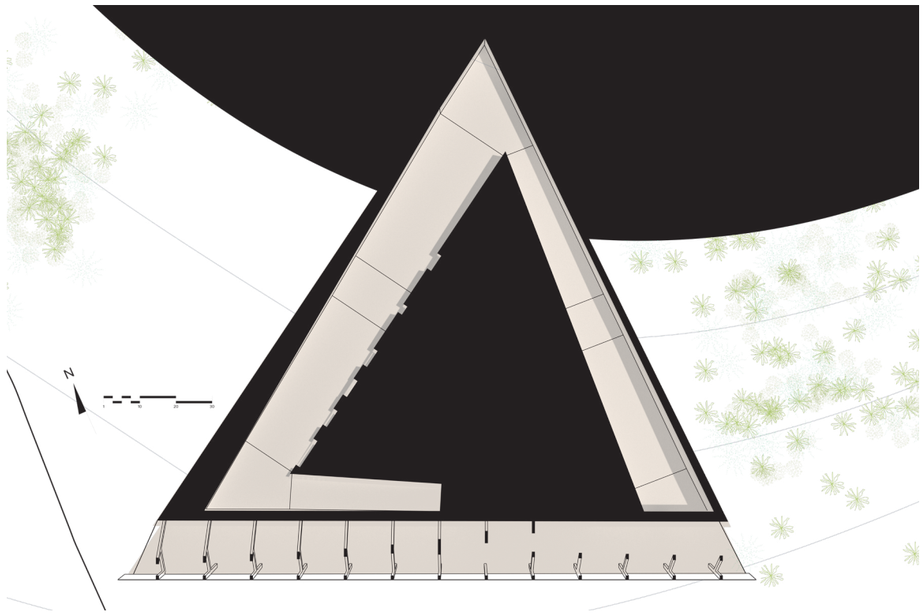
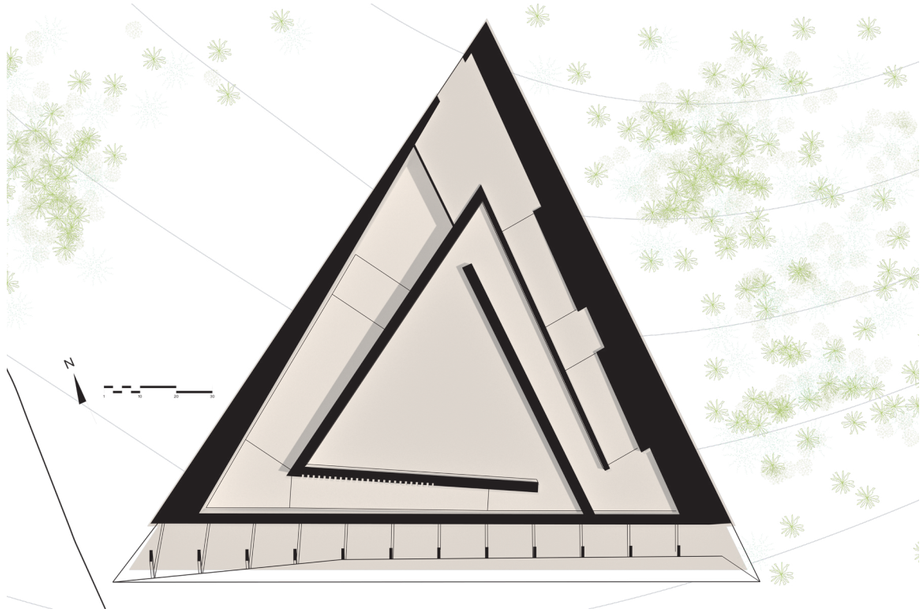


Figure 51: Plan Perspective At 20’



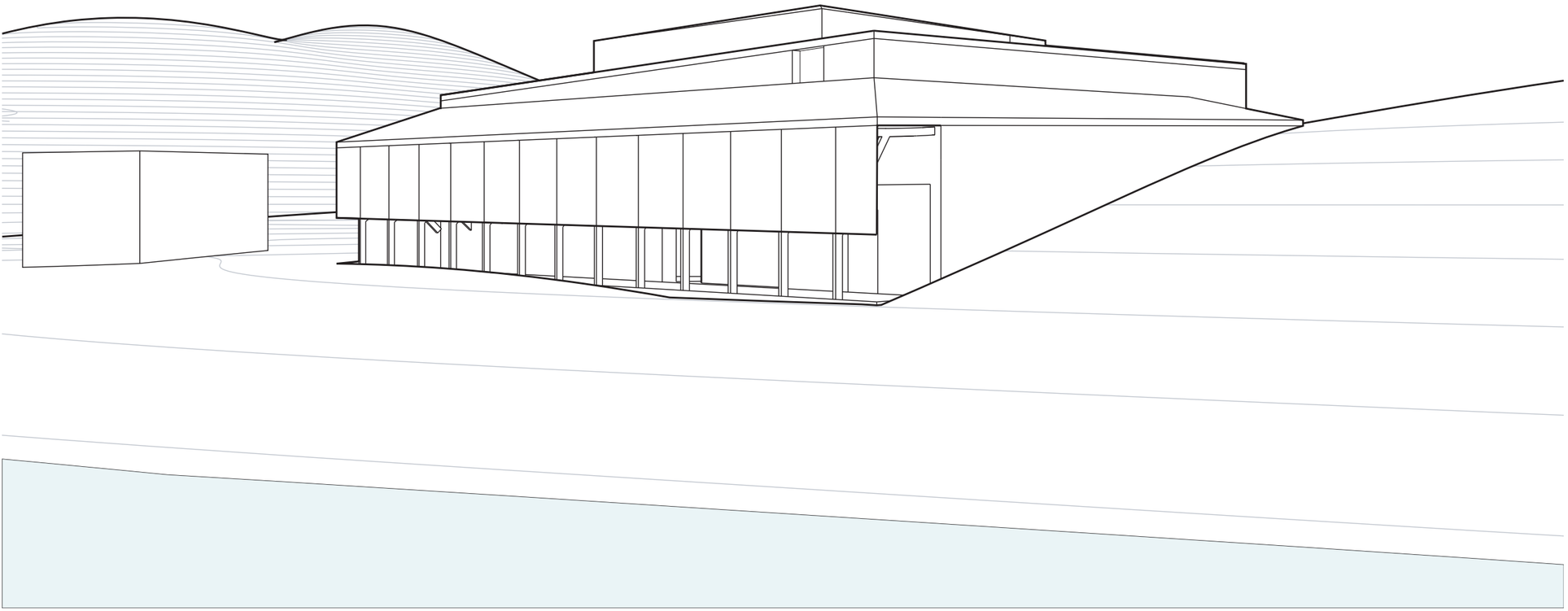


Figure 52:
Elevation
Perspective

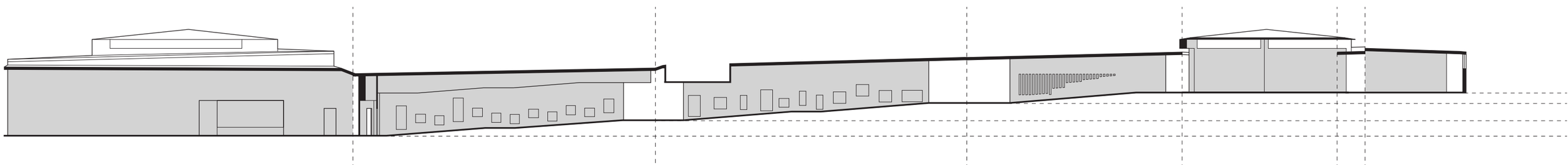


Figure 53:
Unfolded Section

Figure 54: Render of the proposed museum entrance.



Figure 55: Render of a dedicated space for oral histories

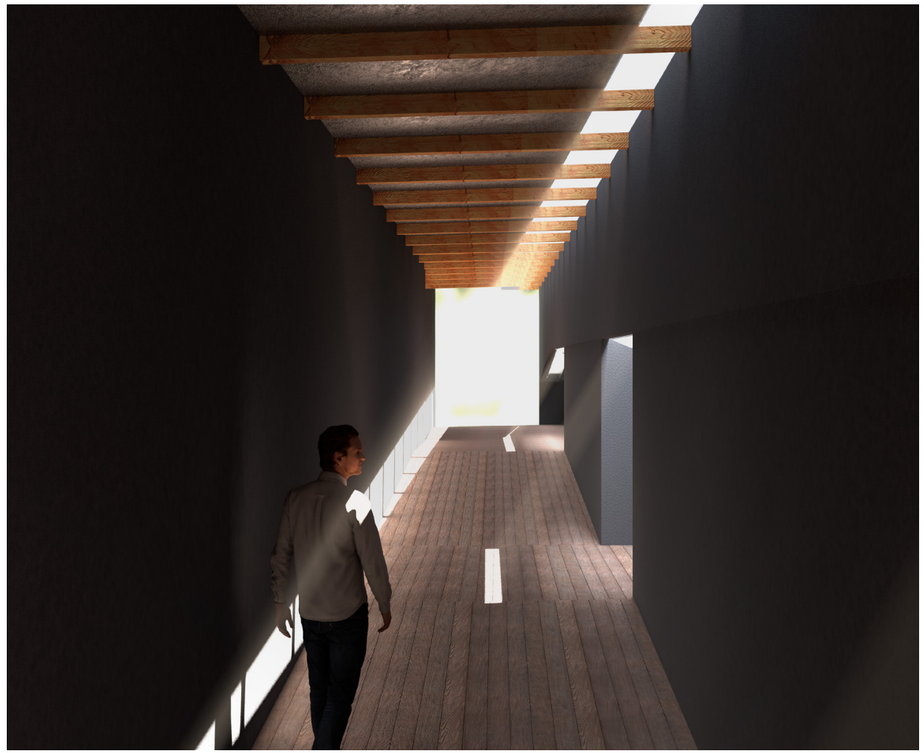


Figure 56: Render of museum interiors

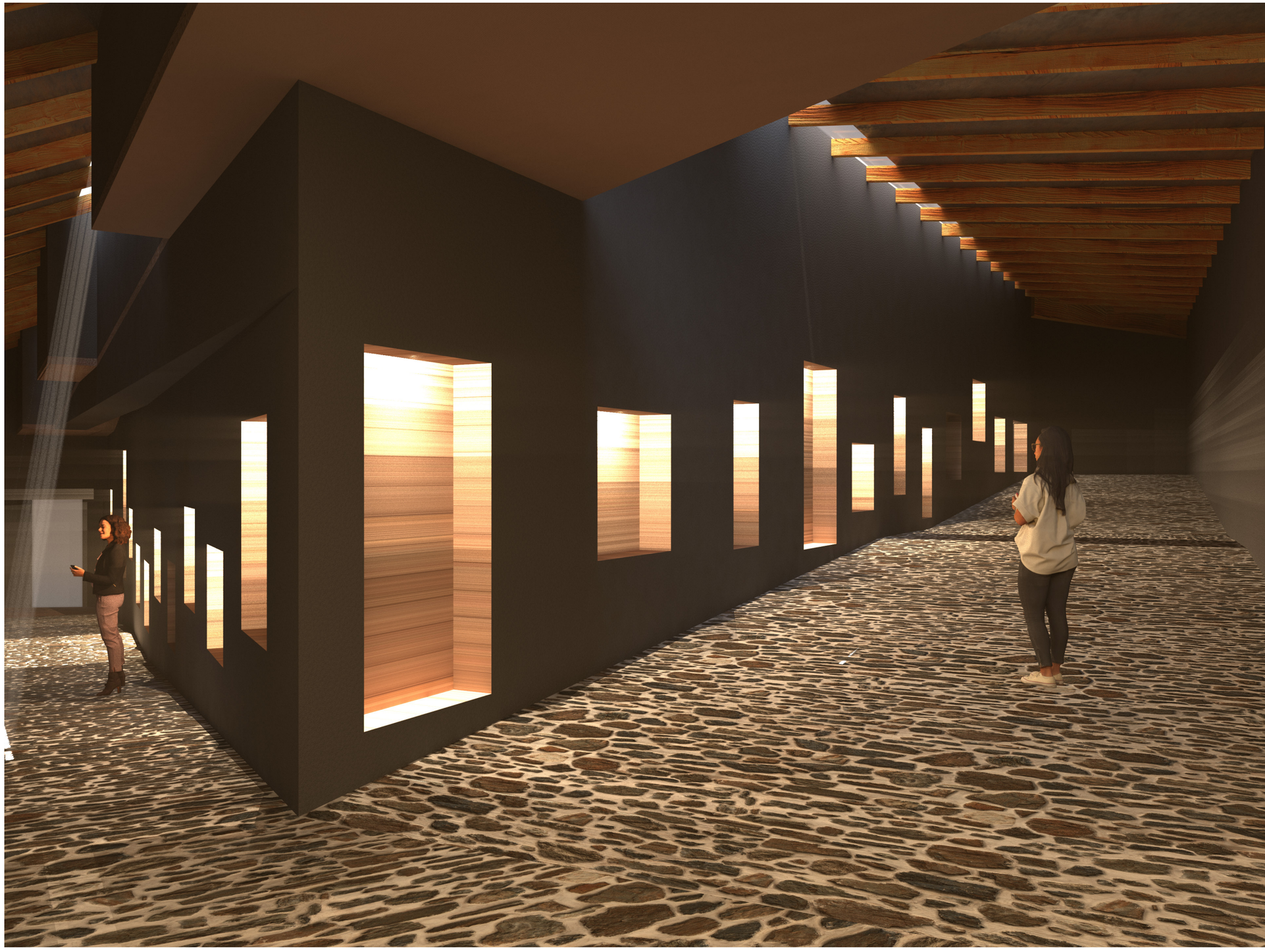


Figure 57: Render of proposed museum interiors

Outcomes

Figure 58: Diagram outlining outcomes achieved by the Memory proposal.



Resiliencia Costera

Project Team

Kayla Parsons
Architect and real estate development student

Emily Padilla-Chicas
Foreign Affairs Analyst and Urban Planner dedicated to promoting sustainable, equitable, and just outcomes for people and the planet

Project Stakeholders

Sociedad Ambiente Marino
Protects Culebra's marine resources with restoration, conservation, and education.

Centro para la Ecología Tropical Aplicada y Conservación en la Universidad de Puerto Rico
Advances conservation research and produces policy-relevant results.

Departamento de Recursos Naturales y Ambientales
Manages and conserve natural resources while promoting sustainable development on the island of Culebra.

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Our vision is to create a sustainable, resilient Culebra that is capable of withstanding the impacts of climate change, while fostering community and environmental autonomy.

Figure 59: An aerial perspective of Sargassum seaweed present on a beach in Culebra. Picture taken by Emily Padilla-Chicas.
Figure 60: Aerial view of sargassum on one of Culebra's beaches. Picture taken by Emily Padilla-Chicas.

Proposal Vision



Envisioning a future for Culebra that prioritizes sustainability and resilience. Through community engagement and environmental stewardship, the island will become more self-sufficient and able to adapt to the effects of climate change. This will require a holistic approach that balances economic development with conservation efforts, ensuring that natural resources are protected while also supporting the local economy. The community will be actively involved in this process, working together to build a stronger, more resilient Culebra. By fostering a sense of ownership and autonomy, the island will be able to thrive in the face of adversity and maintain its unique cultural and ecological identity for generations to come.

Key Objectives

Promote Coastal Resilience Education
Develop and implement educational initiatives to increase awareness and understanding of coastal resilience, including the measures that can be taken to enhance resilience to natural hazards and climate change impacts.

Enhance Public Access to the Coast
Improve infrastructure and policies to ensure easier and safer public access to the coast.

Perserve and Protect Coastal Ecosystems
Enhance ecological health of coastal ecosystems while providing recreational opportunities for locals and visitors.

Key Outcomes

Construction of Research Center
To improve the local marine environment's health and resilience through research, restoration techniques, and education for restoration practitioners.

Create a Community-Based Program
To empower communities to protect and manage their coastal resources, promote sustainability, and preserve biodiversity and ecosystem services.

Policy Implementation to Protect Coastal Ecosystems
Implement policies to safeguard coastal ecosystems and ensure sustainable utilization of resources for future generations.

Historical Milestones

1901

United States Navy Occupation



The US military used Culebra as a bombing range, causing damage to the ecosystem, including the destruction of coral reefs and mangrove forests.

1989

Hurricane Hugo



Hurricane Hugo devastated Culebra Island's terrestrial and marine ecosystems, causing massive deforestation, erosion, and destruction of coral reefs.

2017

Hurricane Maria and Hurricane Irma

Hurricane Maria and Irma, both Category 5 hurricanes, caused severe erosion and accretion of the coastlines of Culebra, leading to significant ecological impacts on its fragile marine and terrestrial ecosystems.

2000s

Non-Sustainable Tourism



Non-sustainable tourism on Culebra's coast has led to habitat degradation, loss of biodiversity, pollution, and erosion, threatening the island's ecosystem, its economy, and its cultural heritage.

2005

2010

2020

Figure 61: US Navy Tank on Flamenco Beach
Picture taken by Angel Vargas.
Figure 62: Destruction after Hurricane Hugo.
Picture taken by Leonna Page
Figure 63: Devastating pollution threatens the beauty of Culebra's beaches.
Pictures taken by Fred Schaffner.

Current Conditions

In the early 20th century, Culebra became a target for the United States military, and in 1903, the U.S. Navy established a naval base on the island. For several decades, the Navy used the island for military training exercises, including bombing and artillery practice, which caused significant damage to the island's flora and fauna. As a result, the island's coasts suffered from erosion and habitat destruction, leading to a decline in biodiversity and the loss of many native species.

In 1975, the Navy relinquished control of Culebra to the Puerto Rican government, but the damage to the island's coasts had already been done. In the years that followed, Culebra experienced an influx of tourism, which put further pressure on the island's natural resources. In particular, the island's beaches have been negatively impacted by the high number of visitors, leading to issues such as litter, erosion, and habitat destruction.

In addition to the ongoing threats to Culebra's coasts from development and human activity, the island has also been impacted by several devastating hurricanes, including Hurricane Hugo in 1989, Hurricane Irma and Maria in 2017. These storms caused significant damage to the island's infrastructure and natural resources, including its coasts, resulting in extensive erosion, beach loss, and habitat destruction. Despite the resilience of the island's inhabitants, the effects of these hurricanes serve as a reminder of the urgent need to protect and preserve Culebra's natural resources.

The condition of Culebra's coasts remains a cause for concern. The island's natural resources are under constant pressure from development, climate change, and human activity. Nevertheless, the island's captivating natural allure continues to attract visitors globally, making it imperative to take measures to conserve and safeguard its coasts.

Despite these efforts, the condition of Culebra's coasts remains a cause for concern. The island's natural resources are under constant pressure from development, climate change, and human activity. Nevertheless, the island's captivating natural allure continues to attract visitors globally, making it imperative to take measures to conserve and safeguard its coasts.



Figure 64: Eroded road PR-250 due to coastal proximity. Picture taken by Emily Padilla-Chicas.

Policy Analysis

Policy	Goal	Affected Stakeholders	Implications
Act 66 - Law for the Conservation and Development of Culebra	Promote sustainable development and conservation of Culebra's natural resources.	• Developers • Culebra businesses & consumers • Visitors of Culebra	This federal law encouraged states and territories to develop plans for managing their coastal areas, including protecting and restoring important habitats. As a result, Puerto Rico developed a coastal zone management program that has helped to regulate development along the coast and protect important natural resources.
Act 416 - Environmental Public Policy Act	Establish a framework for environmental management and protection in Puerto Rico	• Developers • Government agencies responsible for environmental management and protection	Increase accountability and transparency in environmental management and decision-making processes, promotion of sustainable development practices, and protection of natural resources and ecosystems. The act also establishes penalties for non-compliance with environmental regulations and empowers citizens to participate in environmental decision-making processes.
Coastal Zone Management Act in 1972	Preserve, protect, develop, and where possible, restore or enhance the resources of the nation's coastal zone	• Puerto Rico government • Coastal communities • Developers	Establishment of a national policy for the management and conservation of coastal resources, the development of state coastal management programs, and the coordination of federal agency activities related to coastal zone management. The act also provides for the establishment of a national coastal zone enhancement grants program to fund state and local projects that enhance coastal resources and protect them from threats such as erosion and sea-level rise.

Figure 65: Comprehensive analysis of policies impacting coastlines throughout Puerto Rico.

Act 66, Act 416, and the Coastal Zone Management Act of 1972 are policies that relate to the conservation and development of Culebra’s environment. Act 66 focuses on promoting the sustainable development and conservation of Culebra’s natural resources, Act 416 establishes a framework for environmental management and protection in Puerto Rico, and the Coastal Zone Management Act seeks to preserve, protect, and enhance the resources of the nation’s coastal zone.

There is overlap between these policies in terms of their goals of promoting sustainable development, conserving natural resources, and protecting the environment. They also provide a framework for government agencies, businesses, and communities to work together to achieve these goals. However, there are gaps in these policies, particularly in terms of their implementation and enforcement.

One of the downfalls of these policies is the lack of resources and capacity to enforce regulations and monitor compliance. Another gap is the limited participation and involvement of local communities in the decision-making processes related to the conservation and development of Culebra’s environment. Additionally, these policies may not adequately address emerging environmental threats, such as climate change, and may need to be updated to address these challenges.

Overall, while these policies provide a foundation for environmental management and protection in Culebra and Puerto Rico, their success will depend on effective implementation, enforcement, and ongoing evaluation and adaptation to changing environmental conditions.

Community Engagement

During our community engagements on coastal resilience and coastal conditions in Culebra, we met with local residents, environmental organizations, and government officials to discuss the impacts of climate change on the island's coasts and explore potential solutions to mitigate its effects. Through these conversations, we gained a deeper understanding of the challenges facing the community and the urgent need for collaborative action to protect and preserve the island's fragile ecosystems and ensure a sustainable future for generations to come. As a result of our community engagements, we identified several key areas where action is needed to address the impacts of climate change on Culebra's coasts.

One recurring theme that emerged from these discussions was the need to educate Culebrenses on coastal resilience and the importance of preserving and protecting natural coastal ecosystems. Many community members expressed their concern about the lack of awareness and understanding of these issues among the general public and the potential negative impacts on the island's environment and economy. Additionally, enhancing public spaces on the coast was also discussed as a crucial aspect of coastal resilience. Community members emphasized the importance of creating safe, accessible, and inviting spaces for residents and visitors to enjoy the island's natural beauty and cultural heritage. They highlighted the potential benefits of such efforts, including improved community well-being, increased tourism, and a stronger sense of community pride and identity.
Overall, our engagement with the Culebra community exposed the complex and interdependent relationship between ecological, cultural, and historical factors that shape the island's identity and sustainability. We recognized the need for collective efforts to protect the island's delicate ecosystems from the adverse effects of climate change. These valuable insights informed our approach in seeking collaborative and impactful solutions to the challenges confronting Culebra's coasts.



Figure 66: Discussion with the Mujeres de Islas regarding issues on the island and opportunities for improvement. . Picture sourced from Ubaldo Escalante.

> Hurricanes not only affect the island directly with the wind but also it impacts transportation, food imports and energy.
>
> - Dulce del Río-Pineda, Mujeres de Islas

Figure 68: Presenting Culebra's coastal issues to community members. Picture sourced from Ubaldo Escalante.



> Protecting and restoring is so important because conserving a quarter of the planet is not enough.
>
> - Sammy Suleimán-Ramos, Socieded Ambiente Marino



Figure 67: A conversation with activists Benjamin and Doris regarding the Navy occupation of Culebra.. Picture sourced from Emily Padilla-Chicas.

> Mangroves to Culebra are equivalent to what the levees are to New Orleans
>
> - Mary Ann Lucking, CORALations

Coastal Land Use Policies

Objective #2: Preserve and protect coastal ecosystems and enhancing public access to the coast

Coastal areas in Culebra are facing several areas of concern related to privatization and unregulated land development. The island has experienced significant land-use changes over the past century, including the conversion of coastal habitats for agriculture and residential development. As a result, several species of native flora and fauna have been affected, and some are now at risk of extinction. One major issue is the privatization of coastal land, which has limited public access to beaches and important habitats for native species. The privatization of coastal land also limits the ability of government agencies to protect these areas from development and other impacts. Additionally, unregulated land development, such as categorical exclusion, allows developers to bypass environmental regulations and permits, resulting in habitat destruction and fragmentation.The loss and degradation of habitats due to privatization and unregulated land development have had significant impacts on native flora and fauna. To address these concerns, it is essential to implement sustainable land-use practices and to promote public access to coastal areas. These efforts should also include the creation and enforcement of regulations to protect coastal habitats and to promote sustainable development practices.

The implementation of conservation overlay zoning can aid in mitigating the issues of privatization and unregulated land development in Culebra›s coastal areas. This type of zoning applies special regulations that identify valuable conservation areas and promote sustainable land use practices. By designating conservation areas and restricting development in these areas, conservation overlay zoning can help protect the habitats of native flora and fauna and prevent further habitat loss and fragmentation. Additionally, conservation overlay zoning can promote sustainable development practices that balance economic growth with conservation goals.

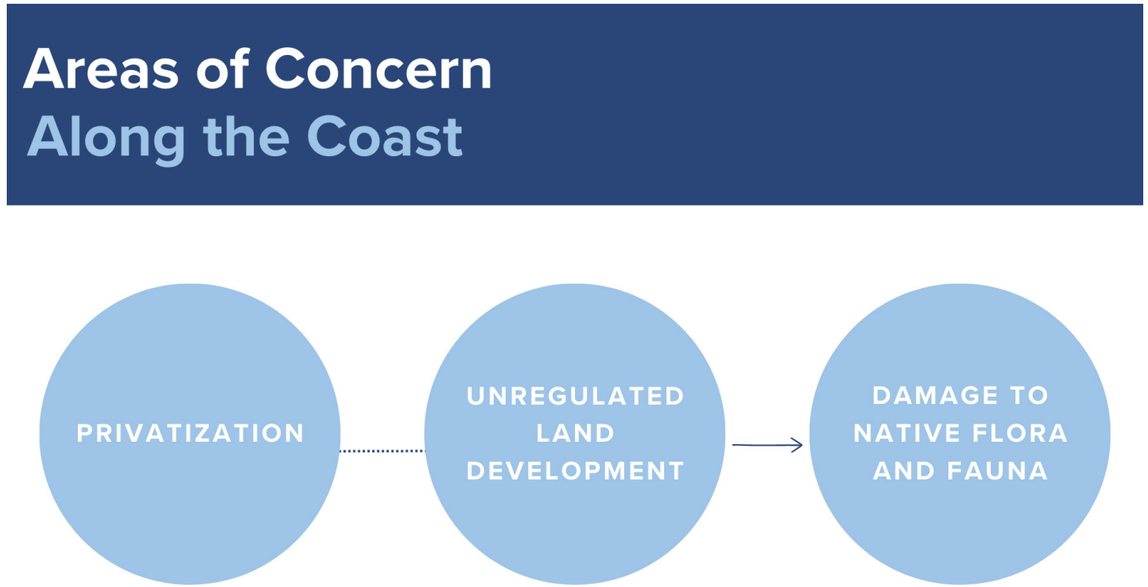


Figure 69: Coastal Concerns

Through comprehensive research on coastal conditions in Culebra, which involved mapping, policy analysis, and qualitative data from local residents, we have identified two major concerns: privatization and unregulated land development, resulting in damage to native flora and fauna.





Figure 70: Proposal One: Conservation Overlay Zoning

This zoning approach involves identifying valuable conservation areas and applying special regulations to promote sustainable land use practices. By designating conservation areas and limiting development in these areas, we can protect native flora and fauna habitats from further habitat loss and fragmentation.



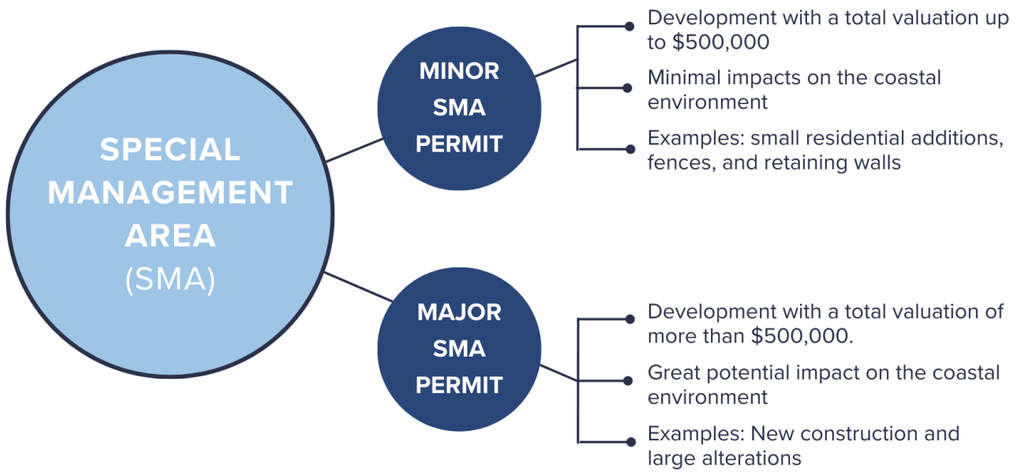
Figure 71: Proposal Two: Coastal Area Permits

This proposal requires all development projects in Culebra's coastal area to obtain permits that take into account the ecological and environmental impact of the proposed development. The system includes Special Area Management Permits and shoreline setback areas to promote sustainable development practices.



Figure 72: Brief Explanation of SMAs

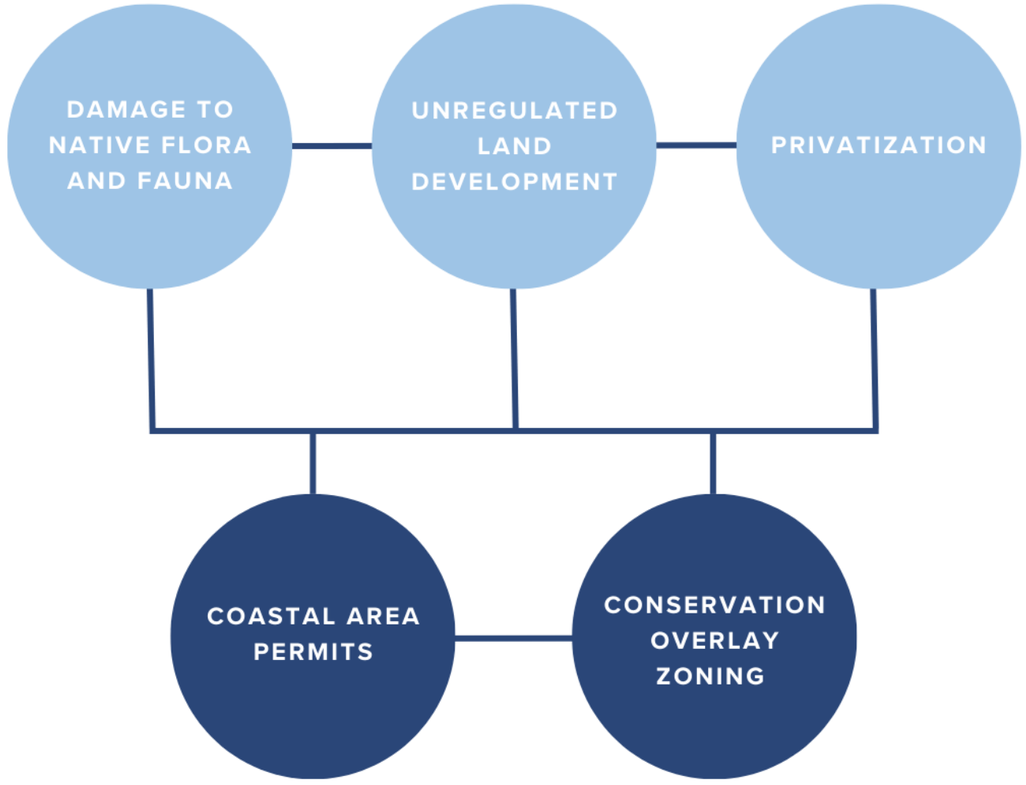
SMAs are separated into minor and major SMA permits depending on the development value, size, and environmental impact. The SMA permits require a more extensive review process to ensure environmentally sound and sustainable development activities.



Proposal Two is the implementation of a Coastal Area Permit system in Culebra. This system would require all development projects in the coastal area to obtain permits that take into account the ecological and environmental impact of the proposed development. The permit process would involve several steps, including a review of the project's impact on water quality, wildlife habitats, and ecosystems. Within the Coastal Area Permit system, one aspect is the implementation of Special Area Management Permits (SMA). These permits would apply to sensitive coastal areas that require additional management and protection. The SMAs would require a more extensive review process to ensure that development activities in these areas are environmentally sound and sustainable. This review process would involve input from local stakeholders, including government agencies and local residents. Another part of the permit system would be the implementation of shoreline setback areas. These areas are designed to protect the natural shoreline by requiring a minimum distance between the shoreline and any development project. The setback areas serve as a buffer zone that allows for natural processes such as beach erosion and sea-level rise. They also protect natural habitats and reduce the impact of development on coastal ecosystems. The implementation of a Coastal Area Permit system in Culebra would have several implications. It would ensure that all development projects in the coastal area undergo a rigorous review process that takes into account the ecological and environmental impact of the proposed development. The permit system would promote sustainable development practices that balance economic growth with conservation goals. It would also provide a framework for the management and conservation of natural resources in Culebra's coastal areas.

Figure 73: Coastal Concerns and Land Use
The diagram illustrates the interconnection between areas of concern such as privatization, unregulated land use, and damage to native flora and fauna in Culebra's coastal areas, and the proposed coastal land use policies of Conservation Overlay Zoning and Coastal Area Permits. These policies aim to mitigate the identified areas of concern and promote sustainable land use practices that balance economic development with conservation goals.

Areas of Concern & Coastal Land Use Policies



The areas of concern along the coast of Culebra, including privatization, unregulated land use, and damage to native flora and fauna, are interconnected and require a comprehensive approach to address them. The privatization of coastal land in Culebra has led to a reduction in public access to beaches and critical habitats for native flora and fauna. Unregulated land use and development, such as categorical exclusions, have resulted in habitat destruction and fragmentation.

The proposed coastal land use policies of Conservation Overlay Zoning and Coastal Area Permits aim to mitigate the identified areas of concern and promote sustainable land use practices. Conservation Overlay Zoning would protect valuable conservation areas, promote sustainable land use practices, and conserve native habitats to prevent further loss and fragmentation. Coastal Area Permits would require all development projects in the coastal area to obtain permits that take into account the ecological and environmental impact of the proposed development. This would ensure that all development activities undergo a rigorous review process that considers the impact on water quality, wildlife habitats, and ecosystems.

Together, these policies provide a framework for managing and conserving natural resources in Culebra's coastal areas while promoting sustainable economic growth and long-term sustainability of the island's natural resources and ecosystems.

Coastal Resilience Center

Objective #1: Educate Culebrenses on coastal resilience

After extensive discussions with local organizations, Dulce, and community members, it has become clear that enhancing knowledge of Culebra's fragile ecosystems is crucial. Natural disasters, climate change, non-sustainable development, and tourism have all impacted the island's natural resources, and education is a vital component of mitigating these effects.

To address this issue, the architecture component of this theme proposes a Coastal Resilience Education Center based in Cayo Pirata. The center would focus on enhancing knowledge of various coastal ecosystems, including coral reefs, seagrass, mangroves, erosion, and oysters. The center would provide educational programs and hands-on experiences for both locals and visitors to increase understanding and appreciation of Culebra's natural resources.

The Coastal Resilience Education Center would serve as a hub for promoting sustainable development practices and coastal conservation efforts. By educating locals and visitors on the importance of protecting Culebra's natural resources, the center would foster a sense of stewardship and promote a sustainable future for the island.

Overall, the proposed Coastal Resilience Education Center aligns with the theme of promoting sustainable development in Culebra's coastal areas. By enhancing knowledge of the island's fragile ecosystems, the center can promote a deeper understanding of the importance of conserving natural resources and preserving the island's unique environment for future generations.



Figure 74: Aerial View of Cayo Pirata

Aerial view of Cayo Pirata provided by Socided Ambiente Marina, showing the existing structures on the island. The structures are the proposed location for the Coastal Resilience Education Center.



Figure 75: Location of Cayo Pirata in Culebra

The map depicts Cayo Pirata, a small island located near Dewey in Culebra

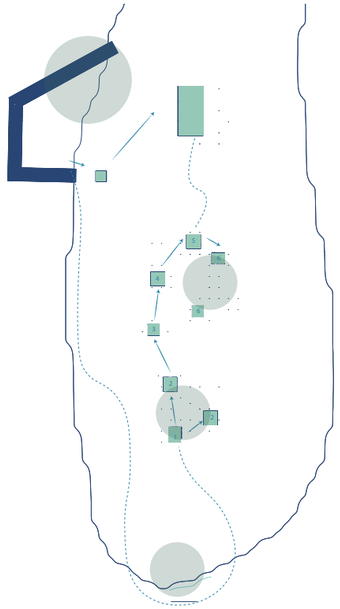


Figure 76: Proposed program layout for the Education Center

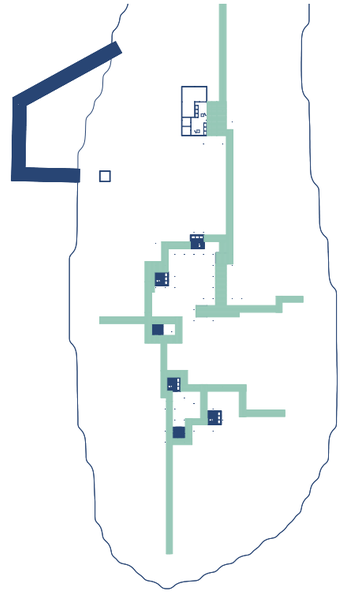


Figure 77: Displays the program layout, including a wooden pathway that connects all gazebos throughout the island

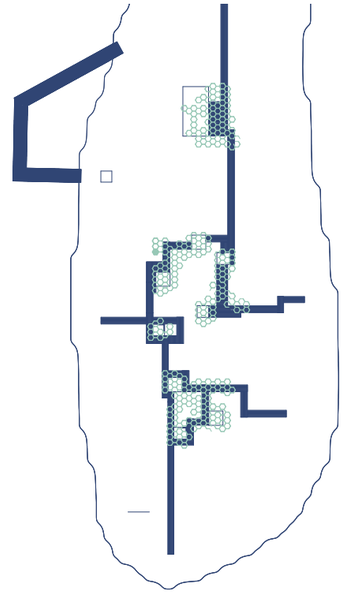
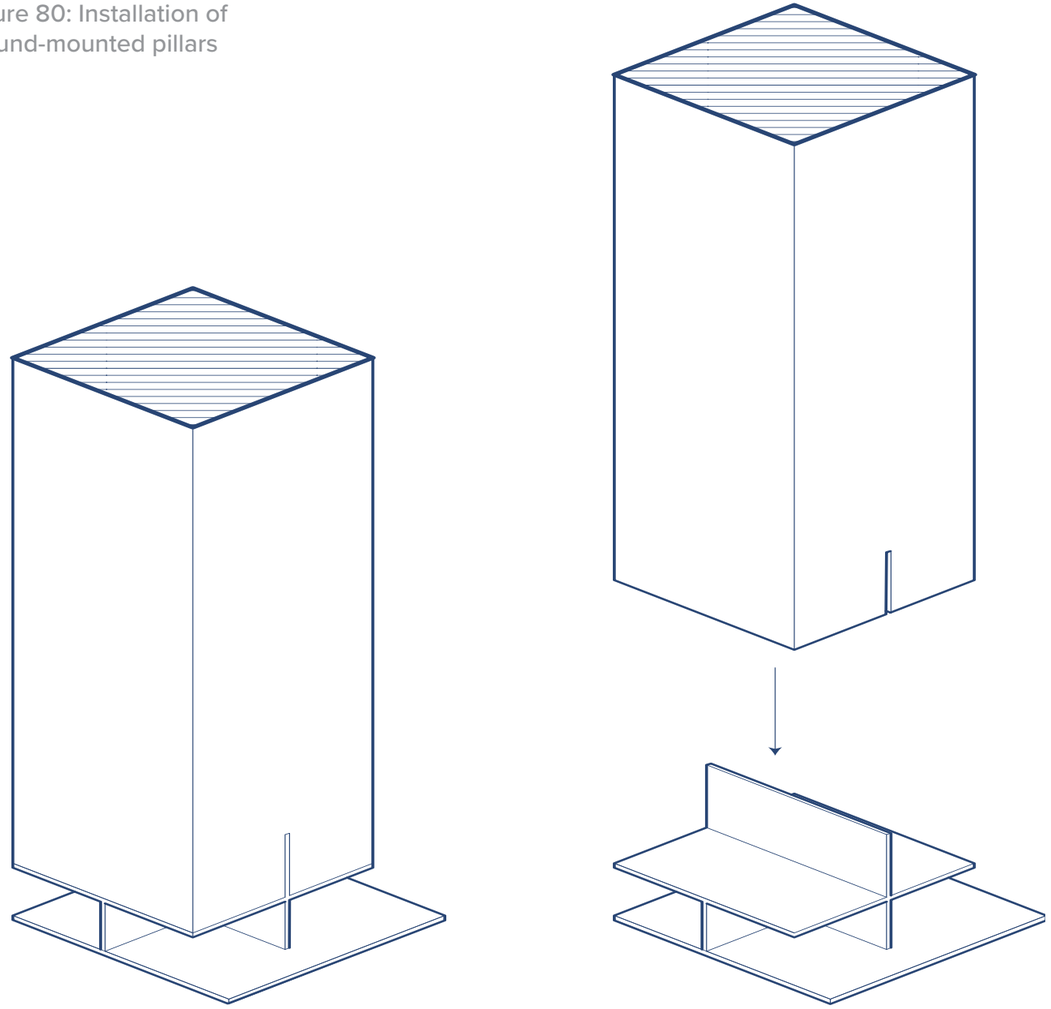


Figure 78: Canopy Structure

Figure 79: Site Axon

Figure 80: Installation of ground-mounted pillars



The proposed architecture for the Coastal Resilience Education Center in Culebra emphasizes flexibility and ease of assembly and disassembly. This approach allows for quick adaptability and modification to suit the changing needs of the center and its users. The modular design of the center allows for the addition or removal of structures as necessary, providing a cost-effective and efficient approach to construction. The open planks featured are designed to allow for natural airflow and sunlight to enter the structures. This design approach not only provides a more comfortable experience for visitors but also contributes to the sustainability of the center by reducing the need for artificial lighting and ventilation.

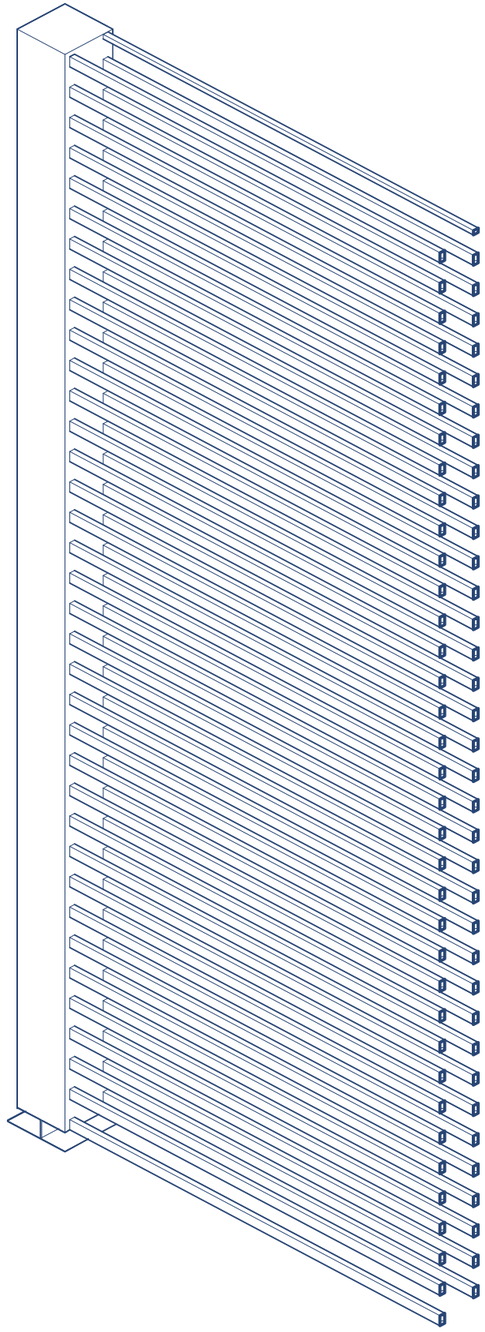


Figure 81: Closed Planks

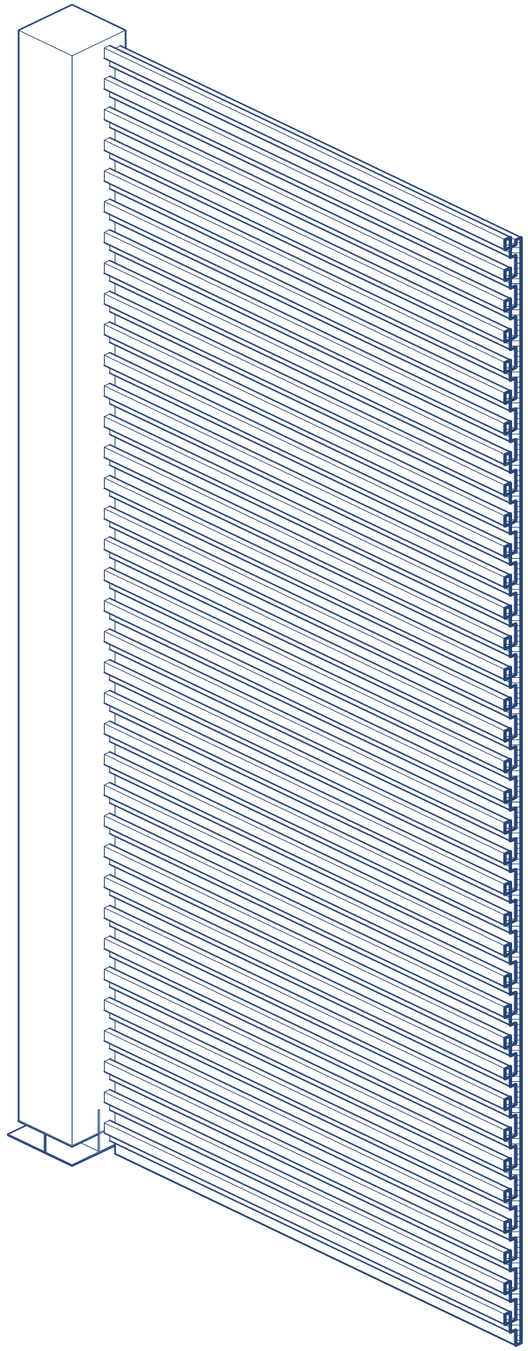


Figure 82: Open Planks

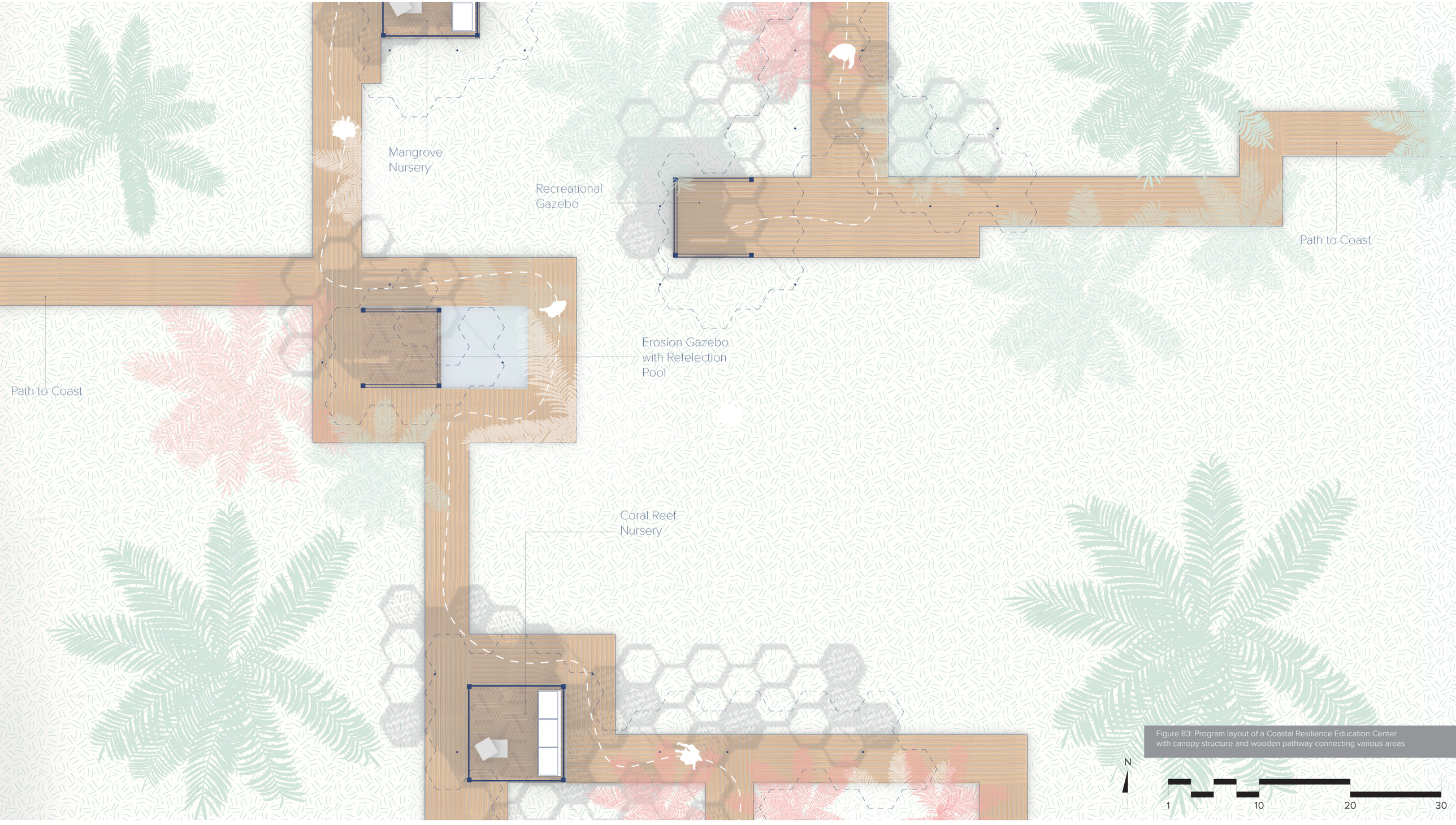


Figure 83: Program layout of a Coastal Resilience Education Center with canopy structure and wooden pathway connecting various areas



Figure 84: Site Section with Canopy Panel Sun Studies

Provides insights into the shading and natural light conditions for the center's different areas throughout the day, helping to inform the design of the canopy and its orientation to optimize natural lighting and shading.



Figure 85: Section of Gazebo

Interior view of a gazebo designated for marine activities with youth.

Funding Sources

SAM has already taken an active role in the proposed marine education center project, having contributed physical labor to clean up Cayo Pirata and presenting the proposal to the Culebra municipality. As such, SAM could serve as a potential source of funding for the center's development and operation. Leveraging their existing involvement and expertise, SAM could provide financial support, resources, and community outreach to advance the project and promote marine conservation and education efforts in the Culebra community.

CATEC can obtain grants from government or private foundations, seek donations from individuals or corporations, or partner with other organizations to raise funds for an educational marine center. They can also provide access to scientific expertise and community outreach programs. Additionally, CATEC may provide financial support for the center's development, including research equipment, educational materials, and staff training.

The local government agency responsible for natural resources and environmental affairs can play a key role in funding sustainable development projects in Culebra by providing financial support through grants and other funding mechanisms. Additionally, they can provide technical assistance, expertise, and other resources to support ongoing initiatives, and may work closely with local organizations to identify opportunities for collaboration and partnership.

Section 112B mandates that 10% of electricity sales revenue from Culebra be deposited into the 'Permanent Fund for the Environmental Preservation of Culebra,' which finances programs to conserve the island's natural resources, cultural heritage and promote sustainable development. This Act supports initiatives that balance economic growth with environmental protection and cultural preservation, benefiting current and future generations while preserving the island's rich history.

Sociedad Ambiente Marino (SAM)

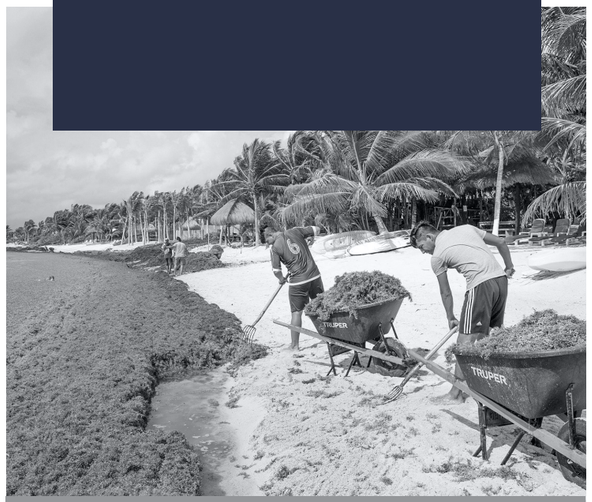


Figure 86: Sociedad Ambiente Marino. Picture sourced from Taylor 2019.

Centro para la Ecología Tropical Aplicada y Conservación en la Universidad de Puerto Rico (CATEC)

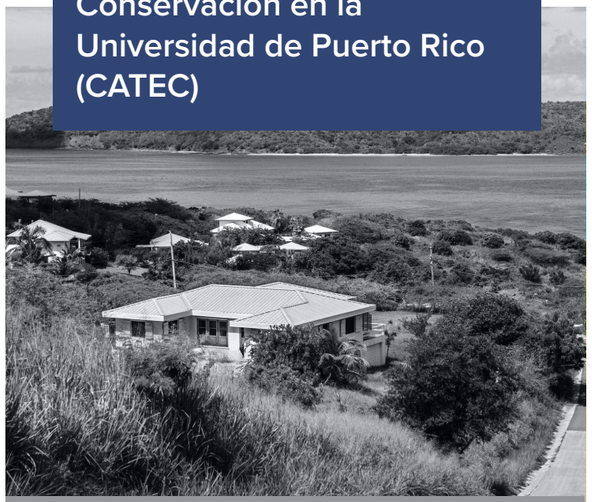


Figure 87: Centro para la Ecología Tropical Aplicada y Conservación en la Universidad de Puerto Rico. Picture sourced from Shane 2014.

Departamento de Recursos Naturales y Ambientales

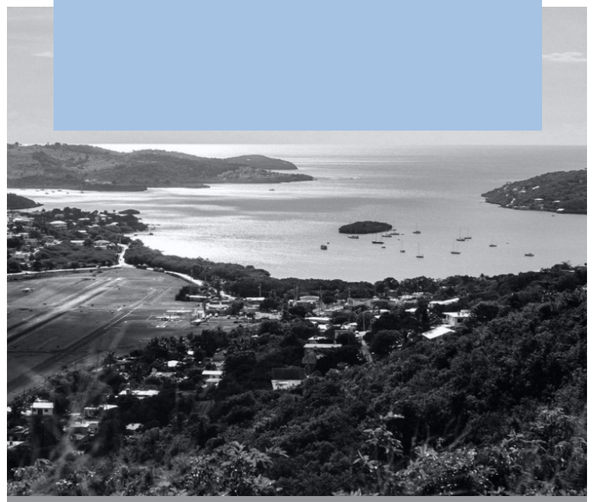


Figure 88: Departamento de Recursos Naturales y Ambientales. Picture sourced from Shane 2014.

Act No. 83, Section 112B- Permanent Fund for the Environmental Preservation of Culebra

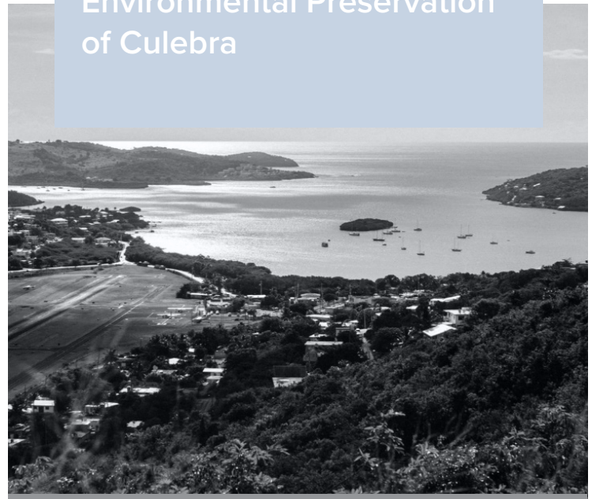


Figure 89: Culebra Conservation and Development Authority. Picture taken by Emily Padilla-Chicas.

Stakeholders

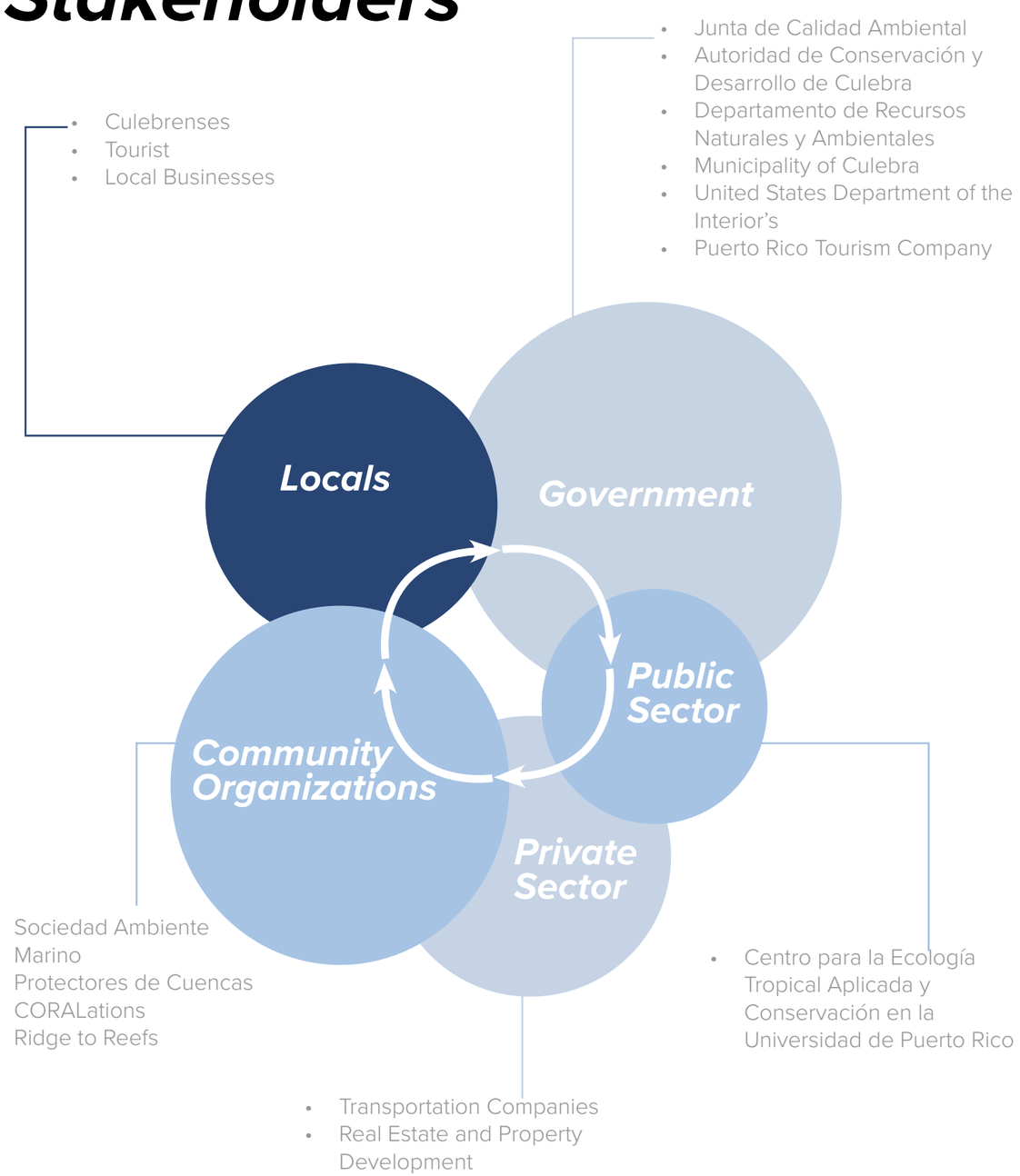


Figure 90: Stakeholder map of the Coastal Resilience proposals.

The stakeholders for the coastal land use policies and the coastal resilience education center play a critical role in the success of these proposals. The stakeholders are diverse and include locals, government agencies, community organizations, and private sector entities. Locals, including Culebrenses, tourists, and local businesses, are essential stakeholders in these projects as they are directly impacted by the policies and education center initiatives. Their input and feedback are crucial for shaping the policies and ensuring that they are effective and relevant to the local community. The government agencies, including Junta de Calidad Ambiental, Autoridad de Conservación y Desarrollo de Culebra, Departamento de Recursos Naturales y Ambientales, and Municipality of Culebra, play a central role in the implementation and enforcement of these policies. Their support and resources are critical for the success of these projects. Community organizations such as Sociedad Ambiente Marino, Protectores de Cuencas, CORALations, and Ridge to Reefs are also important stakeholders as they can provide valuable expertise and resources to support the initiatives. Finally, the private sector, including transportation companies and real estate and property development firms, can be both supporters and opponents of these policies depending on how the policies impact their businesses. Involving all of these stakeholders in the planning and implementation process will ensure that the proposals are effective, sustainable, and supported by the community. It will also help to identify any potential areas of conflict or concern early on, allowing for effective management of any issues as they arise. Ultimately, the success of the proposals will rely on the support and collaboration of all stakeholders involved.

Implementation Timeframe

Short-term Actions

Community Engagement
Engage locals through meetings for policy proposals and education center implementation input and support.

Resource Allocation
Allocate the necessary resources, including funding, staff, and materials, and developing a budget and identifying funding sources.

Permitting and Approvals
Obtain necessary permits, EIA, and approvals and oversee the construction process to identify potential environmental risks.

Designing and Planning
Develop a detailed design and plans, taking into account community input and sustainability goals.

Partnership and Collaboration
Establish working relationships, leveraging expertise, and engaging stakeholders in decision-making processes.

Long-term Actions

Monitoring and Evaluation
Develop metrics for progress and impact assessment to inform future decisions

Adaptive Management
Establishflexible and effective responses to changing circumstances, including contingency plans and responsive decision-making.

Exapansion
Expand the development of new educational programs and materials to enhance the center's education. As well as creating a new center.

Partnership and Collaboration
Identify new partners and opportunities for collaboration, leveraging their expertise and resources.

Capacity Building and Training
Provide ongoing training and support for staff, developing educational programs for local students, and providing professional development opportunities for community.

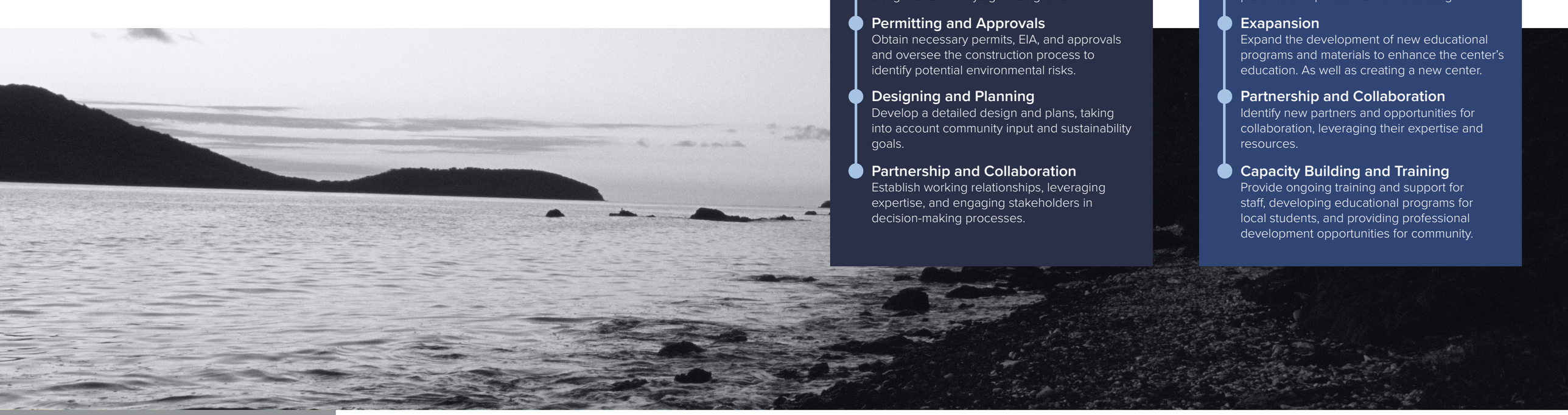


Figure 91: Sunset on one of Culebra's beaches.
Pictures taken by Chris Kumaradjaja.

Outcomes

Figure 92: Diagram outlining outcomes achieved by the Coastal Resilience proposals.



Casa

Project Team

Camila Botero Echeverri
Bachelor's degree in Architecture and Fine Arts. Worked with The United Nations Development Programme (UNDP) and The Ministries of Agriculture and Rural Development, Housing, and the National Planning Department in Colombia

Claudia Kohn Avila
Bachelor's dregree in Environmental Studies and Design, with a concentration in Architecture from Tulane University. Worked with architects in Quito, and is intrested in the development of cities and public housing

Isaiah Graham
Bachelor's degree in Architecture from Temple University. Has worked in various capacities as a designer, visualizer and gallery assistant.

Project Stakeholders

Community of Culebra
Citizens of Culebra that are prospects beneficiaries of the proposal and potential house and lot's owners. Their participation will be dependent on the bylaws on the Land Bank and their engagement in the labor task force.

Local Municipality
The Land Use Planning Office, is part of the Local Government and their role is to assist in the different scenarios and the policy framework to guide the process of obtaining a piece of land or build a house.

Mujeres de Islas
Team responsable for mobilizing resources, information and knowledge about the implementation of the Land Bank and emergency response funds as well as gathering the community for decision making.

FEMA
The Federal Emergency Management Agency is responsible for distributing the individual and household assitance for construction and reparations of houses after hurricanes.

Proposal Vision

Our proposal aims to make reliable and climate-resilient housing more accessible to Culebrenses, increase ownership by leveraging underutilized land and local knowledge by implementing design and policy frameworks. This will reduce external resource dependency in the case of an emergency and help meet community needs in Culebra



Figure 93: View of Villa Muñeco by the sea. Picture taken by Claudia Kohn
Figure 94: Valentina's House. Picture taken by Camila Botero



This proposal aims to tackle a historical housing crisis in Culebra, the issues of land tenure, access, and sustainable forms of living.

The proposal is called Casa, which means home in Spanish, Culebra's native language. For the team, the idea of home not only responds to the physical dwelling where people reside but also encompasses a broader sense of belonging, comfort, and security associated with a place.

> ***Home is a safe haven and a comfort zone. A place to live with our families and pets and enjoy with friends. A place to build memories as well as a way to build future wealth. A place where we can truly just be ourselves (Habitat for Humanity).***

Key Objectives

- **Support the implementation of the Land Bank through strategies and recommendations**

  Provide assistance for the implementation and governance of the Land Bank initiative

- **Provide guidance on the creation of a local work-force group that supports construction assistance**

  Create a skilled and reliable workforce that help increase the availability of housing

- **Design a Toolkit that foster sustainable forms of living and emergency response capabilities**

  Create a comprehensive set of tools and resources that promote sustainable living practices

Key Outcomes

- **Increase the affrodable housing inventory**

  Expand availability of affordable housing, to counter effect the increase in property value and heighten a more autonomous housing system

- **Preserve housing affordability**

  Preserve housing affordability through local, community-driven strategies and municipal policies.

- **Increase knowledge on sustainable forms of living**

  Design homes for the community based on cultural traditions and make sure they are safe and resilient to climate change

History



Figure 96: First parcel division Sourced from Fundación

Spanish Settlement

The first settlement by the Spanish, “San Ildefonso de la Culebra,” was in honor of the Bishop of Toledo. Construction took place from 1882-1886, the first lot division of the island.

1880

US Military

The US military breaks The Paris agreement by displacing the people from San Ildefonso. The majority of people moved to Playa Sardinas I and II, know know as Dewey



1901

Figure 98: Military Ocupation in San Ildelfonso Sourced from Fundación Culebra



Figure 99: Culebrenses fighting the militaru Sourced from “Culebra 135-40.”

End of US Navy

After riots and protests by the Cuelbrenses, the Navy stopped using Culebra as a Military Base and left the island

1975

FEMA Houses

Reconstruction houses by FEMA in Villa Muñeco after Hurricane Hugo´s destruction. The design was not sympathetic to the people, the environment nor their culture, not only because they were made of concrete but also for the lack of ventilation, flat roofs that don’t collect water and their close proximity.



1990’s

Figure 101: FEMA House Sourced from Google Earth

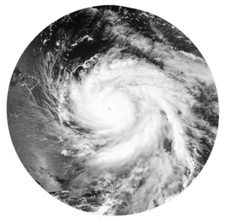


Figure 103: Hurricane Maria Sourced from NOAA

Hurricanes

Hurricane María and Irma happened within two weeks. In Puerto Rico, 300,000 homes were destroyed.

2017

2023

640 BC - 1800’s

Tainos



Figure 95: The Tainos Sourced from Hablemos de cultura

Archeological evidence shows that Taino and Arawak people were the first settlers in Culebra. The Taino were the indigenous tribe from the Caribbean; during the Spanish Colonization, the island was used as a pirate and escape route.

1875

First Spanish Governor

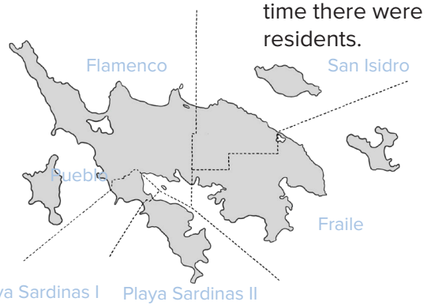


Figure 97: Barrio’s divison Sourced from Junta de Planificacion de Puerto

1894

Six “Barrios”

Public infrastructure: Delegation house, church, public water tank, public house order, dock, and cemetery. By this time there were 519 residents.

1898

End of Spanish-American War

Culebra was given to the United States. The US promised to honor the “Title” of lands granted to Culebrenses by the Spanish government, framed under the agreements reached in the Paris Treaty

1920

Jones Act

These restrictions have caused inflated shipping costs because cargo transport is off-limits to foreign shipping firms, resulting in higher housing material costs. Population: 839

1989

Hurricane Hugo

Category 5 Hurricane. Hurricane Hugo caused tremendous damage to the infrastructure of eastern Puerto Rico; 80% of the wooden houses in Culebra were destroyed (Puerto Rico Hurricane Center).



Figure 100: Hurricane Hugo Distruction Sourced from NOAA

2012

Law 20 & 22

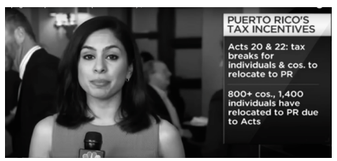


Figure 102: Journalist talking about Acts 20 &22 Sourced from

(Now part of Act 60) The Tax Incentive Code provides tax exemptions to businesses and investors that relocate and/ or are established in Puerto Rico, affecting the housing and real estate industry and invrementing land prices

2017

Airbnb Market

Airbnb market enters Puerto Rico, with over 300 homes in Culebra, causing inequality and rising local real estate prices.

Current Conditions

Culebra is an Island located approximately 17 miles east of the Puerto Rican Big Island, with an approximate area of 11 square miles. Since the Spanish Colonization, the Island was divided geographically into six barrios: San Isidro, Fraile, Playa Sardinas I and II, Flamenco, and Pueblo. Until today the six barrios have unique characteristics and history.

Puerto Rico's government and Culebra's Municipality have made efforts to protect and manage the land. Because of this, the 2015 Puerto Rican Land Use Plan classified 80% of Culebra's territory as Protected Rural Land to safeguard its ecological, natural, aesthetic, and archeological value. The plan also understands Culebra's vulnerability to climate change, thus only classifying approximately 4% of the territory as urban land, aiming at limiting urban expansion and maximizing the current urban fabric.

Due to its location, Culebra is vulnerable to natural disasters. In addition, as climate change continues, hurricanes have increased in intensity and frequency, resulting in higher dependency on the U.S. for resources and materials for post-disaster reconstruction.

Culebra faces a housing crisis; the Island has a limited affordable housing inventory. Paradoxically over 50% of the total housing units are vacant and listed as secondary/ recreational homes. There is no available land for Culebrenses to build their house and own their piece of land.

Additionally, due to the increasing real state market and policies that promote tax exemptions for U.S. Residents, significant investments are incrementing the land value as a consequence.

> ***Culebra is facing a severe housing crisis due to the limited inventory of affordable housing and environmental vulnerability. The proposed housing project aims to create reliable, climate-resilient, and affordable homes for Culebrenses, preserving the island's cultural traditions and reducing its dependence on external resources***

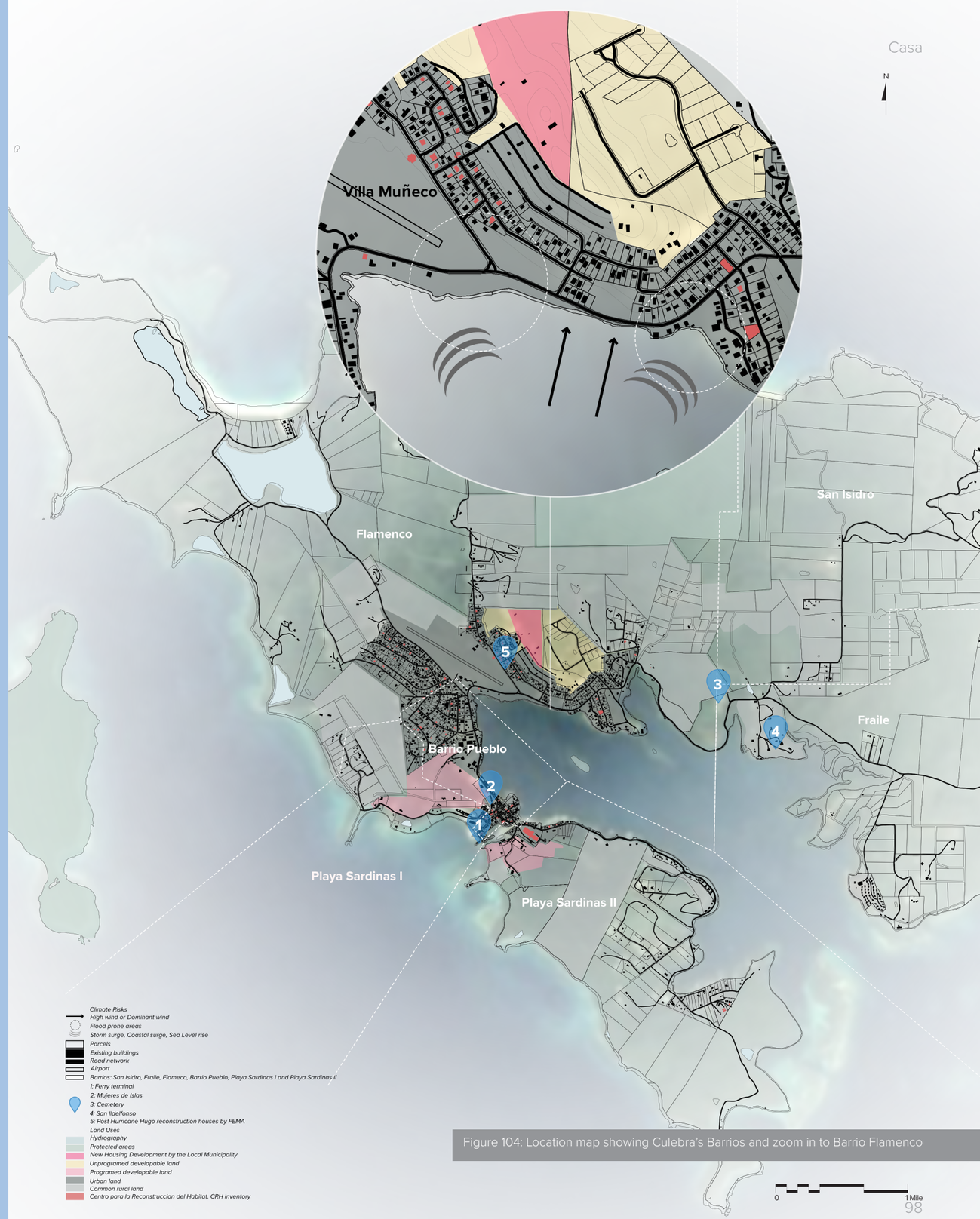


Figure 104: Location map showing Culebra's Barrios and zoom in to Barrio Flamenco

Policy Analysis

Policy/ Program	Goal	Affected Stakeholders	Implications
The Jones Act - Merchant Marine Act of 1920	Promote the growth and sustainability of the U.S. domestic shipping industry while maintaining high standards of safety, and security	• Developers • Consumers • Residents of Culebra	The primary goal of the Jones Act is to support the U.S. domestic shipping industry by requiring that all goods transported by water between U.S. ports be carried on ships that are built, owned, and crewed by American citizens or permanent residents. As a result, The Jones Act can increase the cost of construction goods transported by water between U.S. ports, as it limits competition from foreign ships
Act 60 of 2019 - "Puerto Rico Incentives Code,"	Law that aims to attract investment, stimulate economic growth, and create jobs in Puerto Rico	• Residents of Culebra • Local Municipality	Tax incentives and other benefits to individuals and businesses (including the real estate market) that invest in Puerto Rico, including: 4% corporate income tax rate for export services businesses; 0% tax rate on interest, dividends, and capital gains for individual investors in certain businesses; 90% exemption from Puerto Rico income taxes for certain types of income earned by individuals and businesses; 20% tax credit for eligible research and development expenses. Resulting in increase in land prices.
Community Development Block Grant (CDBG) program	Provide funding to state and local governments to support affordable housing, infrastructure improvements, and economic development	• Puerto Rico Housing Department • Local Municipality • Residents of Culebra • Puerto Rico Housing Finance Authority (PRHFA)	Promote the construction and/or rehabilitation of homes for families and/or elderly people, through financing the difference required to be paid for the construction expenses of low-rent housing, which are usually contributed from other public and/or private funding.
Low-Income Housing Tax Credit (LIHTC) program	Encourage private investment in affordable housing by providing tax credits to developers	• Puerto Rico government • Local Municipality • Residents of Culebra • Developers • PRHFA	The program is administered by state housing finance agencies, which allocate the tax credits to eligible projects. The LIHTC program has been very successful in increasing the supply of affordable housing in the United States, with over 3 million units of affordable housing developed since the program's inception in 1986.
Federal Emergency Management Agency (FEMA) reconstruction funds	Financial assistance to communities and individuals to recover from natural disasters such as hurricanes	• Puerto Rico government • Local Municipality • Residents of Culebra	Individuals and Households Program (IHP), that provides financial assistance to help homeowners and renters repair or replace their primary residence, cover temporary housing expenses, and replace personal property that was damaged or destroyed in the disaster. It is important to note that land titling is necessary to meet with the eligibility criteria and other forms of tenure are not considered.

Figure 105: Comprehensive analysis of policies impacting housing throughout Puerto Rico.

The housing sector in Culebra, Puerto Rico is impacted by several policies and programs. The Jones Act, also known as the Merchant Marine Act of 1920, aims to promote the growth and sustainability of the U.S. domestic shipping industry. This act affects developers, consumers, and residents of Culebra as it limits competition from foreign ships and increases the cost of goods transported by water between U.S. ports.

Act 60 of 2019, also known as the Puerto Rico Incentives Code, aims to attract investment, stimulate economic growth, and create jobs in Puerto Rico. This law offers tax incentives and benefits to individuals and businesses that invest in Puerto Rico. Residents of Culebra and the local municipality are impacted by Act 60.

The Community Development Block Grant (CDBG) program provides funding to state and local governments to support affordable housing, infrastructure improvements, and economic development. This program promotes the construction and/or rehabilitation of homes for families and elderly people, and stakeholders impacted include the Puerto Rico Housing Department, local municipality, residents of Culebra, and Puerto Rico Housing Finance Authority (PRHFA).

The Low-Income Housing Tax Credit (LIHTC) program encourages private investment in affordable housing by providing tax credits to developers. This program is administered by state housing finance agencies, and stakeholders include the Puerto Rico government, local municipality, residents of Culebra, developers, and PRHFA.

Finally, FEMA reconstruction funds provide financial assistance to communities and individuals to recover from natural disasters such as hurricanes. The Individuals and Households Program (IHP) provides financial assistance to help homeowners and renters repair or replace their primary residence, cover temporary housing expenses, and replace personal property that was damaged or destroyed in the disaster. Stakeholders impacted include the Puerto Rico government, local municipality, and residents of Culebra.

Community Engagement

During the second week of March, the Studio traveled to Culebra. Our team had the opportunity to meet and speak to various community members who shared their stories, helping us to develop our proposals further and understand how our work can impact their lives.

One of the first people we met was Valentina, a Culebrense who built her house with the help of her family after receiving a lot from the Municipal Government. Unfortunately, she lost her home during Hurricane Maria in 2017. After the hurricane, she received reconstruction funds from FEMA and used them to pay a private company in mainland Puerto Rico for the designs and materials. However, despite all these efforts, she has been unable to rebuild her house and now owes money to the company.

Many factors contribute to this, including the need for more guidance and the availability of a local workforce that can help culebrenses build their homes. Another contributing factor at a grander scale is that FEMA funds are the same in the U.S. mainland and Puerto Rico, despite Puerto Rico being a territory under the Jones Act. Valentina invited us to her home and shared her story with great pain.

Our team also spends most of the time on the Island sharing experiences with Mujeres de Islas team. Abigail recently graduated from university and moved back to Culebra; she told us how she lives with family members but aspires to own a house someday. Her main concern is that the homes on the island are expensive for locals, primarily due to the rental housing market.

Moreover, the team also had the opportunity to visit the “Museo Polvorin” and learn about the complex history of ownership in Culebra and the displacement caused by the Military Occupation. We heard brutal and violent testimonies on how Culebrenses were removed from their homes with only 24-hour notice and had to migrate and take over other parcels to build new homes.



Figure 106: Valentina, at her house. Picture takeb by Camila Botero.

> La primera casa la construí yo con mi marido y nadie me dio la mano *[I built the first house with my husband and no one helped us]*. Valentina, lost her house during hurricanes Irma & Maria in 2017

Figure 108: Group studio gather at Culebra Municipality. Picture taken by Claudia Kohn



> Puerto Rico has a Titling problem. Génesis from Centro para la Reconstrucción del Hábitat (CRH)



Figure 107. Gratify criticizing the Airbnb market in Culebra. Picture taken by Camila Botero

> Culebrenses houses is where memory is stored and made [...] we learn by doing.
> Ana a member of Mujeres de Islas

Toolkit and Incremental Housing

Objective #3: Design a Toolkit that foster sustainable forms of living and emergency response capabilities

During our visit to Culebra, we compared our research with the stories and testimonies of the locals to determine the best approach to housing that would suit the needs of the community. After careful analysis, we concluded that an infill approach would be the most appropriate solution. We were determined to ensure that our approach was not only culturally sensitive but also environmentally and economically viable.

While we were on the island, we met with Centro para la Reconstruccion del Habitat, who shared the inventory of 100 potentially abandoned properties in Culebra. This properties were identified through a mapping process by the CRH inventory of public nuisances. This was one of the first inputs for this process.

Commonly, in Puerto Rico these properties are usually restored and sold to the highest bidder in the real estate market, but a partnership between Mujeres de Islas, the local Municipality, and the community proposed a Land Bank to avoid this.

This offered us a perfect opportunity to implement an infill approach to address the dire need for affordable housing on the island for locals.

During our visit, we also made note of the different land and housing typologies in the area, as well as the risks that come with each type. These include waterfront properties that are at risk of flooding, sloped properties that are at risk of sliding, and flat lots. We intend to consider these risks as we continue to develop our plan for the community.

Our goal is to create an approach that will address the housing needs of the community while also considering the unique challenges and risks associated with the different land and housing typologies. We are committed to ensuring that our approach is sustainable, culturally sensitive, and resilent to extreme weather. We believe that the infill approach we have chosen is the best way forward, and we will continue to work with the community to ensure that our plan meets their needs and expectations.

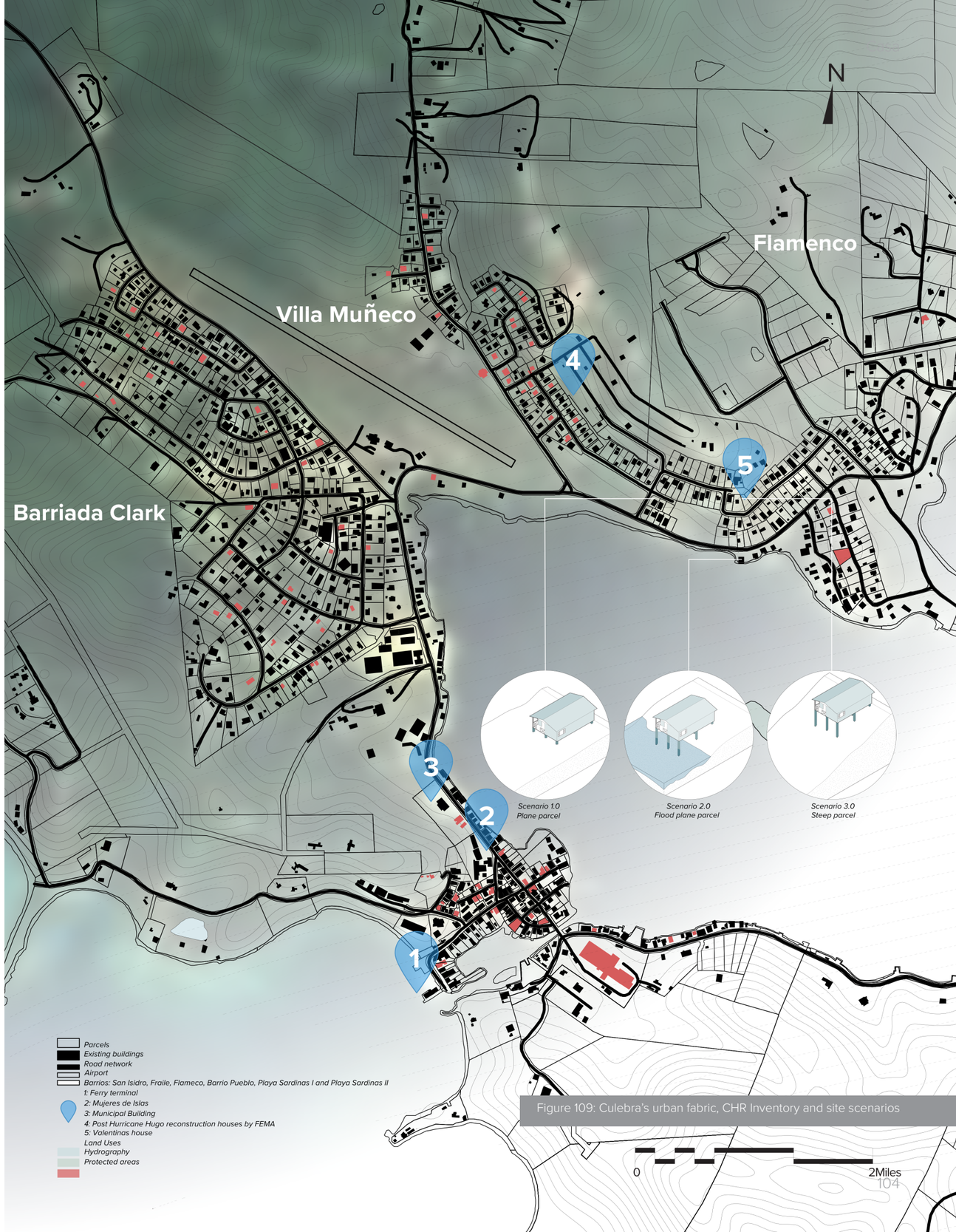
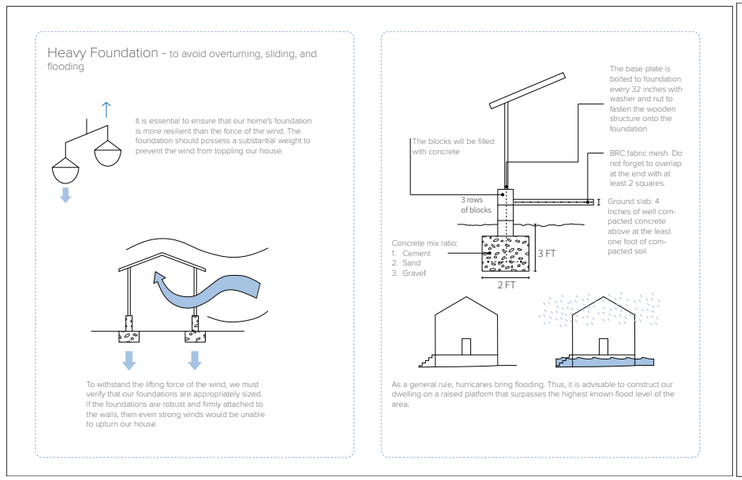
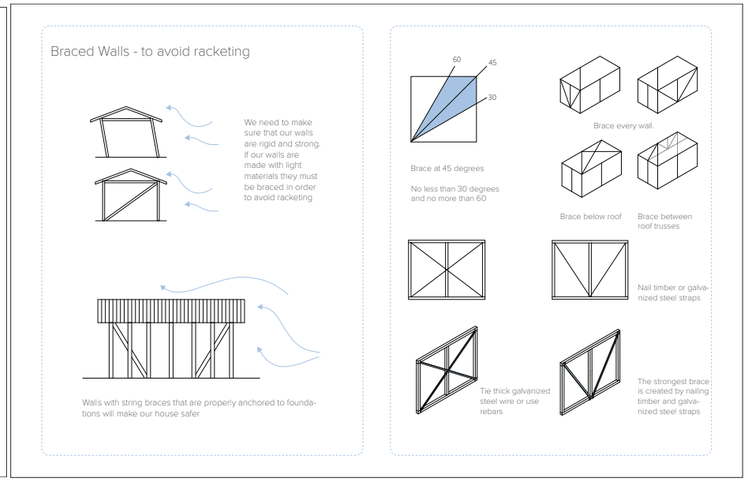
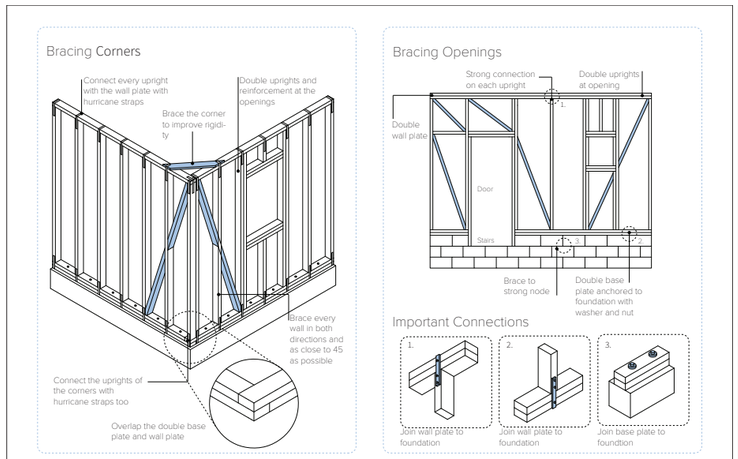
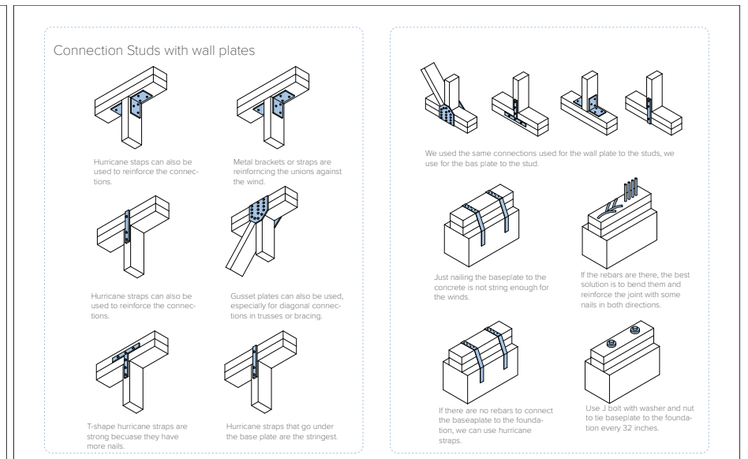


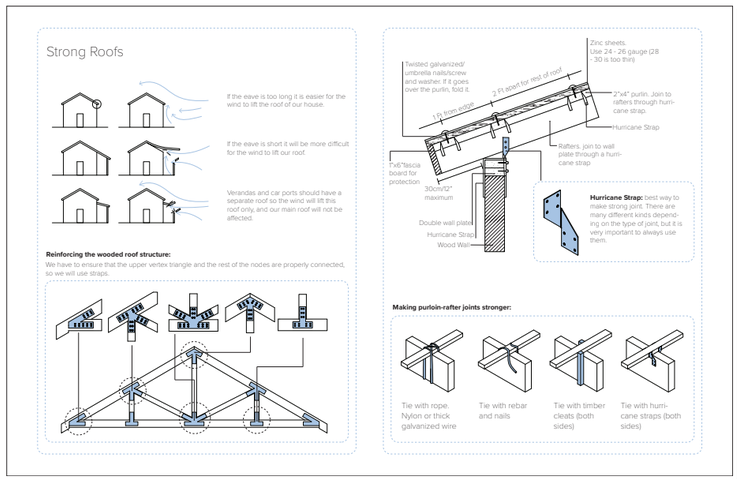
Figure 109: Culebra's urban fabric, CHR Inventory and site scenarios











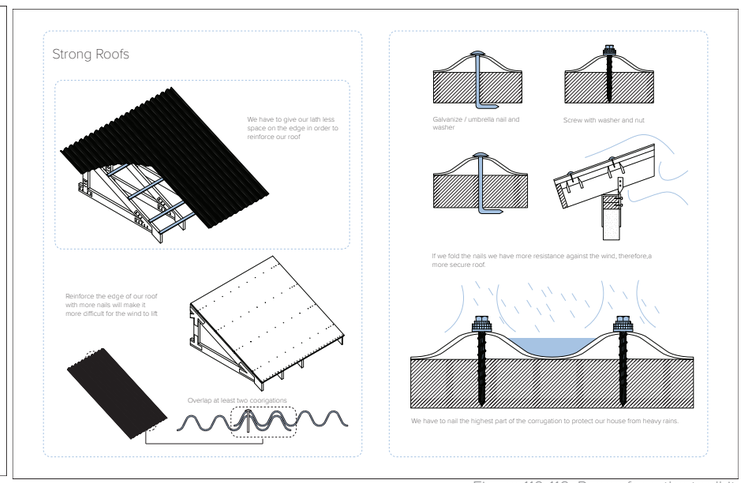
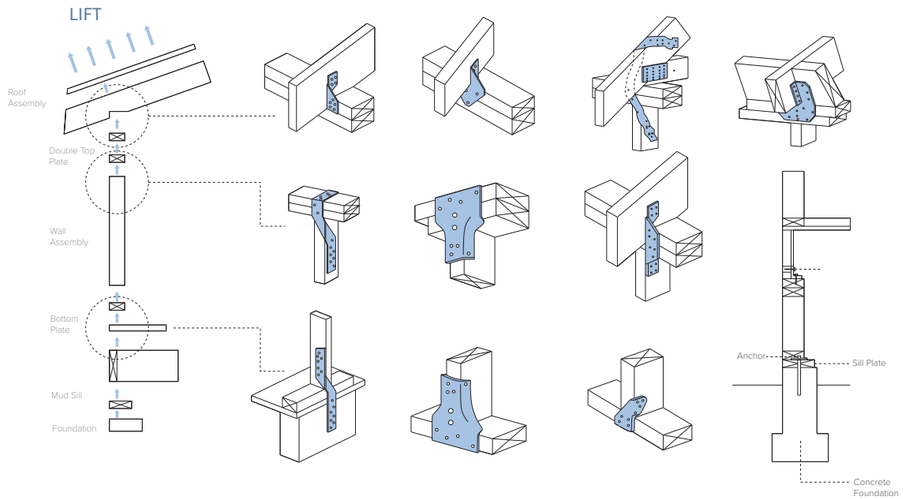


Figure 110-116: Pages from the toolkit.

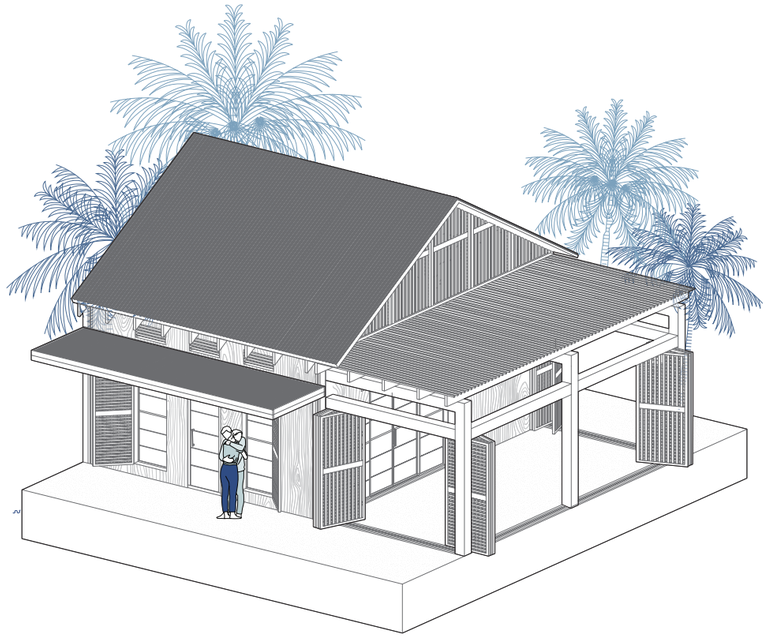
Design ToolKit: Hurricane Resilent Wood Structures

This toolkit not only explains how our housing proposal will be constructed but also provides guidance on how Culebrenses can fortify their existing wooden structures.



Designing infrastructure on an island like Culebra comes with unique challenges, and we made sure to acknowledge this during our preliminary design discussions. In our conversations with our clients, they shared their personal experiences with hurricanes on the island and the impact they have had on their lives throughout history. Hurricanes have devastated the islands of Puerto Rico, destroying homes and other vital infrastructure. The most vulnerable populations are the locals who live and work on the island and are unable to afford to rebuild or move from disaster-prone locations. With all of this in consideration, our first step was to ensure that our housing is designed to be hurricane-resistant.

Our clients expressed their nostalgia for wood construction, despite the fact that Hurricane Hugo demolished 80% of the wooden structures on the island, leading to a rebuild effort primarily of concrete homes, something that the locals feel does not resonate with them culturally or with island living. The challenge for us was to find a way to design with wood while still ensuring that the structures were hurricane-safe and resistant. To achieve this, we conducted research on hurricane-safe wood construction, referencing sources such as Habitat for Humanity and FEMA. We created a toolkit for hurricane-resilient wood structures that our implemented design would follow. This toolkit not only explains how our housing proposal will be constructed but also provides guidance on how Culebrenses can fortify their existing wooden structures.



Incremental Design for Flexibility

Over time, the home can be built upon, following our toolkit based on the family's needs.

After learning how to design for hurricane resilience, the next step was to design housing that could withstand the forces of nature while also being flexible enough to adapt to the ebb and flow of life. During our visit to Culebra, we spoke to a wide range of demographics and family types, all with the same need for affordable housing. However, it became clear that the demographic most in need of affordable housing was young people and young families. To meet this demand, we designed an incremental approach to housing.

The design begins with a main unit that we call the nucleus. The nucleus serves as the hub for all main living, electrical supply, water usage, and drainage, and features a wrap-around veranda for outdoor living, laundry utilities, and growing food. Over time, the home can be built upon, following our toolkit based on the family's needs. The house can grow from the nucleus, which is a studio apartment of about 370 square feet, to a 4-bedroom home of roughly 1,170 square feet that can sleep up to 8 individuals. By providing a flexible and adaptable housing solution, we hope to meet the needs of the community, particularly young families, while also ensuring the permanence of the structure against natural disasters.

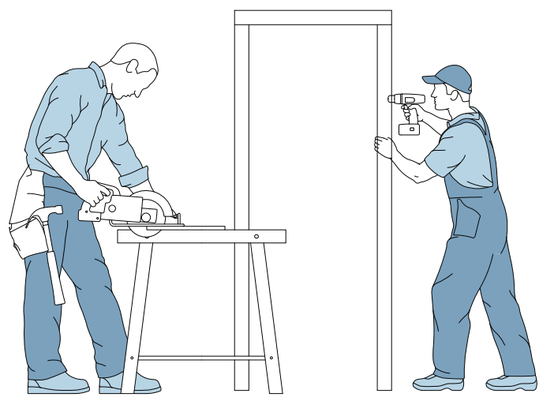


Figure 117: Construction of a house.

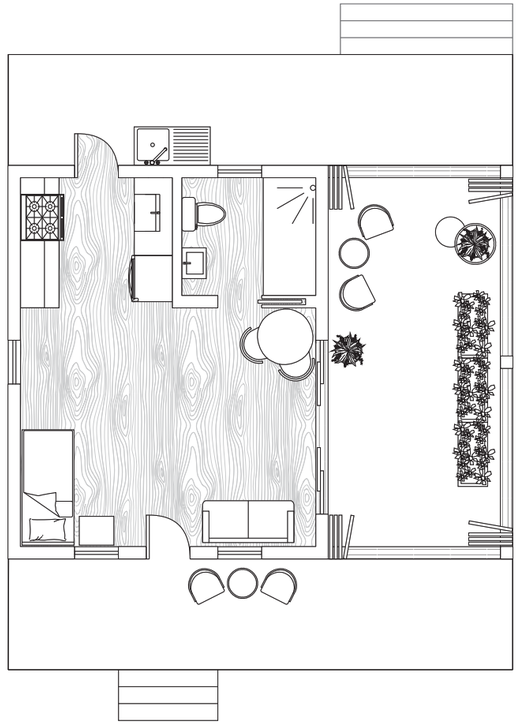
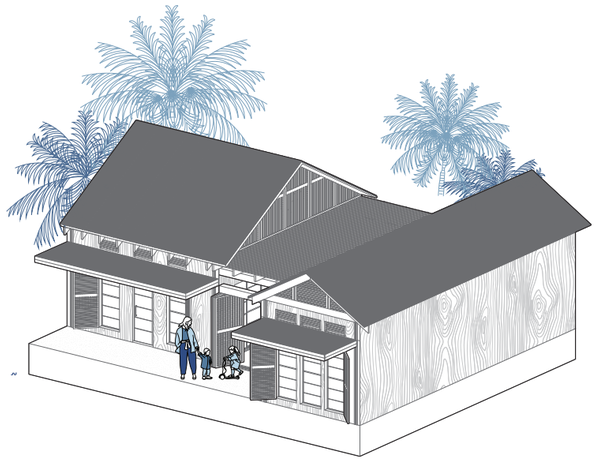


Figure 118: Familia de 1-2
Dormitorios: studio
Ft^2: 370

Figure 119:
Familia de 2-4
Dormitorios: 2
Ft^2: 744



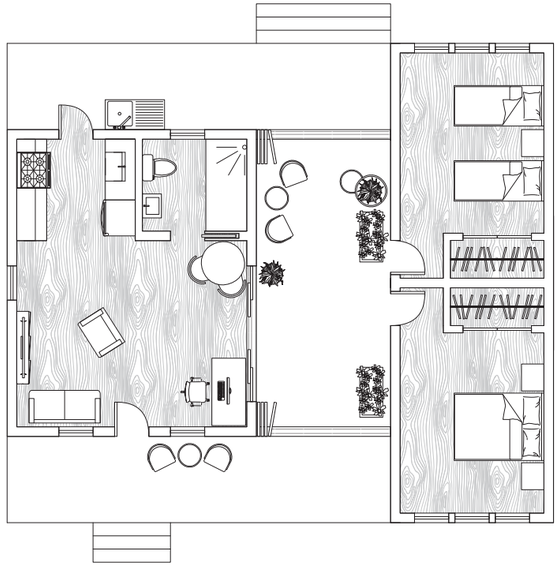
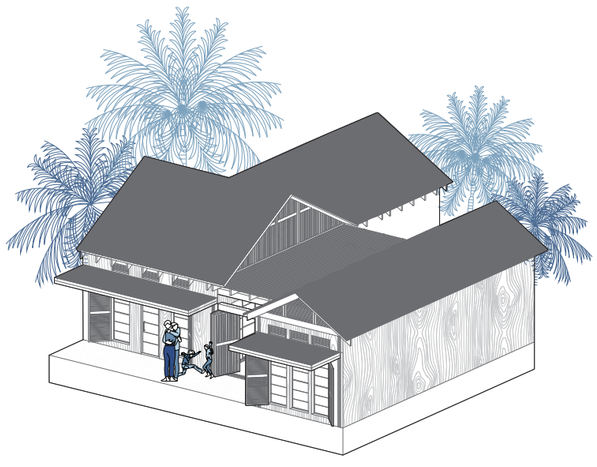


Figure 120:
Familia de 3-6
Dormitorios: 3
Ft^2: 940



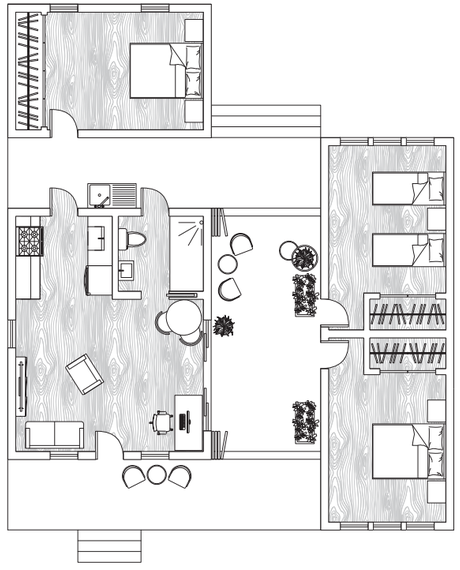
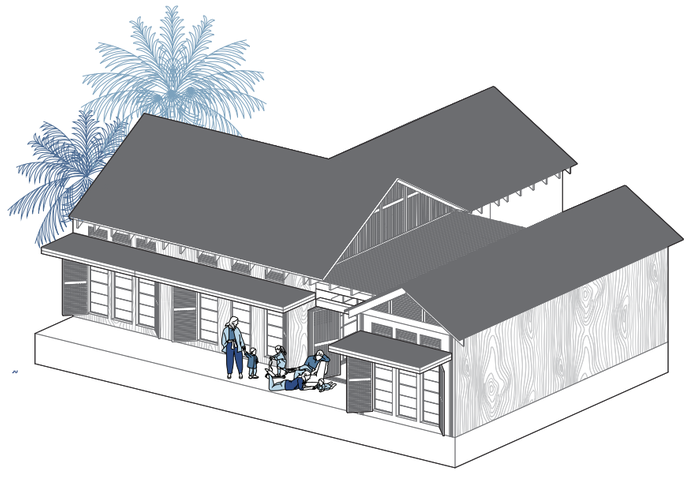
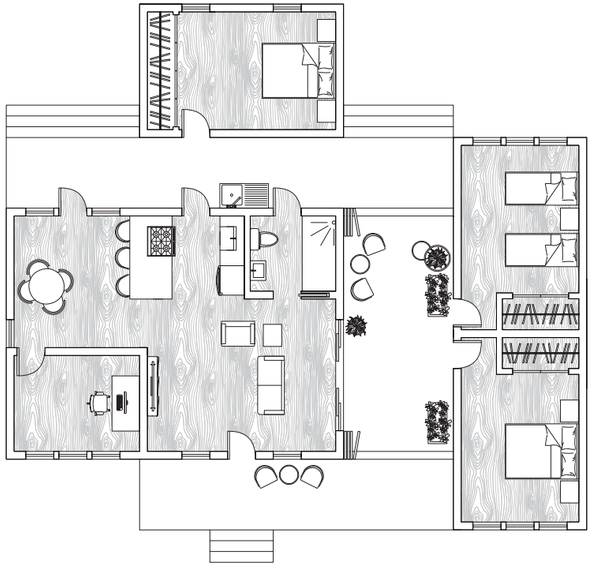


Figure 121:
Familia de 3-8
Dormitorios: 3-4
Ft^2: 1,172





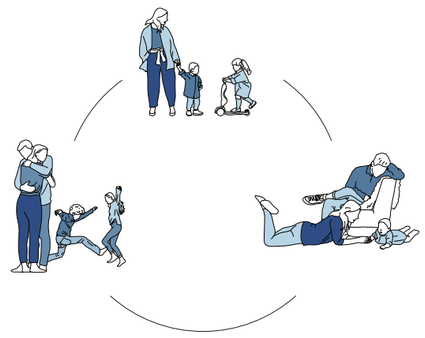


Figure 122: Designed For Flexibilility

The housing units can expand incrementally to accommodate various living scenarios, such as single living, families, housemates, in-laws, and potentially rentable bedroom units within the home.



Figure 123: Shared Utility Breezeway

Every housing unit includes an outdoor laundry washing and drying station. As the house expands, there are additional unique and intimate spaces, such as the utility breezeway. This area includes a communal laundry facility and exterior access to the house's bathroom.



Figure 124: Veranda Open

The veranda provides a semi-private outdoor gathering space for families, open to the island breeze and offering connection oto Culebra's vibrant nature.



Figure 125: Veranda Closed

The enclosed veranda provides a cozy atmosphere, while still allowing for an audible connection to the elements. It offers a private outdoor space where one can enjoy nature while remaining out of public view.

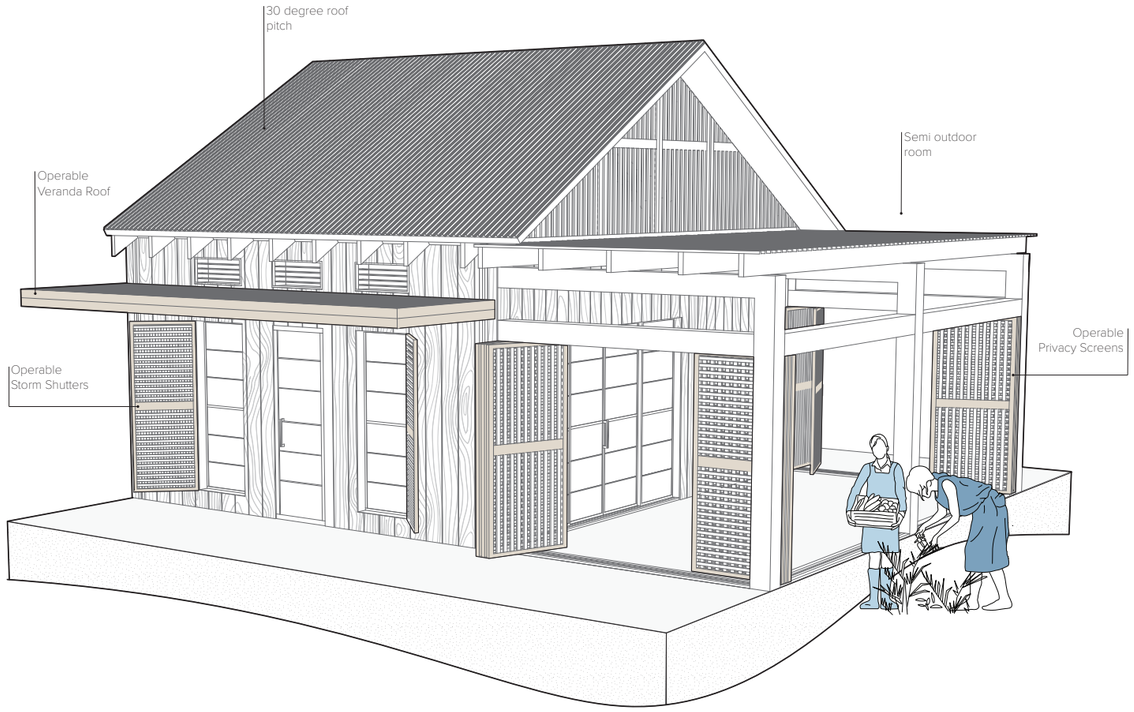


Figure 126: Resilient Housing Design

The design incorporates key features to ensure they are resilient in the face of extreme weather conditions. One of the main features is the inclusion of operable storm shutters for every window, which can be closed and locked to protect the home from strong winds and flying debris during a hurricane. This design element adds an extra layer of protection to the home and provides a sense of security to its occupants during extreme weather events.

In addition to the storm shutters, the homes are designed with a 30-degree roof pitch that is optimal for preventing uplift during severe hurricane winds. This design feature ensures that the roof remains intact and the home remains structurally sound during extreme weather events.

The operable veranda roofs are also an important aspect of the design, as they can be unfolded flat against the facade of the home to completely shield it from flying debris during a hurricane. These design features work together to create a resilient home that can withstand the harsh weather conditions that are common in Culebra.

Figure 127: Opperable Storm Shutters

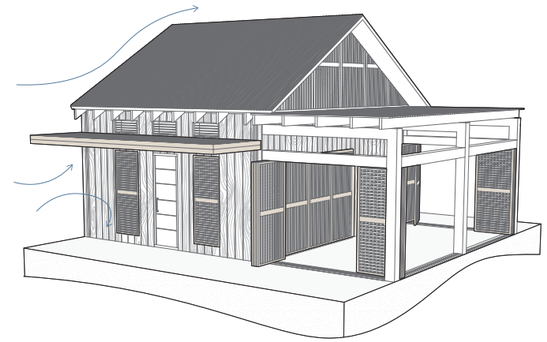


Figure 128: Operable Veranda

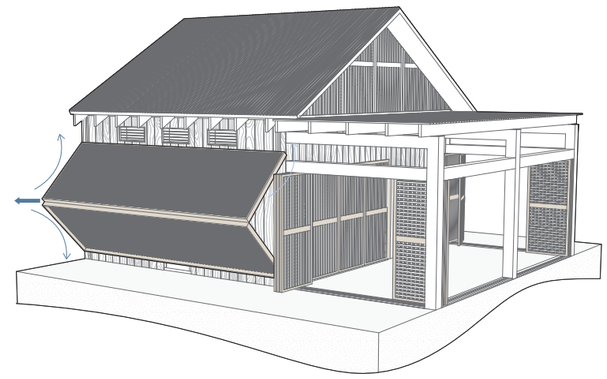


Figure 129: Fortification

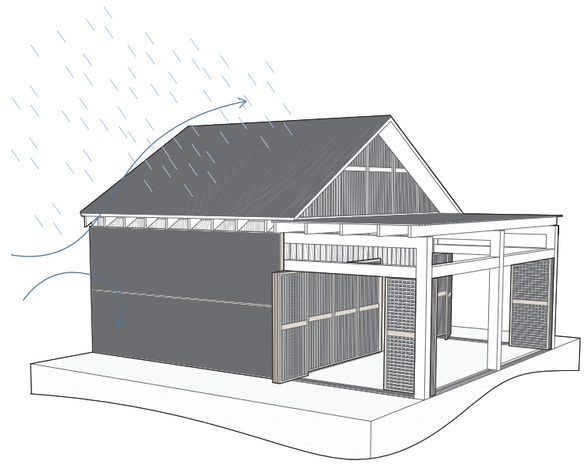


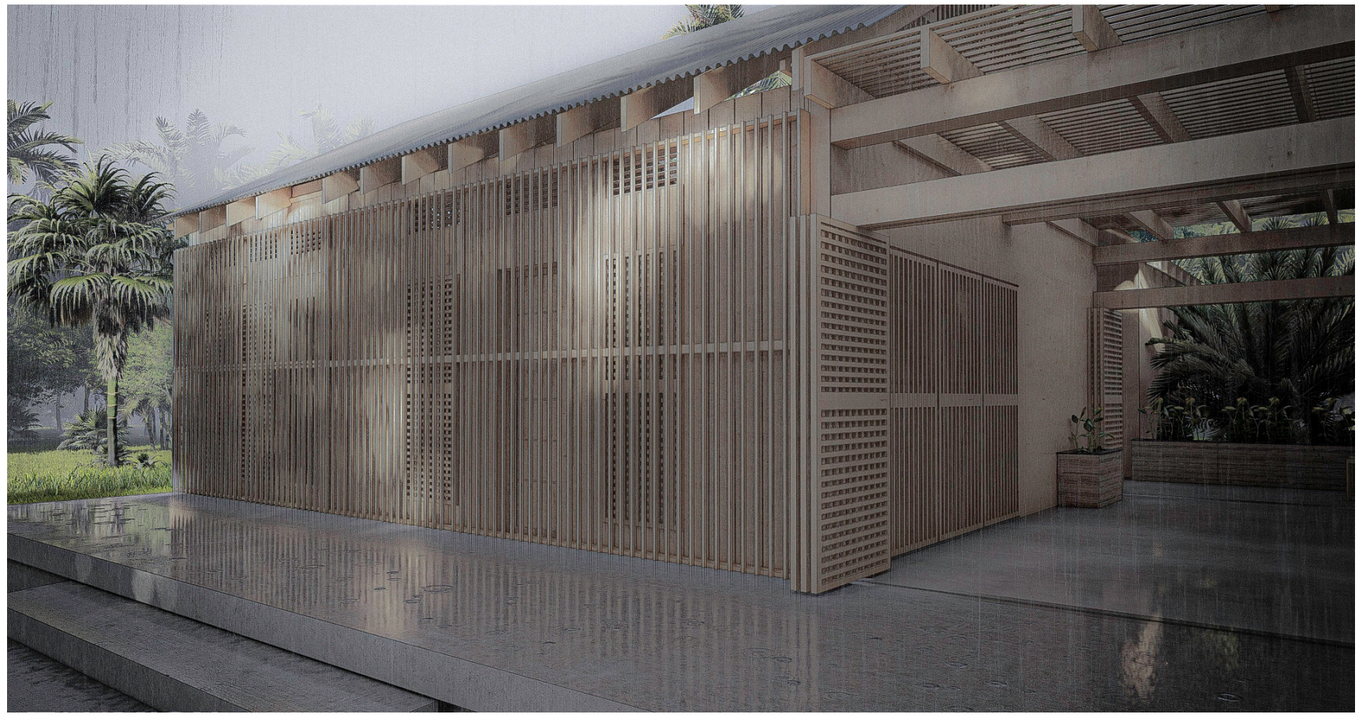
Figure 130: Front Veranda - Open

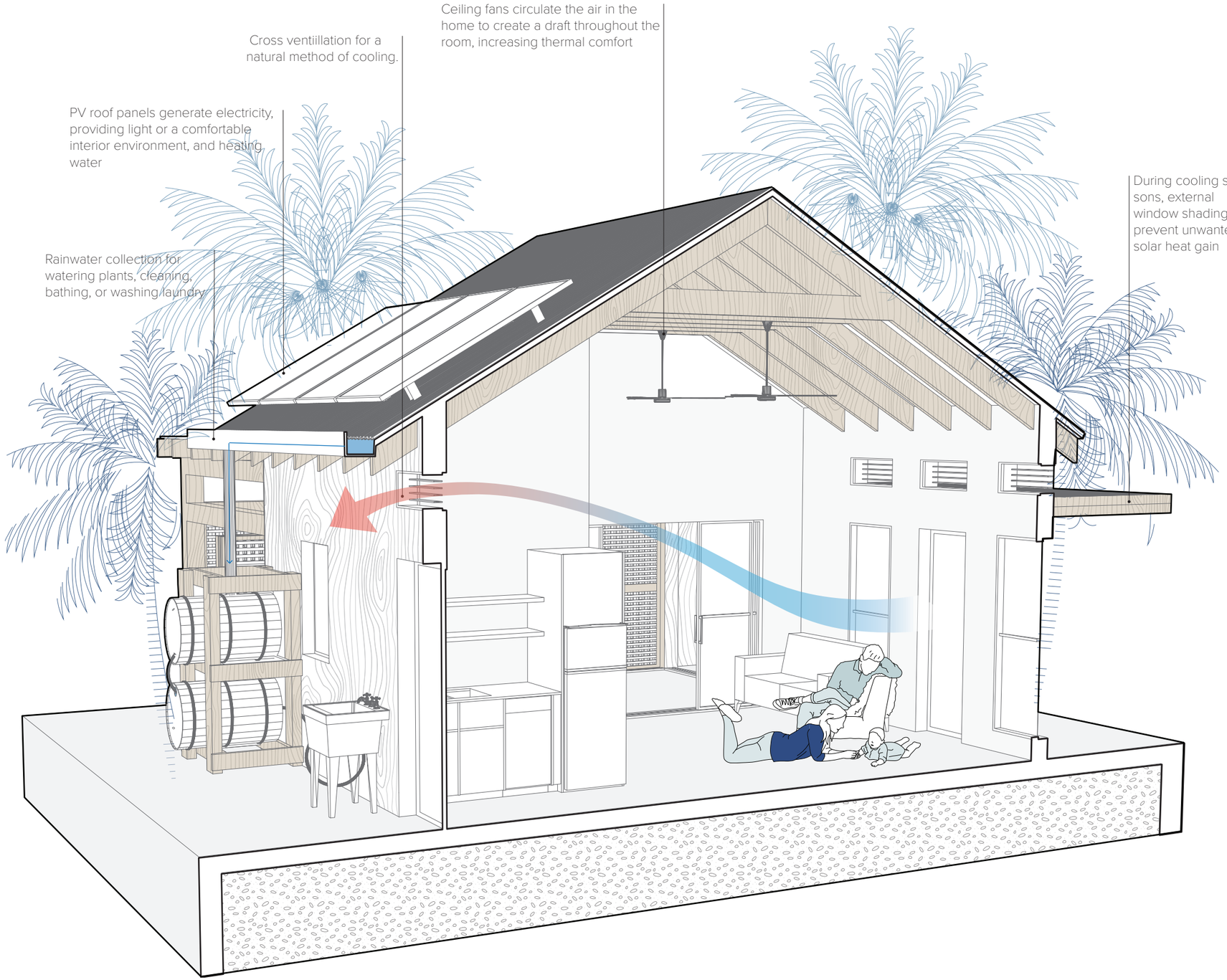
The front veranda is designed to serve as a space for gathering and connecting with neighbors when it’s open. It also provides shading and protection from harsh sun conditions with the help of the operable roof.



Figure 131: Front Veranda - Open

In the case of extreme weather, the operable roof folds down to shield the façade, adding another layer of fortification to the structure. This versatile design feature not only enhances the functionality of the veranda but also ensures its durability and resilience against weather fluctuations.





Sustainability:

Figure 132: The homes are designed to offer various opportunities for sustainable living.

The homes are designed with sustainability in mind, offering various features to promote sustianable living. One such feature is the roof pitch, which allows for the installation of PV roof panels that generate electricity and heat water, supporting the island's goal of becoming entirely solar-powered in the near future. The design also facilitates rainwater collection, which is culturally important to the residents of Culebra.

In addition, the homes incorporate natural cooling methods such as cross ventilation, ceiling fans, and external window shading to reduce the need for air conditioning during hot seasons, thus increasing thermal comfort and reducing energy consumption. These sustainable design features allow residents to live in a comfortable, home while reducing living costs and their impact on the environment.

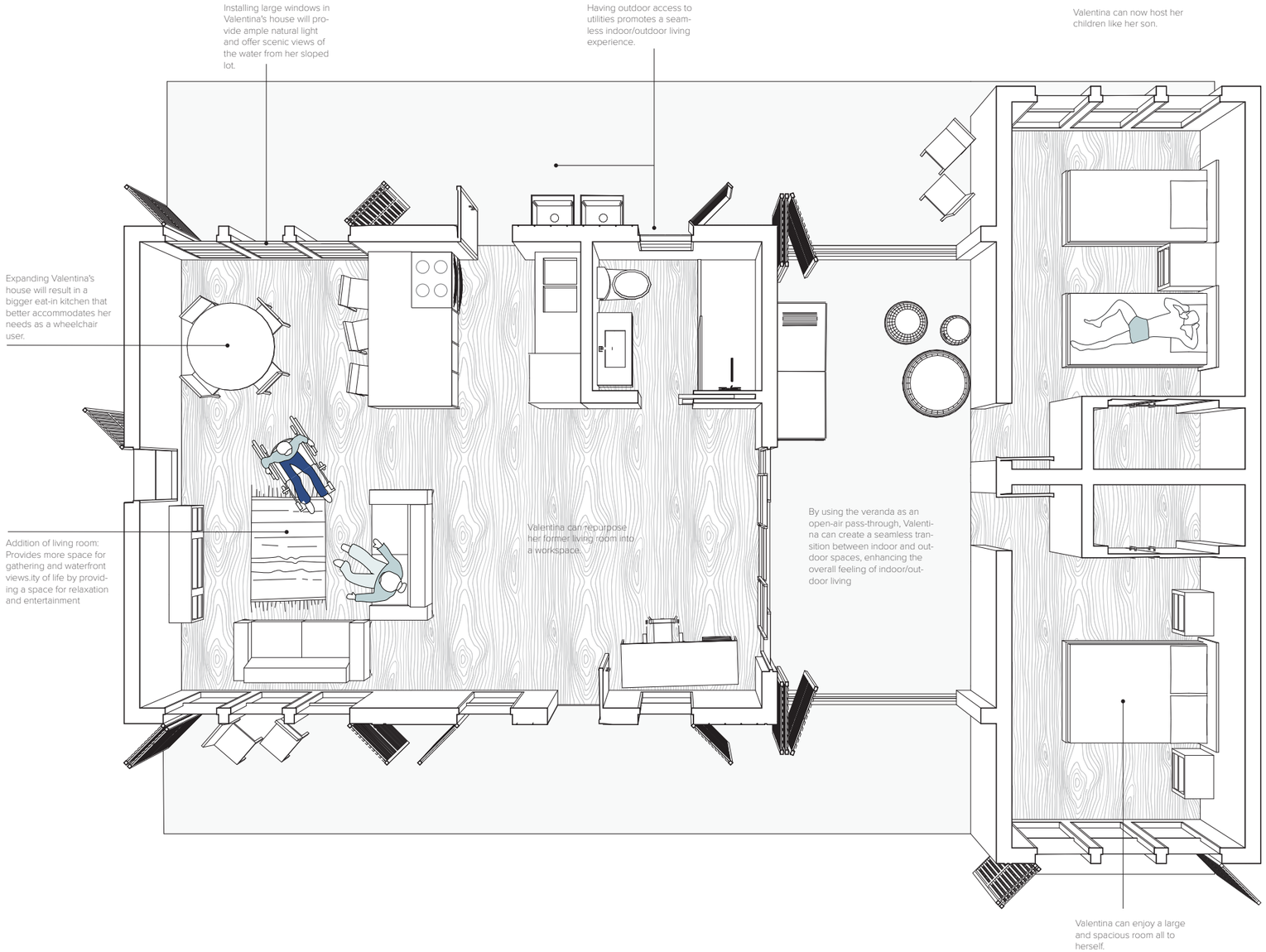
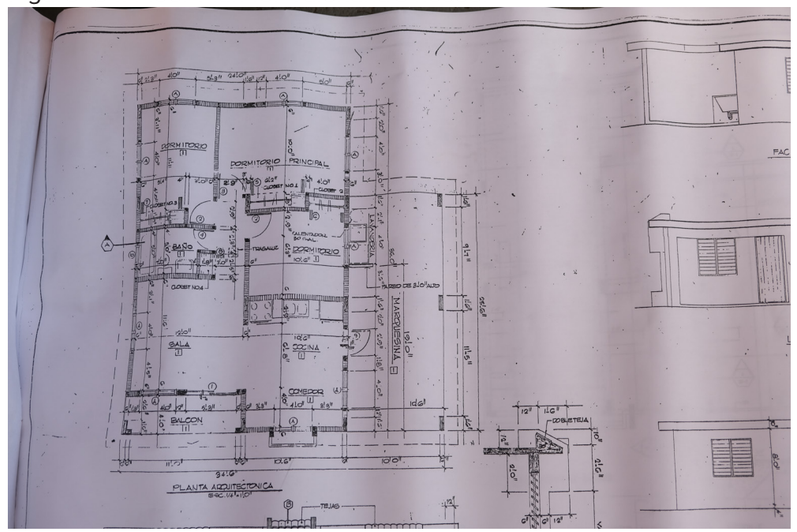


Figure 133: Floor Plan

Figure 134: Floor Plan for Valentina’s house.



Valentina’s case study serves as an example of how incremental housing can be applied in practice. By examining the house plans she acquired after losing her home in a hurricane, we can observe that the basic elements of both homes are similar.

However, the new home she purchased was not suitable for her existing sloped lot and was made of concrete with a flat roof, which may not be appropriate for the climate and cultural preferences of Culebra.

Valentinas plan, on the other hand, offers an alternative approach. It features a nucleus, two bedroom addition, and a living room addition, providing Valentina with sufficient living space for herself and visiting children like her son.

The design also takes advantage of the home’s location by offering views of the lagoon from the back of the house.

This incremental approach allows for flexibility and adaptability in housing design, accommodating changing needs and preferences over time



Figure 135: Render of a house designed for flexibility and sustainability

Land Bank

Objective #1: Support the implementation of the Land Bank through strategies and recommendations
Objective #2: Provide guidance on the creation of a local work- force group that supports construction assistance

The second objective under the housing focus area is a proposal that advocates for implementing a Land Bank that enables Culebrenses to reclaim their territories. This approach will expand the housing inventory while ensuring housing affordability is maintained, and land tenure is achieved under the U.S. legal framework.

As mentioned before, Culebra is currently facing a housing crisis; this could be attributed, among other factors, to its vulnerability to natural disasters such as Hurricanes. In addition, as climate change continues, hurricanes have increased in intensity and frequency, resulting in higher dependency on the U.S. for resources and materials for post-disaster reconstruction.

Unfortunately, this reconstruction resources most of the cases only apply to those residents that can prove titling ownership over their land or property. This is the case with FEMA reconstruction resources.

Additionally, the Island has a limited affordable housing inventory. Even Though over 50% of the total housing units are vacant and listed as secondary/recreational homes, there is no available land for Culebrenses to build their house and own their piece of land. This is exacerbated due to the increasing real estate market and policies promoting tax exemptions for U.S. Residents, where significant investments are incrementing the land value.



Figure 136: Villa Muñeco. Photo taken by Camila Botero

How does the Land Bank will work in Culebra?

During our visit to Culebra, the Mujeres de Islas team shared one of their initiatives to promote affordable housing on the island and encourage community participation.

They spoke of their ongoing relationship with the Centro Para la Reconstrucción del Hábitat (CRH), the only non-profit organization in Puerto Rico dedicated exclusively to stopping the problem of deteriorated and abandoned properties, using a comprehensive intersectoral approach.

The CRH works to identify and map abandoned properties that could become public nuisances, conducts collaborative planning activities, and promotes implementing strategies to transform them into assets of long-term recovery, community development, and resilience.

The organization has already conducted a mapping process in Culebra, identifying approximately 100 abandoned properties and parcels that could become public nuisances. Moreover, it is working hand in hand with the local municipality and Mujeres de Islas to design a process where the land is not sold back to the market but goes back to the community. (Map below)

The current cycle for property disposition typically involves mapping abandoned properties that could pose a risk and identifying willing property or landowners willing to take the necessary measures to recover the land or property.

The local government expropriates tax delinquent or foreclosed properties, then assesses them to determine their condition and land value.

Potential buyers then place bids on the property, with the highest bidder typically winning the auction. In Puerto Rico, these properties are commonly restored and sold to the highest bidder in the real estate market, where land speculators can drive up land prcaneaving little opportunity for community members to purchase land at reasonable prices.

Instead of selling these properties back to the real estate market, the local Municipality has opted to transfer ownership of the properties and land to the Land Bank. This involves the Municipality declaring properties as nuisances, acquiring abandoned properties, clearing titles and debts, and transferring them to the Land Bank. The Bank can then donate, sell, or rent the properties according to the strategy established by the Board and Council. This helps stabilize land prices and prevent speculation, a common issue in the real estate market.

It is important to note that past studio proposals have sparked Mujeres de Islas's and the community's interest in a better understanding of community-driven land acquisition processes, such as the Community Land Trust (CLT). Currently, the Land Bank is an ongoing initiative being implemented by the Municipality to promote community participation in the acquisition and management of land.

Figure 137: CHR Inventory of Abandoned properties in Culebra

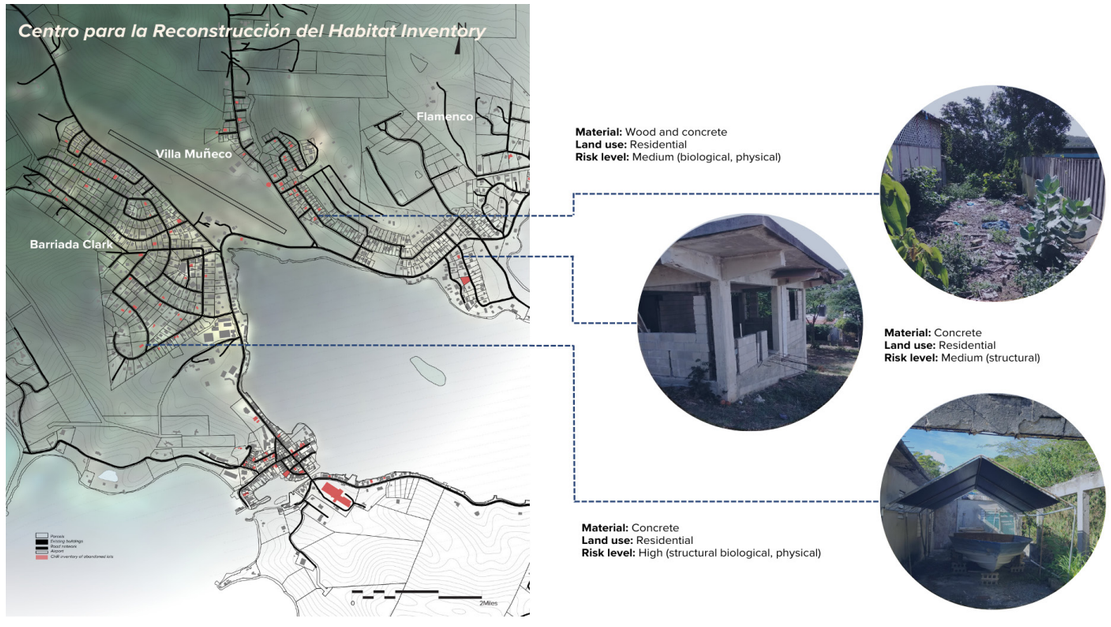


Figure 138: Land Bank implementation process



Case Study:
Caño Martín Peña CLT
San Juan, Puerto Rico

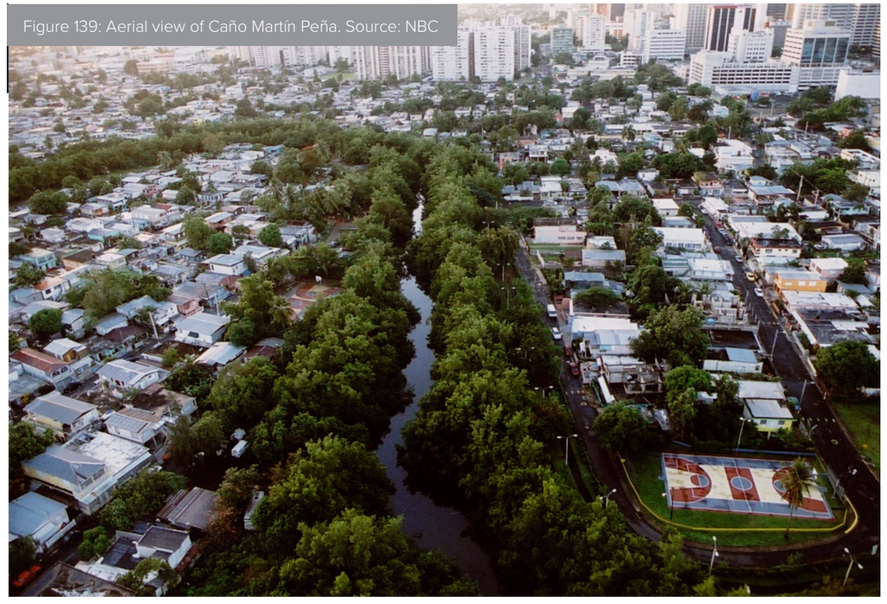


Figure 139: Aerial view of Caño Martín Peña. Source: NBC

What is Caño Martín Peña Community Land Trust ?

Caño Martín Peña Community Land Trust (CMPCLT) is an initiative in San Juan, Puerto Rico. The purpose of CMPCLT is to address housing affordability and environmental challenges. It is a community-driven effort where residents seek to maintain their ownership by incorporating land titles and improving the surrounding area's ecological conditions of the surrounding area.

Caño Martín Peña is a water channel that goes through various neighborhoods in San Juan, including Buena Vista, Las Monjas, and San Mateo. The channel was clogged with debris, water, and other pollution. The Obstruction of the water led to flooding and the contamination of homes along the canal. When the community started the cleaning process, they were aware of the possibility of a rising process due to speculati

The Community land trust is an instrument to prevent new generations' displacement after the water channel's cleaning and restoration. The land trust makes it accessible if the land price rises and makes the beneficiaries the people of the community.

This initiative also tackles the problem of land titles. Many individuals in the area did not have tags, so the program works with the legal aspect. CMPCLT has created d examples of protection of infrastructure in Puerto Rico. This initiative has proven successful and worked as an example across Latin America. In 2018, the Favela Community Land Trust consulted the people behind the CMPCLT for advice.



Figure 140: Protest in Caño Martín Peña. Source: NBC News

Figure 141: Key Takeaways from the Land Bank Implementation

1. Establish a Community Land Bank to acquire abandoned, vacant, or dilapidated properties as part of the housing catalog of affordable and community development.
2. The proposal is based on the Municipal Code of Puerto Rico, which grants municipalities the power to exercise the Legislative and Executive powers in municipal matters that result in the community's well-being and economic, social, and cultural development.
3. The Municipal Code allows municipalities to own, manage, sell, encumber, and dispose of their properties and accept and receive donations of goods. In most cases, the sale and lease of municipal properties must be carried out through the public auction process.
4. The creation of a Board to administer the CLB. The Board will consist of the Mayor or his representative and six additional members, one of whom will be the Director of Planning, and the others will be appointed for periods of 2, 4, and 6 years. All members will be appointed by the Mayor and confirmed by the Municipal Legislature.
1. The bylaws presents a regulation adopted to regulate matters concerning the municipal jurisdiction delegated by Law No. 107-2020, Law No. 210-2015, and Law No. 55-2020. This regulation applies to all the Land Bank of the Municipality of Culebra properties.
2. The public policy promotes the reuse of properties for equitable community development and creates opportunities for affordable housing and economic development.
3. The priorities for the use of the Community Land Bank include places and spaces for public use, affordable housing programs, economic-community development, and any other use.
4. The Affordable Housing Program was established in order to create new opportunities for primary home acquisition with an emphasis on meeting the needs of low- and middle-income populations, and a range of priorities will be applied as the first level of eligibility evaluation for the disposition of property that is based on bona fide residence and income.

As of today, The Local Municipality of Culebra, Mujeres de Islas, Centro para la Reconstruction del Habitat (CRH), and the community have united efforts to move forward with implementing the Community Land Bank. Currently, they drafted the legal proposal to authorize the Municipality of Culebra to Establish a Community Land Bank and also drafted the bylaws for the initiative. The diagram exposes the main takeaways of the documents

Final Recomendations

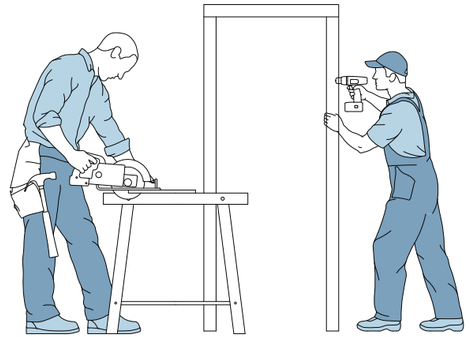


Figure 142: **Establish a Working Construction Force Group**

Creating a local construction force group would bring together people with construction knowledge and experience in the community. This group would oversee construction processes, offer guidance, and provide expertise, ultimately avoiding the need for foreign aid. Some of the tools that can support this initiative are the resiliency toolkit and models of incremental housing proposed. In addition, this approach would create local job opportunities and stimulate the local economy.

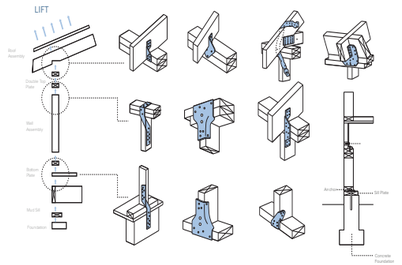


Figure 143: **Create a Co-Op to Decrease Material Costs**

Creating a cooperative to decrease material costs and establish a supply chain for construction would benefit the community in multiple ways. By pooling resources, members could purchase materials at a lower cost, and the supply chain would help guarantee a stable source of materials for future construction projects. This would also help ensure quality control and fair pricing.

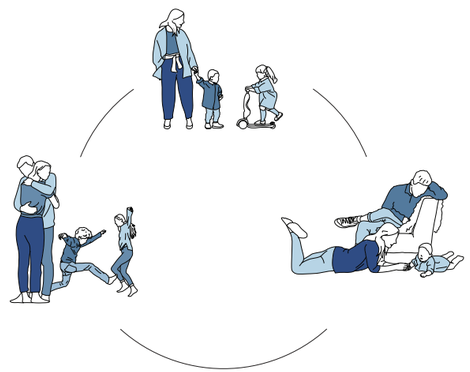


Figure 144: **Establish a Governance Model for the Land Bank**

Besides the board, an advisory committee and community participation would ensure transparency and accountability. The advisory committee would comprise experts in affordable housing, community development, and land use. Community participation would allow for regular input from residents and help build trust between the community and the land bank. This governance model would ensure that the community's needs are addressed and that the land bank operates with the community's best interests in mind.

Funding Sources

The Incremental Housing and Banco de Tierras proposals have access to public and private funding sources to support their development and operations. The Federal Emergency Management Agency (FEMA) plays a crucial role in assisting in the aftermath of natural disasters; this is done through the Individual and Household program—the U.S. The Department of Housing and Urban Development contributes through the Community Development Block grants program, which provides funds for states and local governments to support the development of affordable Housing.

In 2022, the Infrastructure Bill allocated more than $184 million to infrastructure resilience. This bill is a significant funding source, allocating resources to improve housing infrastructure and create more affordable housing. Additionally, the Internal Revenue System offers tax incentives for developers encouraging developers to build affordable housing projects. Locally, the Puerto Rico Development Bank received $109 million from the Biden-Harris Administration to help grow the economy and job opportunities, including the housing sector.

The Department of Housing of Puerto Rico provides grants and loans to promote affordable housing units through the Affordable Housing Trust Fund. The Puerto Rico Housing Finance Authority (PRHFA) supports affordable housing initiatives through its low-income housing tax credit program. This program provides tax credits to developers who undertake projects targeting low-income households. Additionally, the PRHFA's CDBG-DR Gap LIHTC Program addresses the specific needs of vulnerable populations, such as the elderly and families.

At a municipal level, the municipality of Culebra plays an essential role in the funding. From the private sector, venture capital firms can also be a funding resource. The investment will emphasize the financial priority and social and environmental outcomes. Development banks, such as the World Bank, can also become investors. With this divers range of funding sources, the housing project and landbank can effectively address housing needs and contribute to the community's well-being.

Federal Emergency Management Agency

FEMA

Figure 145: FEMA logo
Source: Feders Emergency Management Center

Municipio de Culebra



Figure 146: Flag of Municipio de Culebra
Source: Municipio de Culebra

Department of Housing Puerto Rico

DEPARTMENT OF HOUSING

Figure 147: Department of Hosuing of Puerto Rico
Source: Department of Hosuing of Puerto Rico

World Bank

WORLD BANK GROUP

Figure 148: World Bank Logo
Source: World Bank Group

Stakeholders

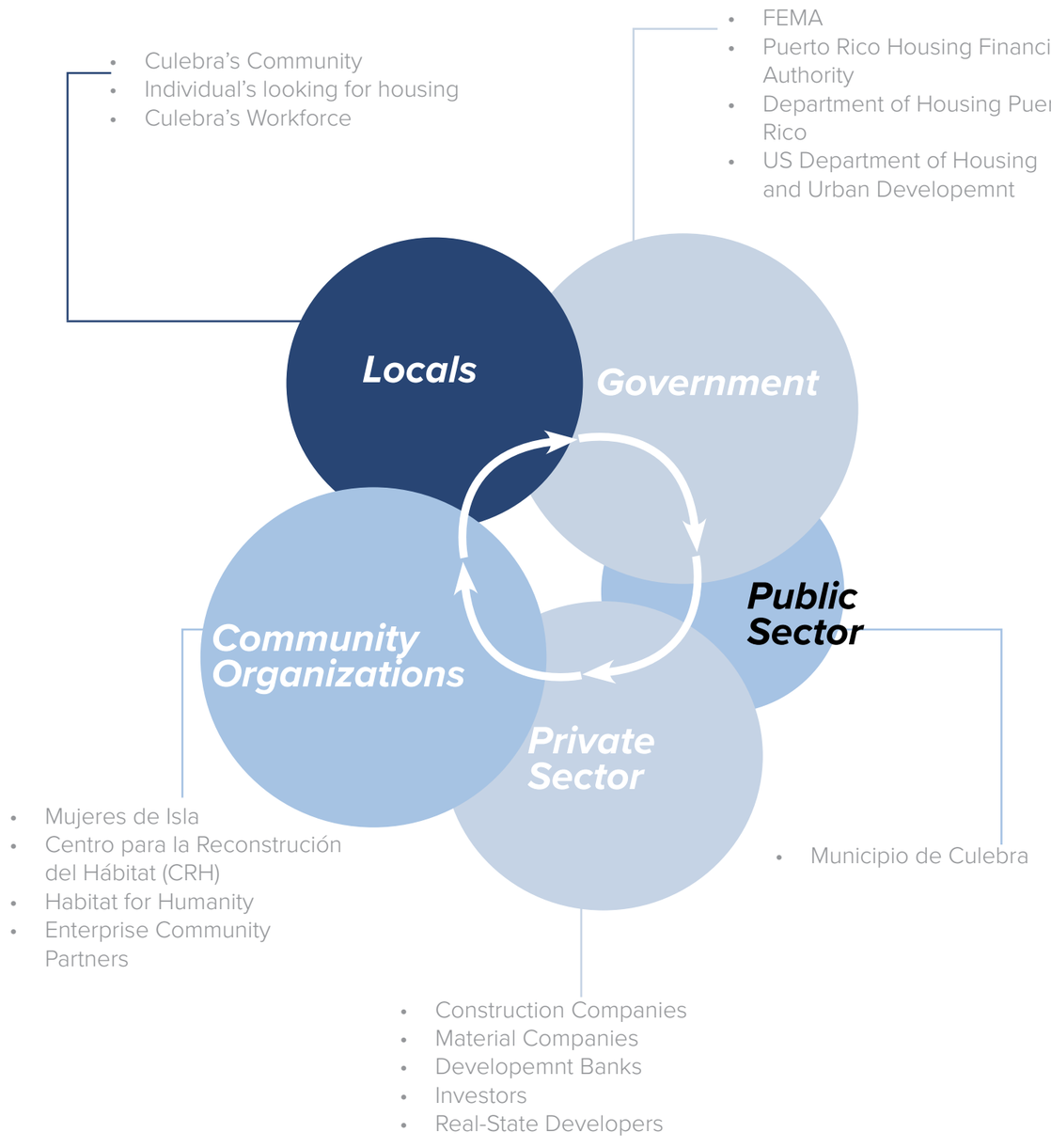


Figure 149: Stakeholder map of the Casa team’s proposals.

The Toolkit-Incremental Housing and Banco de Tierra have a wide range of stakeholders who play a crucial role in the implementation and success of the proposals. Culebras community has an essential stakeholder role by actively participating in the planning and decision-making. Mujeres de Islas, our client, can implement both projects and facilitate communication between stakeholders. Both proposals aim to help the Community of Culebra achieve autonomy by implementing and maintaining affordability. Individuals seeking affordable housing are crucial stakeholders; they would be impacted the most by the execution of the projects. The local workforce of Culebra will be essential to bring the project into execution.

The Centro para la Reconstrucción del Hábitat (CRH), a Puerto Rico organization focused on classifying nuisance property, brings data to support the identification of possible lots for the Banco de Tierra. FEMA provides financial support in the case of an emergency and ensures that affected communities have access to affordable and safe housing. Construction and material companies involved in the development are significant stakeholders, contributing resources and services to ensure a successful construction—the U.S.

The Department of Housing and Urban Development will provide guidance, support, and funding to promote the affordable housing project. Organizations such as Habitat for Humanity and Enterprise Community Partners work towards implementing affordable housing and community development, offering expertise and partnerships. These stakeholders contribute collectively with resources, knowledge, and funding to implement the Toolkit-Incremental Housing and Banco de Tierra proposals.

Implementation Timeframe

Short-term Actions

Community Participation
Community participation is crucial in the proposal of Banco de Tierras, as it guarantees their active involvement in the consolidation process.

Financial Modeling
The creation of a finance model encompasses the process through which community members obtain financial assistance from both public and private sources.sectors.

Site Fasibility Analysis
The site analysis based on the CRH inventory will identify the available plots and determine the housing typology to be implemented.

Lot Distribution
A carefully planned and meticulous process of lot distribution by Banco de Tierra will guarantee that community members receive their designated parcel.

Workforce program
The creation and establishment of a local workforce will reduce the dependency of workers on the main island.

Long-term Actions

Expand Career Training
The expansion of career training will yield benefits during the construction phase, leading to increased community and economic development.

Pilot Implementation
The workforce program will pilot its implementation by selecting a site and overseeing construction activities to provide employment opportunities.

Construction Phase
The housing construction will include the community of Culebra attaining full ownership of their houses.

Evaluation
The evaluation phase will assess the success of implementing both proposals.

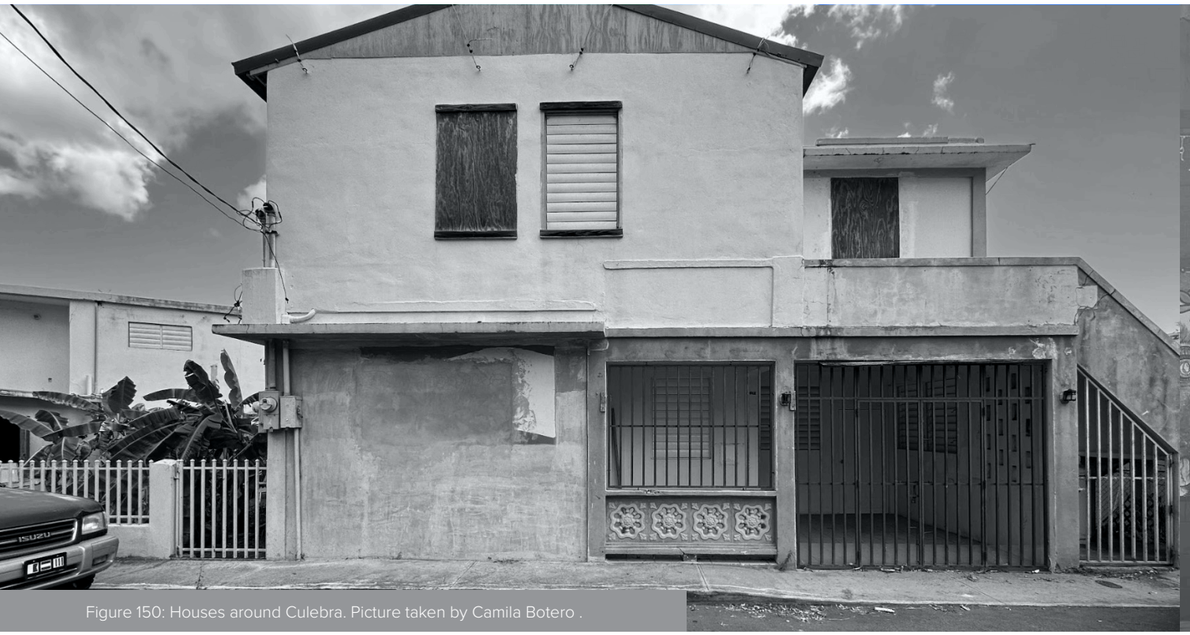
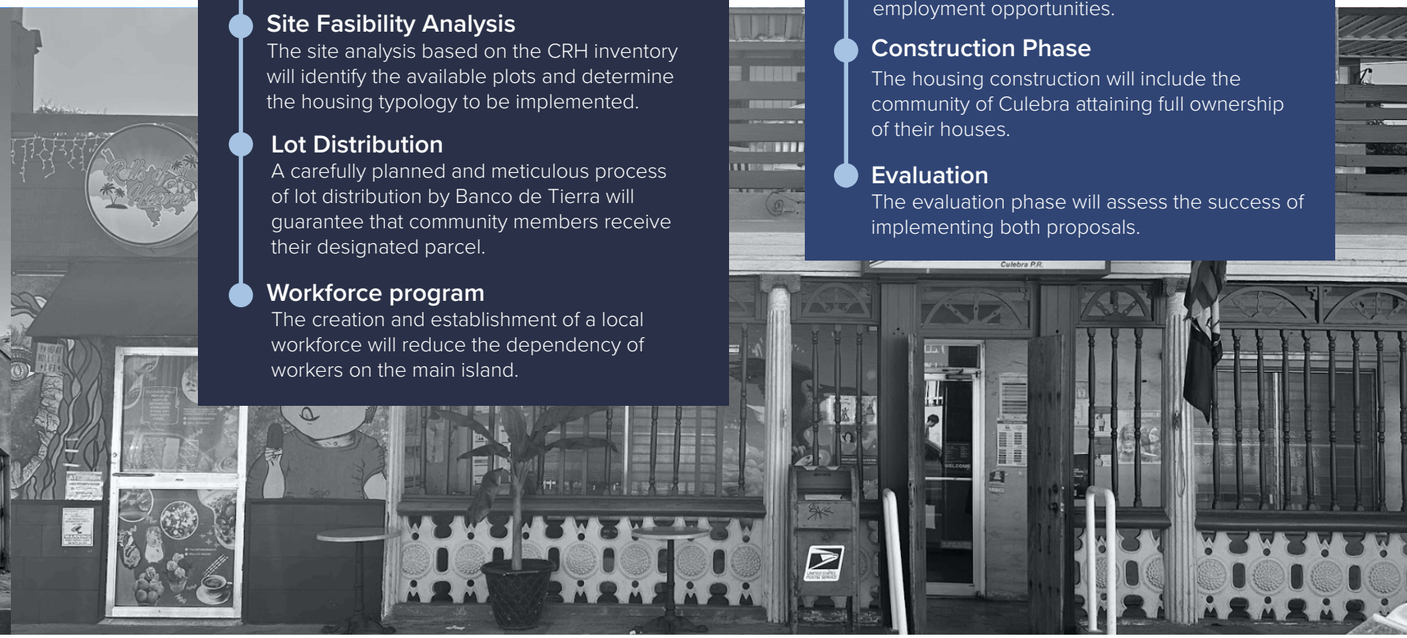


Figure 150: Houses around Culebra. Picture taken by Camila Botero .



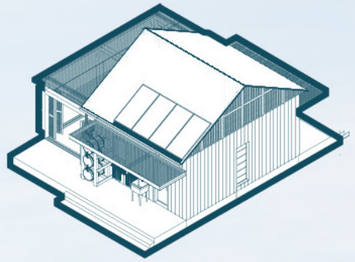
Outcomes

Figure 151: Diagram outlining outcomes achieved by the Casa proposals.

Housing

-Design Toolkit /Adaptation

-Implementation of Land Bank





Outcomes

Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome02-A
Increase knowledge of sustainable forms of living

Outcome02-B
Disaster-resilient systems

Outcome03-A
Increase the affordability of resources

Outcome03-B
Reclaim territories

Outcome04-A
Push policy mechanisms

Outcome04-B
Community-led initiatives

Energía

Project Team

Eric Hagerman
Architect and researcher interested in the intersections between the built environment, civil engineering, data science, and social equity

Soichiro Harada
Architect and urban planner passionate about data analytics & the built environment

Dhwani Laddha
Urban planner & interdisciplinary designer passionate about disaster preparation and resilient city design

Project Stakeholders

LUMA Energy
In 2021, LUMA took over and privatized the operation and maintenance of Puerto Rico's power transmission and distribution system

U.S. Department of Energy (DOE)
DOE's Grid Deployment Office has begun a two-year 100% Renewable Energy Study (PR100) to investigate the potential of solar and wind

Local Municipality
Responsible for providing many of the services within their local boundaries, while also leading public outreach and participation activities

Non-Profits
Environmental law organization EarthJustice stands strongly in opposition to LUMA's contract while the Environmental Defense Fund takes lead on financing microgrid projects

N

0 0.5 1 2 Miles

Proposal Vision

To leverage Culebra's solar energy capacity to create energy sovereignty through a network of resilient and community-led solutions.



Culebra's dependance on the big island & the rest of the United States for its power generation creates issues of sovereignty particularly in times of extreme weather events. Following these challenges, the local community has come together to push to become a 100% solar-powered island by 2050.

Proposed solutions need to address these issues of dependance but also build upon existing community-led and organizational efforts. To create a more autonomous and climate-prepared island, in regards to energy sovereignty, one must investigate location-specific policies, educational programming, and public spaces.

Key Objectives

- **Develop an actionable long-term plan for becoming a 100% solar-powered island**
  Kickstarting a renewable energy movement by laying out community goals & visions for solar power
- **Model a solar hub that envisions the future of energy in Culebra**
  Visualizing a public space for solar power education, training, and community partnerships
- **Increase local technical knowledge on solar power and energy infrastructure**
  Dedicating workshopping and practical learning spaces for volunteers to become technical experts

Key Outcomes

- **Climate Preparedness**
  Adapting to climate change and building resilience through limiting the devastating impacts of extreme events like hurricanes
- **Job Creation**
  Creating clean energy jobs in the transportation industry, in administrative settings, and for the installation & maintenance of infrastructure
- **Education**
  Offering career training for future leaders in the renewable energy sector, and increasing local knowledge of solar infrastructure

Figure 152: Diesel generators, donated by USACE, can supply the entire island with power. Picture taken by Dhwani Laddha.
Figure 153: Historical building with solar panels formerly owned by the U.S. Navy. Picture taken by Dhwani Laddha.

Historical Milestones

1890s

Decree Establishing Electric Service

The Spanish government issued a decree inviting proposals for establishing an electric energy service for Puerto Rico. Sociedad Anónima de Luz Eléctrica (SALE) installed the first electric lighting system in San Juan in May 1893 (Latimer Torres 2021).

1910s

First Energy Service In Puerto Rico

Pre-1910s, foreign capital from the private sector was the main financier of electricity. In 1915, Puerto Rico's electric system was inaugurated with the Carite Hydroelectric Plant (Latimer Torres 2021).



1950s

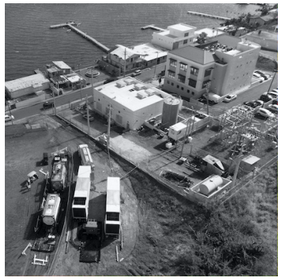
Culebra's Own Power Plant

The Culebra Power Plant was built mid-century and has since undergone several upgrades. Owned and operated by the Puerto Rico Electric Power Authority (PREPA), the power plant has been unreliable in generating power for the island.

1980s

Underwater Transmission Line

Completed in 1983, an underwater transmission line was installed by PREPA, that runs from the big island via Vieques, to supply power to the Culebrenses.



2017

Hurricanes Irma & Maria

After Irma & Maria, 80% of Puerto Rico's power lines went down. Culebra's underwater transmission line was not one of the lucky few to survive, leaving most residents without power for 3 months, and some in the dark for up to 11 months. In the coming months, PREPA intermittently supplied energy for 12 hours per day, Tesla donated batteries for storage, and USACE donated two diesel generators to Culebra.

2018

Privatizing Energy Transmission

The Puerto Rico Electric Power System Transformation Act was implemented to privatize Puerto Rico's electricity supply. Today, LUMA Energy operates the transmission and distribution system of electric power in Puerto Rico. Residents have repeatedly taken to the streets on the big island to protect LUMA and its control over energy distribution given issues with frequent blackouts and high energy costs (O'Connell-Domenech, 2022).

2019

Looking To The Future

The Puerto Rico Energy Public Policy Act established a renewable energy target of 100% for all of Puerto Rico. In response to this goal, Culebra is looking to become 100% solar-powered by 2050.

Figure 154: The Carite Hydroelectric Plant, the first hydroelectric plant owned by the government of Puerto Rico. Picture sourced from Cooperativa Hidroeléctrica de la Montaña.
Figure 155: Emergency backup generators that can supply power to the entire island during blackouts. Picture sourced from Centro de Periodismo Investigativo.

Current Conditions

In the past, blackouts were a common concern faced by the Culebrenses due to a lack of energy sovereignty and autonomy on the island. Since the 1980s, PREPA has supplied power to Culebra through an underwater transmission line that runs from the big island via Vieques. The line forces Culebra to be heavily reliant on fossil fuels for energy generation. Hurricanes Irma & Maria brought these issues to light when most locals on the island had no access to electricity for 3 months, and some were left in the dark for as long as 11 months.

Following these events, the United States Army Corps of Engineers (USACE) donated two diesel generators to Culebra. These generators have enabled blackouts to be less frequent and catastrophic as they can power all the homes and businesses on the island. The Puerto Rico Energy Public Policy Act was enacted in 2019 to chart a path for Puerto Rico to be 100% renewable energy powered by 2050.

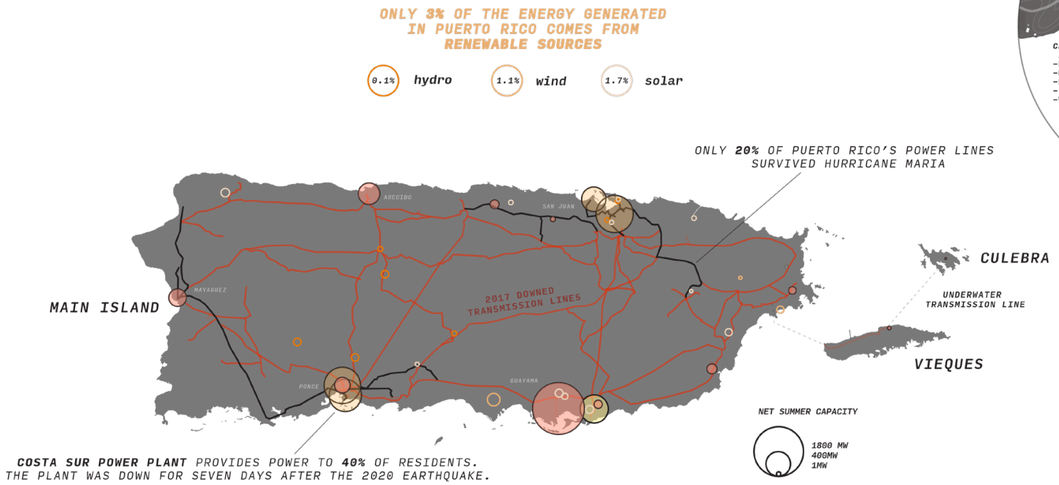
In terms of existing infrastructure, there is already a solar farm on the island, however, it is privately owned and doesn't supply the rest of the island with solar power. Quite a few solar systems also exist on non-residential buildings but some are not in operation and need maintenance/equipment. The non-profit Environmental Defense Fund has also funded panels for 46 homes but power surges after blackouts can easily damage these systems. Home-owning receivers of these systems also need to be educated on solar infrastructure and how to maintain these systems.

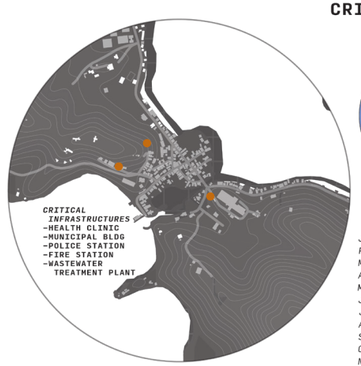
The challenge with solar power in Culebra is that replacement parts and technical expertise don't exist on the island. This is made more problemsome by the Jones Act as it restricts the transportation of energy-related goods and materials to Puerto Rico resulting in higher shipping costs and higher energy prices for consumers on Culebra.

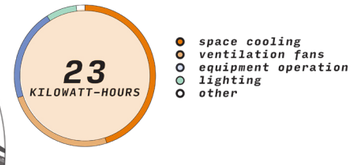


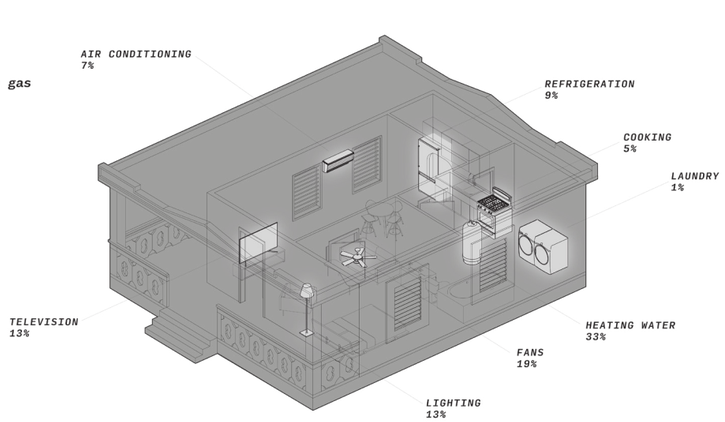
Figure 156: Map of Culebra's existing public solar projects, critical infrastructure, and underwater transmission line.

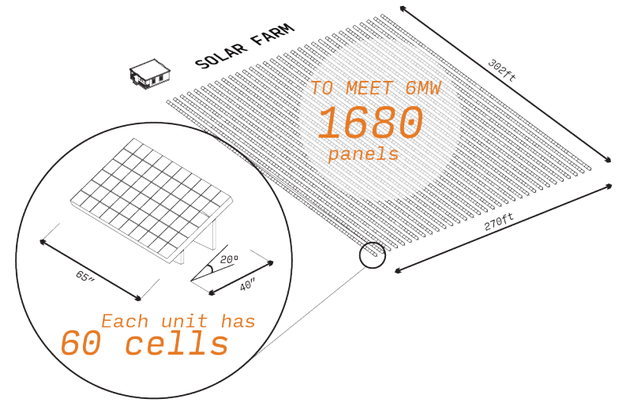
Current Conditions











THE REMAINING 97% OF ENERGY GENERATED COMES FROM NON-RENEWABLE SOURCES

37% petroleum
43% natural gas
17% coal
0.1% landfill gas

Figure 157: Map of the energy generation sources and power lines of Puerto Rico.
Figure 158: Diagram of a typical Culebrense house's energy consumption by use.
Figure 159: Diagram of the typical energy consumption of critical infrastructure in Culebra.
Figure 160: Diagram of how individual homes can sell excess energy back to the grid.
Figure 161: Diagram of calculations for meeting the total energy demand of Culebra with solar panels.

Frequent power outages pose a significant challenge for the inhabitants of Culebra, primarily due to the island's lack of energy sovereignty and autonomy. Since 1971, Culebra has depended on a singular underwater transmission line for its electricity supply.

A majority of the territories in Puerto Rico derive their power from natural gas or petroleum, with a mere 3% of energy generation sourced from renewable alternatives. This situation becomes particularly precarious during hurricane season. In the aftermath of Hurricanes Irma and Maria, 80% of Puerto Rico's power lines were incapacitated. The transmission line serving Culebra was also affected, resulting in a complete loss of power for all residents for a period of three months, and in some cases, extending up to 11 months. Notably, power outages remain a persistent issue beyond the hurricane season, occurring on a weekly, or even daily, basis due to outdated infrastructure and power grid failures.

In terms of energy consumption, Culebra's total energy demand amounts to 6 MW, with 43% originating from the residential sector and 45% from the commercial sector. A typical household in Culebra allocates the largest proportion of its electricity consumption (approximately 33%) to water heating, followed by the use of fans and lighting. While data on the commercial sector's energy usage is limited, it has been determined that the island's critical infrastructure consumes 23 kilowatt-hours per month.

Lastly, our analysis indicates that satisfying Culebra's 6 MW total energy demand would necessitate approximately 1,700 solar panels, occupying an area slightly smaller than a baseball field. From a financial perspective, the unit cost of a solar panel in San Juan stands at $2.8 per watt; thus, the total cost of powering the island using solar energy would amount to just under $17 million.

Policy Analysis

Policy	Goal	Affected Stakeholders	Implications
Jones Act (1920)	To protect and promote the U.S. maritime industry by regulating commerce between domestic ports	• U.S. shipping industry • Puerto Rican businesses & consumers • U.S. maritime workforce	The Act requires all goods transported between U.S. ports to be carried on ships built, owned, and operated by U.S. citizens or permanent residents. This restriction on the transportation of energy-related goods and materials to Puerto Rico results in higher shipping costs and higher energy prices for consumers on Culebra.
Puerto Rico Net Metering Program Act (2007)	To encourage the adoption of renewable energy sources	• Puerto Rican energy consumers • Utility companies • Renewable energy system manufacturers	The net-metering legislation from August 2007 allows customers of PREPA/LUMA to use electricity generated by solar, wind, or other renewable-energy resources to offset their electricity usage, and to also sell excess power back to the grid at a fair price.
Puerto Rico Oversight, Management, and Economic Stability Act / PROMESA (2016)	To restore fiscal stability by establishing a fiscal oversight board to oversee the territory's budget, debt restructuring, and financial management	• Puerto Rico government • Puerto Rican citizens, businesses, & bondholders • U.S. federal government	U.S. federal law enacted in 2016 that established a financial oversight board to combat the Puerto Rican government-debt crisis and help approve critical infrastructure projects (including grid modernization).
Puerto Rico Electric Power System Transformation Act (2018)	To privatize the Puerto Rico Electric Power Authority (PREPA) and promote competition in the energy market	• PREPA / LUMA • Puerto Rican energy consumers • Private energy Potential investors	The 2018 policy was implemented to privatize Puerto Rico's electricity system, with the goal of attracting private investment and improving the reliability and efficiency of the system.
Puerto Rico Energy Public Policy Act (2019)	To establish a comprehensive energy policy framework and kickstart the transition towards 100% renewable energy by 2050	• Puerto Rico government • Energy consumers • Utility companies • Renewable energy system developers	The 2019 Act established a renewable energy target of 100% for the island, phased over the next 30 years, and mandated that Puerto Rico obtain 40% of its electricity from renewable sources by 2025.

Figure 162: Comprehensive analysis of policies impacting energy generation and distribution throughout Puerto Rico.

This analysis evaluates the impact of various policies on Puerto Rico's energy generation and distribution, economy, and maritime industry. It encompasses the Jones Act, which affects the shipping industry and Puerto Rican businesses by regulating commerce with Puerto Rican ports; the Net Metering Program Act which promotes renewable energy adoption; PROMESA which addresses Puerto Rico's financial crisis through establishing a financial oversight board; the Electric Power System Transformation Act, which aims to privatize energy encourage market competition; and the Energy Public Policy Act, which establishes a framework for transitioning to 100% renewable energy by 2050.

By assessing the goals and affected parties of each policy, this analysis provides insights into their effectiveness and potential implications on Puerto Rico's sustainable development and economic growth. So far, the Electric Power System Transformation Act of 2018 has received the most backlash from the public. Since Luma Energy officially took over control of Puerto Rico's power grid in June 2021, Puerto Ricans have complained about experiencing "longer restoration times, voltage fluctuations and poor customer service" (Imbert, 2022). Two months before Hurricane Fiona caused power outages, hundreds of protestors marched to Governor Pedro Pierluisi's residence in Old San Juan, demanding the cancellation of LUMA's contract (Imbert, 2022). Little has also been done to reduce the burden of high energy costs on locals. Data from the U.S. Energy Information Administration shows that residential customers "pay 27.68 cents per kWh on average, while the U.S. average is around 15 cents per kWh" (Imbert, 2022).

Community Engagement

Solar power and energy autonomy from both the big island and the mainland United States have been identified as key priorities by Mujeres De Islas, the local community, and the local municipality. In initial conversations with the Mujeres De Islas team, an interest was identified in making Culebra the first fully solar-powered island in the Caribbean, and in bringing civil service jobs in the energy sector to the island. This vision of becoming fully solar-powered requires the island to have the technical solar expertise and backup replacement parts on hand for efficient and convenient maintenance and repairs.

Similarly, through the Recovery Plan for the Municipality of Culebra for 2023 (Plan de Recuperación del Municipio de Culebra), the local municipality outlined specific goals that aim to further energy sovereignty on the island. These include reducing municipal dependency on electric energy from the big island and strengthening physical infrastructure specific to energy for future disasters. Reducing this municipal dependency through establishing more solar energy systems safeguard's the island's ability to adapt to climate change and natural disasters. The more disaster-resilient systems can increase knowledge of more sustainable forms of living while also reducing the impacts of global price shocks.

Through community engagement, it was made apparent that local community associations and businesses too shared an interest in making the island 100% solar-powered and in installing solar infrastructure on their own sites. Asociación Pesquera de Culebra is an example of one organization looking to become solar-powered to power their energy-intensive freezers and ice machines more sustainably.



Figure 163: Wall art highlighting Culebra's nickname. Picture sourced from Camila Botero Echeverri.

> Hurricanes not only affect the island directly with the wind but also it impacts transportation, food imports and energy
>
> - Dulce del Rio-Pineda, Mujeres de Islas



Figure 165: Public school Escuela Ecologica De Culebra with solar panels. Picture sourced from Dhwani Laddha.

> Culebra is Cuna del Sol Borincano [Cradle of the Borincano Sun]
>
> - Dulce del Rio-Pineda, Mujeres de Islas



Figure 164: Gardin and Rosita, proud recipients of solar panels funded by the Environmental Defense Fund. Picture sourced from Dhwani Laddha.

> We have the greatest resource in our hands - the sun
>
> - Baby Jamanera, Fundación de Colibrí



Figure 166: Energy team sharing their research and ideas with the Mujeres De Islas team. Picture sourced from Emily Padilla-Chicas.

> Some houses were too damaged to hold the dead load [of solar panels] - inverters, controllers, and batteries need a cement wall ... Not many local contractors exist to update the houses [to support the weight of solar infrastructure]
>
> - Abimarie Otaño Cruz, Environmental Defense Fund

Figure 168: A local solar farm that is privately owned and operated. Picture sourced from Dhwani Laddha.



> Public policy is moving all of Puerto Rico towards renewable and more carbon-free energy sources
>
> - Baby Jamanera, Fundación de Colibrí



Figure 167: Diesel generators, donated by USACE, can supply the entire island with power. Picture taken by Dhwani Laddha.

> We want to become the first fully solar-powered island in the U.S. & the Caribbean
>
> - Dulce del Rio-Pineda, Mujeres de Islas

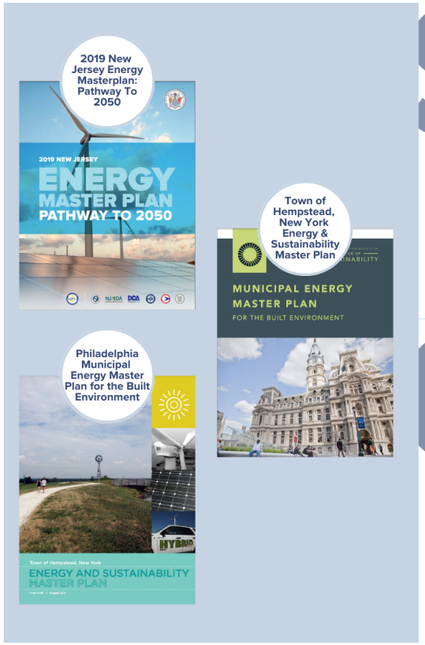
Culebra is nicknamed the ‘Cradle of the Borincano Sun’ due to its geographical location and picturesque views associated with the rising and setting of the sun. The nickname captures the poetic and symbolic essence of Culebra, emphasizing its connection to Puerto Rican history and the beauty of its natural surroundings. Locals greatly value the sun and think of it as the greatest resource in their hands.

Baby Jamanera from the Fundación de Colibrí points out that the Culebrenses started taking more ownership of solar power generation only after the hurricanes in 2017. Since then, there has been a lot of tension with the government’s implementation of solar solutions in Culebra. While federal funds are mobilizing the sector, locals would much rather create a decentralized system to harness the power of the sun. The government is responding to this by starting to open up to community input more, and relying on the community and private sector to establish stronger networks and collaboration. There is also a strong desire from the community to have replacement parts for solar systems to exist on the island in order to reduce dependency on the big island or the mainland United States.

The couple Gardin and Rosita, proud recipients of solar panels funded by the Environmental Defense Fund, pointed out how the simple act of receiving free solar panels has not only significantly reduced their energy bills, but has also encouraged a healthier relationship with energy. Since receiving the panels, the couple has learned about energy efficiency practices and invested in more energy-efficient appliances and water heaters. These indirect effects of solar panels can help ensure a more sustainable way of life for the Culebrenses.

Energy Masterplan Guide

Objective #1: Develop an actionable long-term plan for becoming a 100% solar-powered island
Objective #3: Increase local technical knowledge on solar power and energy infrastructure



STRENGTHS

- Outlines key goals voiced by the community
- Limits the number of strategies proposed based on the current energy management status
- Conducts a series of scenario-based analyses & rigorous data gathering and validation to understand the impacts of variable strategies
- Incorporates stakeholder participation
- Assigns each action item to a primary stakeholder/organization for responsibility

WEAKNESSES

- Doesn't lay out a realistic step-by-step plan for achieving each action item, or identify key community stakeholders for each stage
- Doesn't showcase community engagement outcomes i.e. summarized survey results
- Doesn't assess or create a funding matrix as a guide for external stakeholders and individuals
- Doesn't hold stakeholder input and participation activities to create a community-led movement

OPPORTUNITIES

- Prioritize key goals and strategies based on stakeholder input & participation
- Create an energy stakeholder map with contacts
- Create a funding matrix for individual stakeholders
- Designate strategies and action items, and create performance metrics to assess progress
- Improve and expand existing programs
- Timestamp goals & establish check-in meetings

THREATS

- Conducting stakeholder input and participation activities will lengthen the masterplan creation process but form a stronger community-led push
- Implementation timeframes may be incorrect, and action items may become obsolete with time
- Technical knowledge of solar infrastructure is scarce on the island so guiding external stakeholders on designs/plans is difficult

Figure 169: Existing Masterplans SWOT Analysis

The above diagram identifies the strengths, weaknesses, opportunities, and threats of three existing energy masterplans from the mainland United States. This diagram can aid the team in identifying how to create their own energy masterplan, and provide tips on what to avoid/what to replicate in their own energy masterplan.

In her interview, Baby Jamanera from the Fundación de Colibrí mentioned that Culebra lacks knowledge of the full energy ecosystem and data on whether or not Culebra has the hosting capacity for this large-scale a solar vision. Additionally, while the local municipality and Mujeres De Islas prioritize renewable energy and the shift away from fossil fuels, there is no singular plan consolidating all the solar efforts on the island or laying out the steps to making Culebra fully solar-powered by 2050.

In response to this need, a comprehensive plan that outlines the municipality's strategy for managing its energy use and reducing its carbon footprint can consolidate island-wide efforts and guide the population towards making the shift to renewable energy. An energy masterplan can additionally help the local municipality identify and activate stakeholders in the energy ecosystem. These masterplans are particularly useful for: (1) establishing an energy baseline through creating an inventory of all energy-consuming assets and the municipality's current energy use, (2) setting specific, measurable, and time-bound goals for reducing energy use and greenhouse gas emissions, (3) assessing the feasibility of using renewable energy sources while also identifying potential barriers to implementation, (4) listing financing options and funding sources available to the municipality to implement strategies, and (5) creating a plan for the monitoring and evaluating of the implementation of the energy masterplan.

As the creation of an energy masterplan is time-consuming and requires stakeholder coordination and management alongside strategy implementation assessment, an office within the Puerto Rico Department of Housing or the Puerto Rico Energy Bureau would likely need to be created. This office can also apply for grants and funds like the Puerto Rico Energy Resilience Fund. The masterplan as a whole can help Culebra reduce its energy consumption and energy bills, figure out a realistic pathway to becoming 100% solar-powered, increase energy efficiency and energy consumption awareness, and improve the overall resilience of the municipality to energy disruptions and disasters.

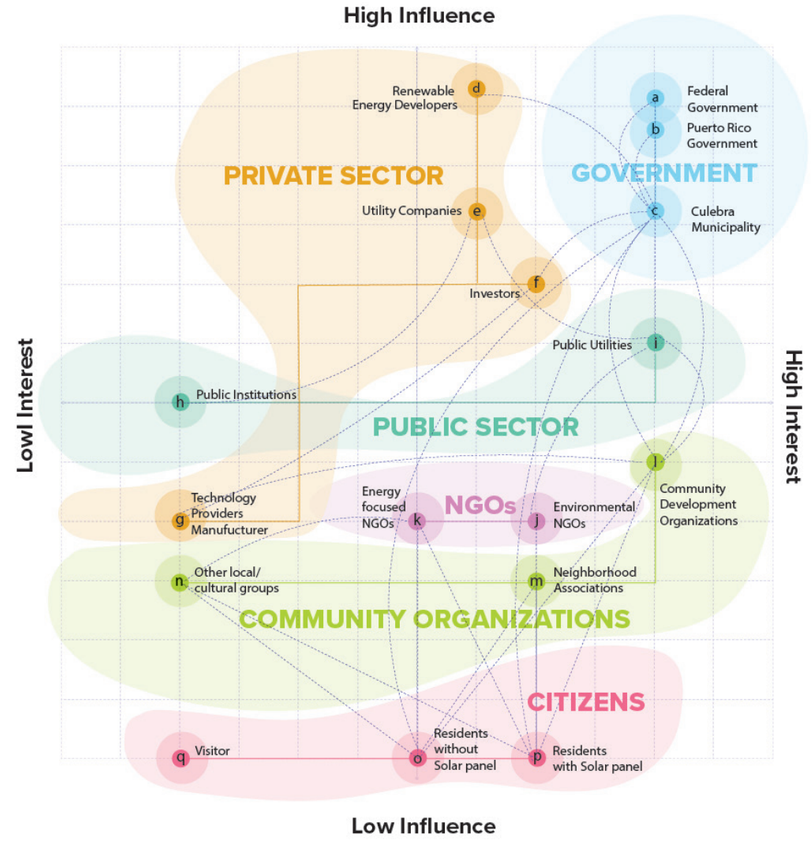


Figure 170: Stakeholder Map

The diagram to the left identifies the numerous stakeholders that can or already do play a role in the local energy sector. Forming partnerships with these individuals or organizations will prove useful in actualizing energy targets and implementing energy strategies.



Figure 171: Masterplan Step-By-Step Process
The diagram to the left sets out a general step-by-step process for the team creating their own energy masterplan for the municipality of Culebra.

Creating an energy masterplan for Culebra involves establishing clear goals and objectives, collecting and analyzing data, developing and evaluating scenarios, and engaging with stakeholders. The process aims to identify and implement the most sustainable, cost-effective, context-specific, and energy-efficient solution for the island.

Key aspects of the process include assessing the current energy situation, exploring renewable energy potential, and developing implementation strategies. This requires collaboration with local residents, businesses, and government agencies to ensure a comprehensive and inclusive plan.

The timeline for creating an energy masterplan can vary depending on the complexity of the project and the level of stakeholder engagement. Generally, it may take anywhere from several months to a few years to complete the process, from initial data collection to final implementation.
Securing necessary funding and resources is crucial for the plan's success, as is ongoing monitoring and evaluation to ensure the plan remains effective and adaptive to changing circumstances.

Proposed Strategy	2050 Target	Action Items	Core Outcomes
Maximize energy efficiency & reduce peak demand usage in households	**Reduce residential energy consumption by 30%**	• Regulate the construction of new buildings to be energy-efficient with improved insulation and smart HVAC systems • Educate the population on energy-efficient appliances & practices • Reduce peak demand usage through demand response programs, time-of-use pricing, and smart grid technologies • Adopt strict building codes and incentives for building retrofits	
Accelerate the deployment of renewable energy systems	**Have all municipal and public buildings be 100% solar-powered**	• Invest in smart grid technologies and energy storage solutions to facilitate the integration of renewables and optimize distribution • Adopt policies that promote the use of renewable energy systems, including providing tax incentives, subsidies, and loan guarantees for those that invest in renewable energy • Establish funding mechanisms (green bank or revolving loan fund)	
Electrify the transportation sector	**Achieve 70% market share of electric vehicles & 100% solar-powered golf carts**	• Begin phasing out the existing gas station • Promote the adoption of electric vehicles (EVs) for household use • Expand pedestrian and bicycle-friendly infrastructure to encourage alternative transportation methods • Create more green spaces to reduce the urban heat island effect & encourage walking/biking	
Increase the resilience of energy systems	**Upgrade and modernize 90% of the electricity grid**	• Establish more resilience centers • Establish solar training for technicians so they can provide technical assistance to homeowners & businesses • Establish storage for solar replacement parts • Consolidate community organizations to aid recovery efforts post-hurricane	
Support community-led energy planning	**Facilitate the development of 50 community-owneed or managed solar projects**	• Partner with local schools to encourage clean energy innovation • Survey the community to understand energy demand, available resources, and potential barriers to renewable energy deployment • Foster public engagement through monthly community meetings to tackle the infrastructural challenges of solar (like cost-effectiveness and social equity)	

Figure 172: Table Of Strategies & 2050 Energy Targets

The above table lays out key strategies, targets, action items, and core benefits that can help kickstart the masterplan design process for the team. These strategies have been consolidated from existing energy masterplans from the mainland United States.

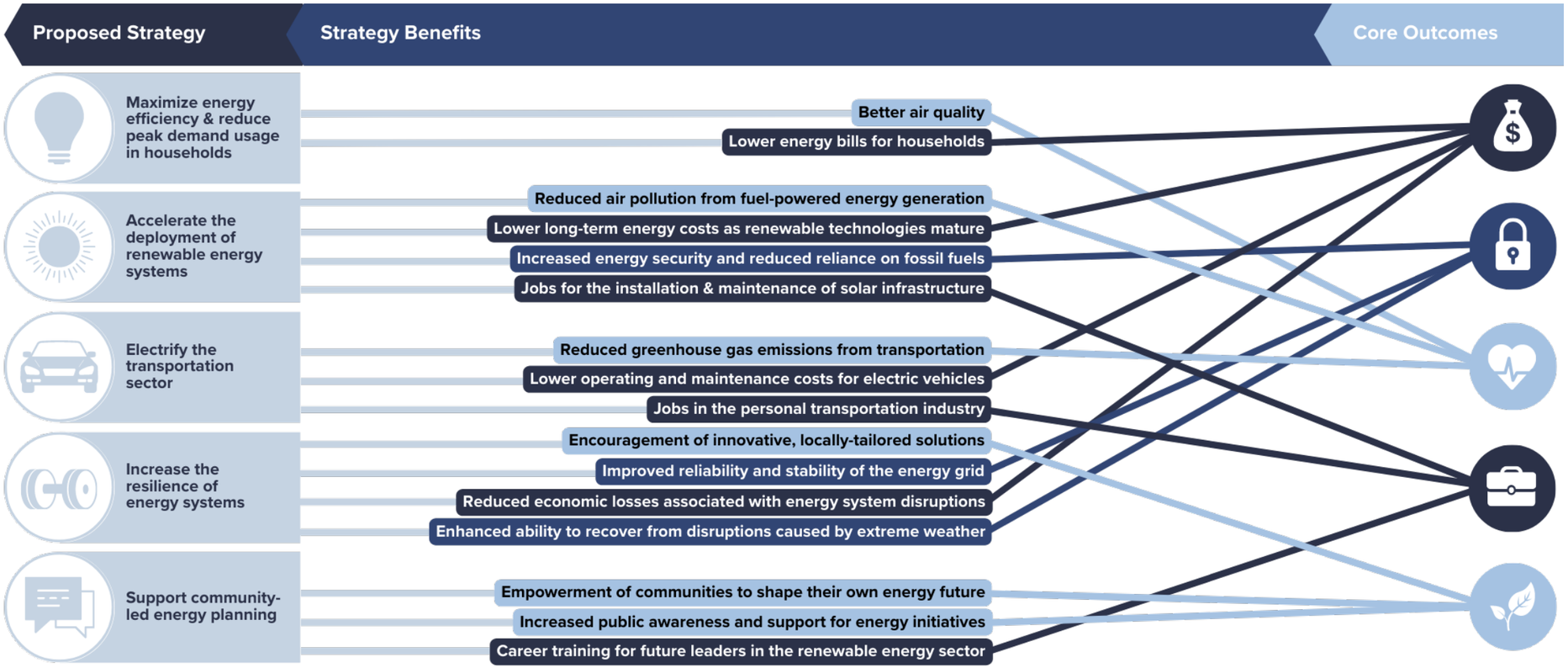


Figure 173: Identifying Masterplan Benefits

Adding on to figure 16, the above table identifies key benefits that are likely to result from each of the identified strategies and targets. The overarching outcomes include (1) financial savings, (2) energy security and independence, (3) improved public health, (4) the creation of jobs in the renewable energy industry, and (5) encouragement of community empowerment and innovation.

The core outcomes for these select five strategies include financial savings, increased energy security, improved public health, increased job opportunities, and community empowerment. Property owners save financially in terms of lowered energy bills, and operating and maintenance costs. The municipality wins through reduced economic losses and social impacts associated with energy system disruptions. Similarly, increased energy security benefits the community and the local municipality by reducing the island's reliance on fossil fuels, increasing the stability of the energy grid, and enhancing the island's ability to recover from and adapt to energy disruptions.

Other key benefits include improved public health as reduced greenhouse gas emissions from transportation and energy generation will result in better air quality. Economic impact is generated in jobs being created for the installation and maintenance of solar infrastructure and in the personal transportation industry. Lastly, career training in the renewable energy sector will result in increased public awareness and support for energy initiatives and empower the local population to shape their own energy future.

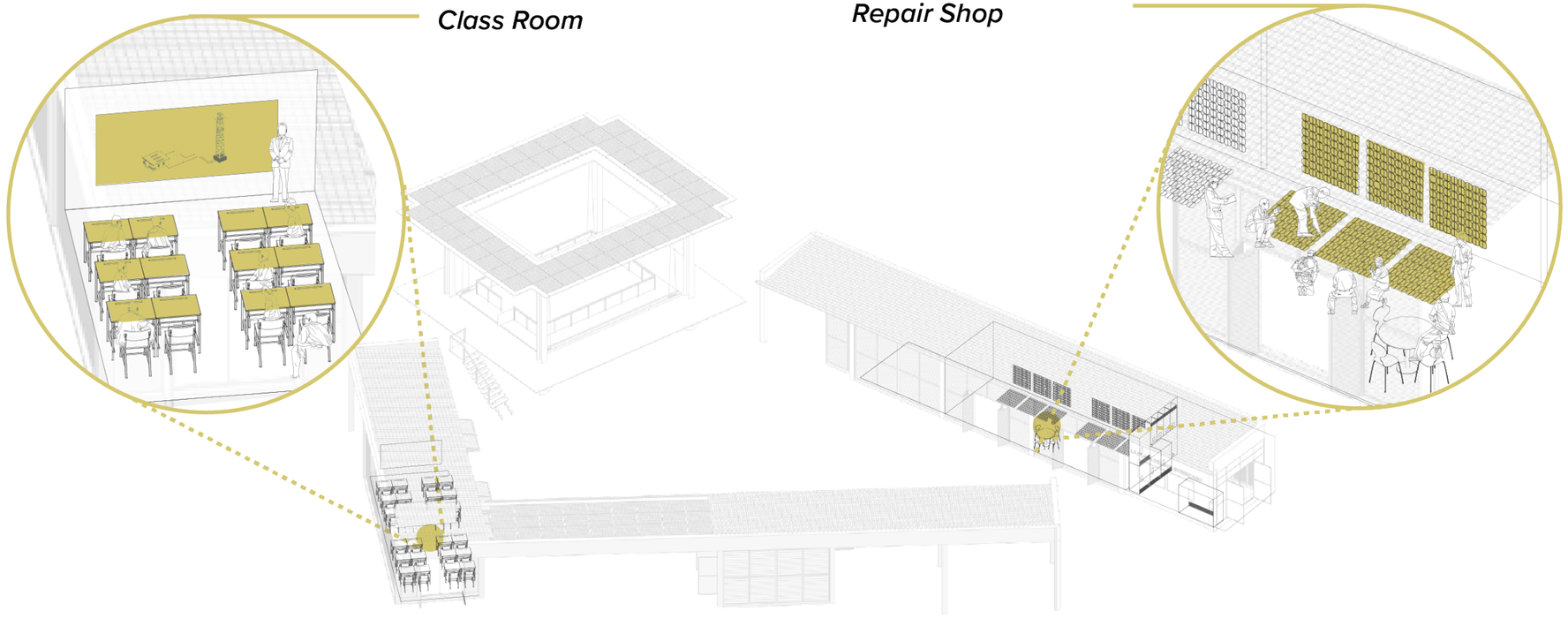
This proposal aims to utilize a community-led policy mechanism to reinforce energy infrastructure in Culebra. Ultimately, actualization of this proposal could lead to decreased dependence on the big island and the mainland United States by encouraging economic competitiveness, and improving disaster response and emergency management.

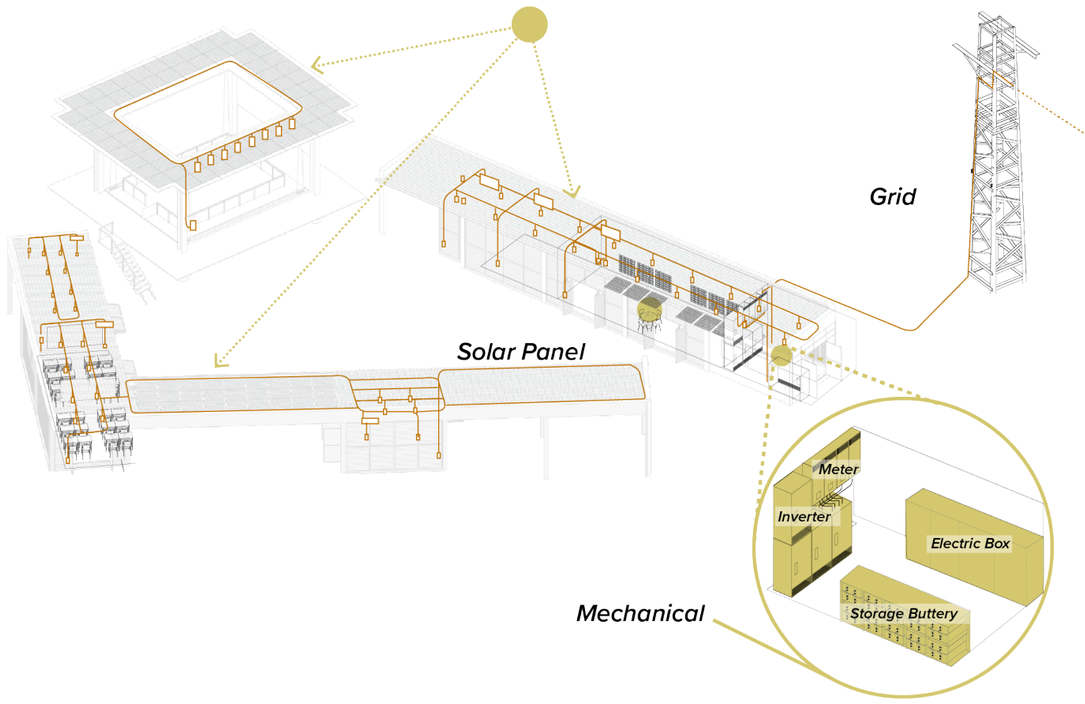
Figure 174: Programs related to solar systems

This facility provides a space where both theory and practice related to solar systems can be learned. In the classrooms, students can acquire theoretical knowledge. Here, they have access to courses covering topics such as solar grid studies, for example, solar system design, fundamental learning, and maintenance, among other technical

Figure 175: Conceptual diagram of the solar system

The entire electricity demand of the facility is met by the power collected from solar panels installed on the roof of the facility. Excess power can be stored in batteries or sold to power companies through the grid.





Visualizing the identified strategy of community-led energy planning of this energy masterplan may include the creation of architectural spaces for classrooms and workshops. These solar-centric spaces can act as career training and education opportunities for the local community to not only increase their solar knowledge but also to become technical solar experts on the island. The need for technical expertise is vast in Culebra, particularly to help reduce dependence on the mainland and to ideally mitigate the impacts of natural disasters on blackouts, power surges, and downed systems.

Similarly, visualizing the identified strategy of increasing the resilience of the energy grid of this energy masterplan may include a proposed solar installation being disaster-resilient. Disaster resilience can lead to greater energy autonomy on the island, particularly in the face of natural disasters, global price shocks, and climate change.

La Plaza Del Sol Borincano

Objective #2: Model a solar hub that envisions the future of energy in Culebra
Objective #3: Increase local technical knowledge on solar power and energy infrastructure

The dry dock in Dewey, as it stands currently, houses four abandoned steel structures, leftover from the days when the site was used for the construction, maintenance, and repair of ships, boats, and other watercraft. Today, these structures are being proposed for adaptive reuse to create the structural layout for 'La Plaza Del Sol Borincano,' the island's first and only solar hub. The intentionality behind this hub is to enable a communal space for the Culebrenses to gather and learn about solar power, alongside being an iconic and touristic attraction for visitors to learn about the island's solar energy efforts.

Site programming is dictated by conversations with the local community and energy stakeholders. It includes an indoor workshop space for technical training and solar panel repair, communal space for learning about solar power, an assembly space for administrative meetings, an indoor technical room for power storage and backup energy infrastructure (backup batteries, etc.), an indoor administrative space for the office managing and overseeing solar infrastructure on the island, and both outdoor and indoor practical lecture spaces and classrooms.

These practical elements are complemented with more playful site components like outdoor cardio gym equipment that generate kinetic electricity, an open exhibition space for small creative and educational exhibitions, an open cafe space for the community to gather, outdoor seating, an electric bicycle rack and golf cart station, and more trees and greenery to allow for a more pedestrian-friendly site with shading and cooling benefits.

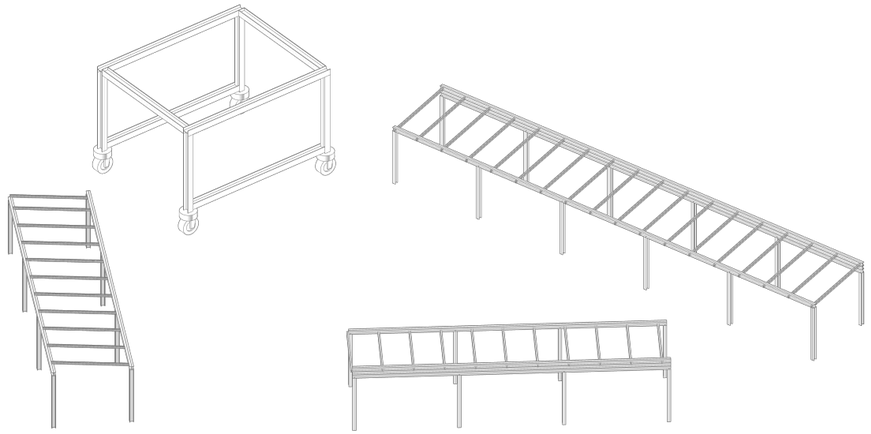


Figure 176: Existing Structures
Currently, there are four abandoned steel structures spread across the dry dock site. These structures are being adaptively reused for the purposes of establishing 'La Plaza Del Sol Borincano,' Culebra's first and only solar hub.

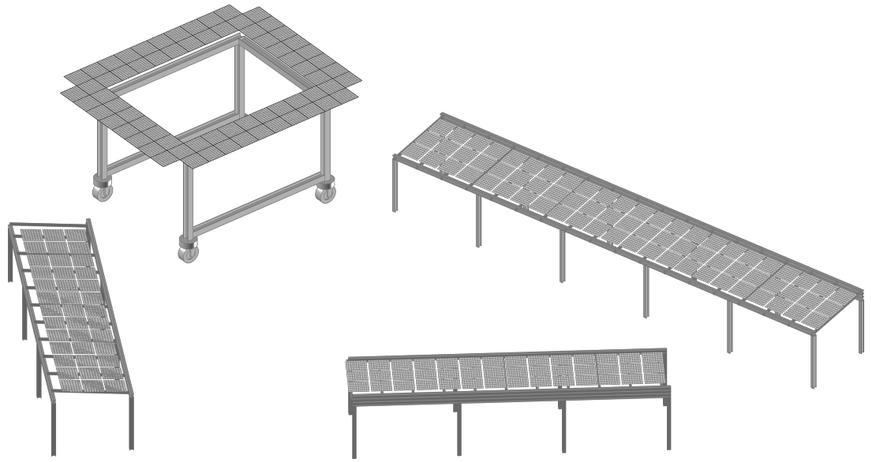


Figure 177: Solar Panel Additions
Adding solar panels to the steel structures allows for their energy production on-site. With 20 watts being generated per square foot, these panels should be able to suppor the energy demands of the intentioned programming.

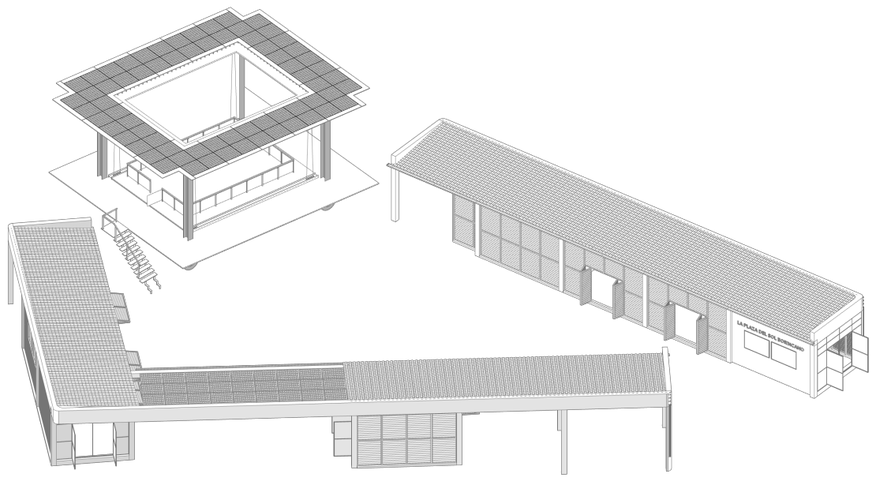


Figure 178: Architectural Forms
Architectural forms will be added to extend the shading on-site, to create individual rooms for intentioned programming, and to create a central stage for entertainment purposes.

Figure 179: Site Programming

With the architectural forms under the solar panels, this site incorporates an indoor storage space for backup energy infrastructure, an indoor workshopping space for panel repairs & maintenance, an indoor administrative space, an outdoor practical lecture space, an indoor classroom, an open exhibition space, and an open cafe space.

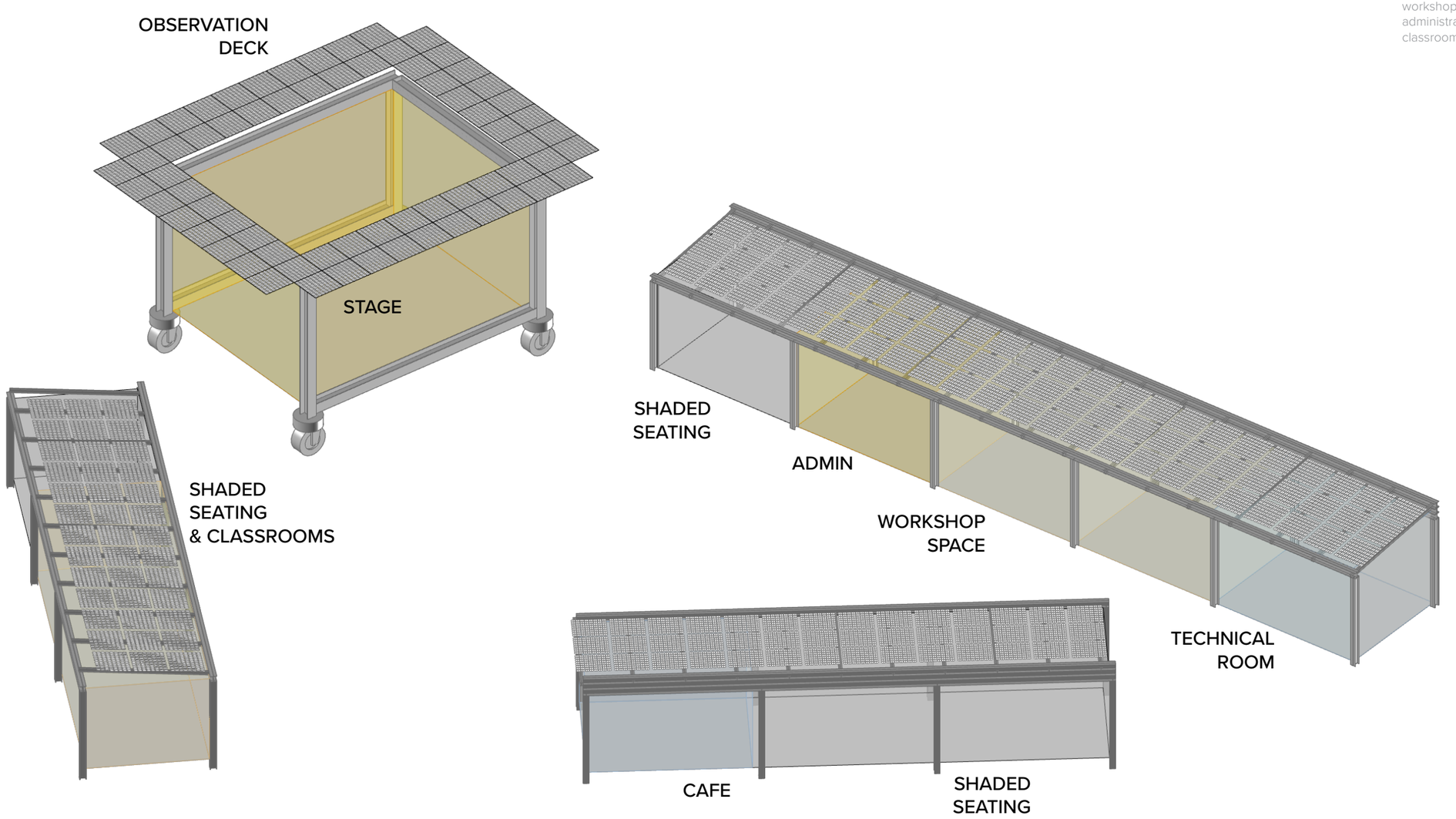




Figure 180: Entrance View

The site entrance houses space for electric bikes and electric golf carts, while also creating a visually appealing aesthetic from the street view.



Figure 181: Steel Structure Section

The section shows the interior spaces created with the steel structures and rooftop solar panels. Sliding doors and translucent panels help create a more open space where visitors can peak into indoor spaces.

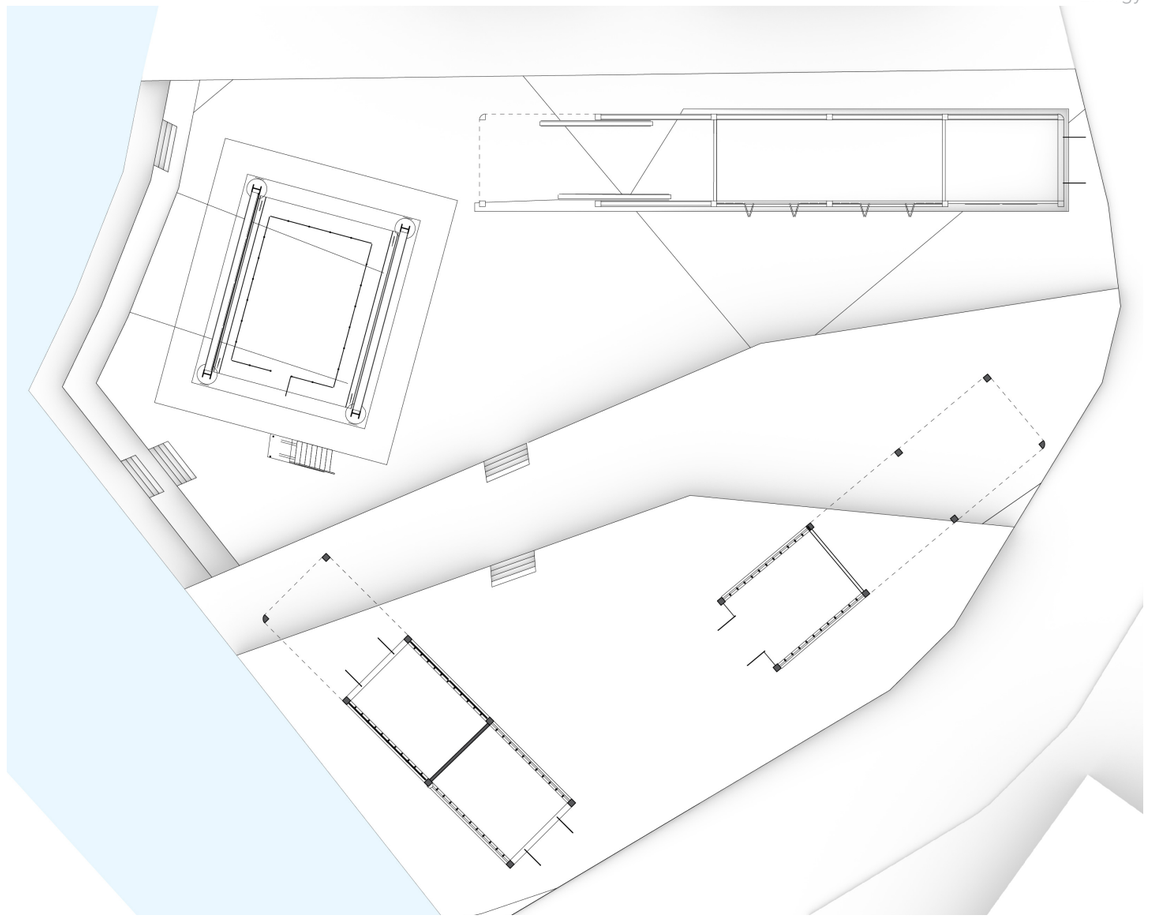


Figure 182: Site Plan

The site plan exemplifies components like the stepped seating that help activate the waterfront, the steel structure additions that enable adaptive reuse, and the stage setup that repurposes the central steel structure.

The adaptive reuse of this site is complemented with waterfront activation and the creation of a public space for the community. La Plaza Del Sol Borincano hopes to not only engage the local community with solar training and educational opportunities, it also hopes to create a communal gathering space. The local community doesn't solely have to utilize this site for solar, they can use this site in their everyday lives to interact with the waterfront and even assemble for meetings. The site will additionally stand as an iconic centerpiece pushing the island to become 100% solar-powered by 2050. The visual landmark will attract tourists and spread the messaging around solar power potential.



Figure 183: Entrance Render

The site entrance is viewable from the street to both cars and pedestrians. It houses space for electric bikes and electric golf carts, while also creating an interactive space where people can get a glimpse into the site without even stepping in.

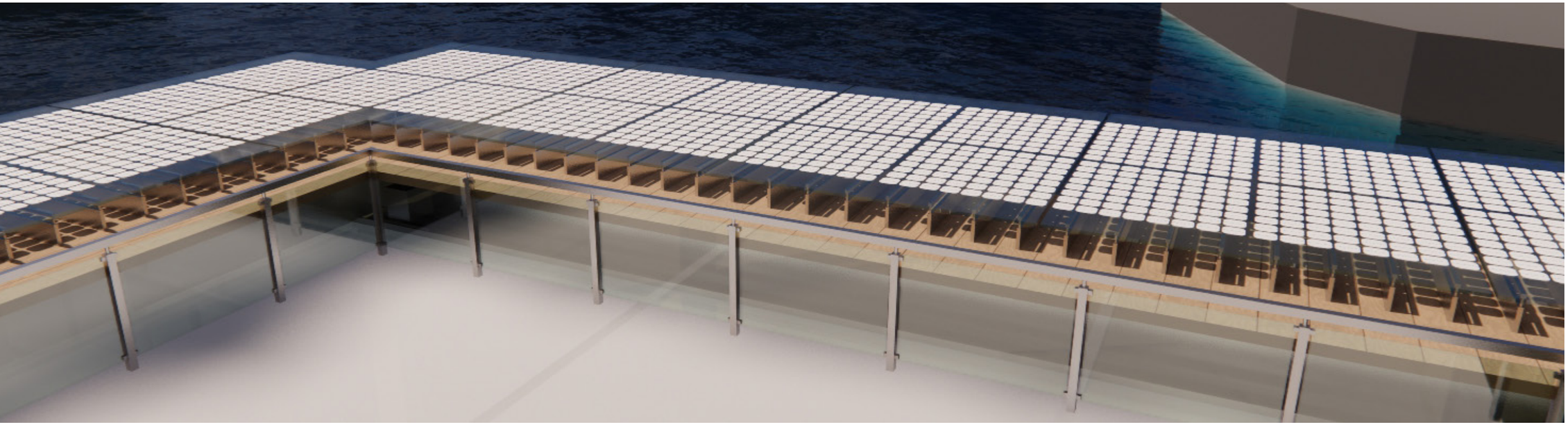


Figure 184: Central Stage Observation Deck Render

The central stage that houses the solar panels on the rooftop also houses an observation deck that visitors that climb up to for a visually appealing scenery, and to get a closer look at the solar panels.

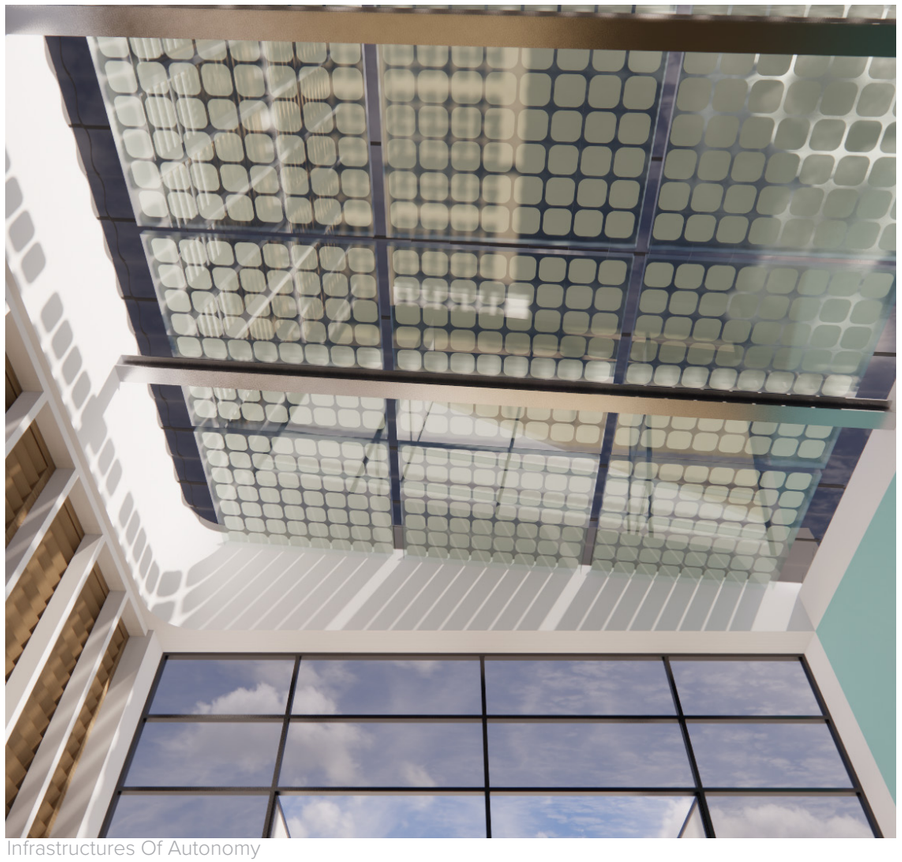


Figure 185: Rooftop Solar

The rooftop solar panels allow for shade in interior rooms with a playful aesthetic, while also generating solar power.



Figure 186: Exterior Render

This exterior render showcases the intricate panels that allow for natural cooling and shading, and glass panels to allow visitors to look into the indoor spaces.



Figure 187: Central Stage Render

The central stage that houses the solar panels on the rooftop also houses an observation deck that visitors that climb up to for a visually appealing scenery, and to get a closer look at the solar panel and solar systems.

Funding Sources

The energy master plan and solar hub require a strategic funding approach combining public and private resources to achieve the ambitious goal of transitioning the island to 100% renewable energy by 2050. The proposed funding allocation consists of 75% public funding and 25% private funding.

Public funding sources include federal grants from FEMA, the Puerto Rico Department of Housing, the Puerto Rico Energy Resilience Fund, and the U.S. Department of Energy's State Energy Program. These funds will support key aspects of the master plan, such as infrastructure development, grid strengthening, and the integration of complementary renewable energy sources.

Private funding sources are vital for driving innovation, research, and development in the renewable energy sector. Companies like Tesla, a key private sector stakeholder, have demonstrated their commitment to Puerto Rico's renewable energy future. Tesla has deployed six battery projects to power two islands in Puerto Rico and plans to continue its involvement in the region. Tesla's expertise in energy storage systems and electric vehicle infrastructure can significantly contribute to Culebra's renewable energy transition.

Other private funding sources include NGOs like the Environmental Defense Fund, Fundación Colibrí, and Earth Justice, which can provide expertise and financial support for specific initiatives. Private investments and donations from individuals, businesses, and philanthropic organizations can also help fund innovative solutions. Partnerships with private sector companies, including energy developers and investors, will be crucial for developing decentralized solar power systems, such as rooftop solar panels and community solar projects.

By leveraging these diverse funding streams, Culebra will be well-positioned to become a leader in renewable energy and achieve its ambitious goal of becoming a 100% renewable energy island by 2050. This strategic funding approach will not only facilitate the successful implementation of the master plan but also serve as a model for other communities seeking to transition to renewable energy.

Federal grants from agencies based in the mainland United States, including FEMA and the U.S. Department of Energy's State Energy Program

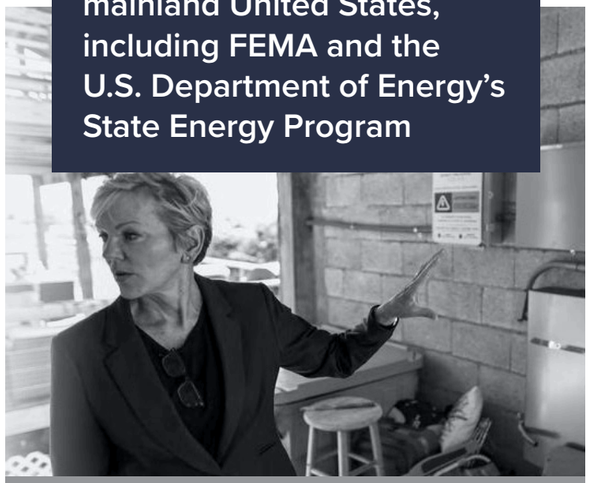


Figure 188: U.S. Energy Secretary Granholm welcoming the renewable energy transition in Puerto Rico. Picture sourced from the Puerto Rico Fiscal Agency and Financial Advisory Authority.

Federal grants and funds from local agencies including the Puerto Rico Department of Housing and the Puerto Rico Energy Resilience Fund

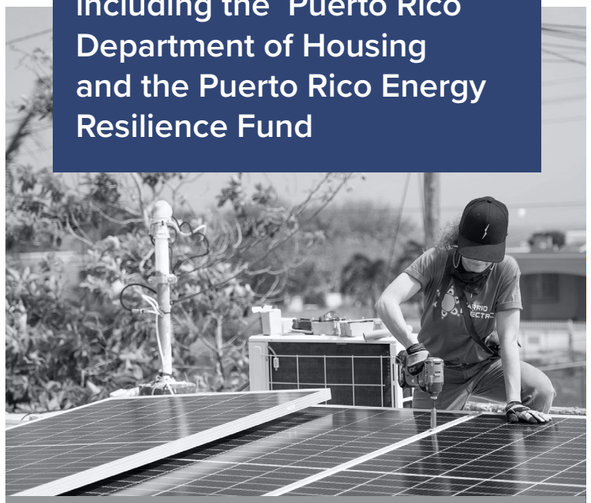


Figure 189: Solar panels being installed in Puerto Rico by the non-profit organization, Barrio Eléctrico. Picture sourced from Aoun Angueira

Public-private partnerships with globally-recognized companies in the energy sector, including Tesla, which has a long-standing relationship with Culebra



Figure 190: Tesla installed large-scale solar photovoltaic and battery projects in Culebra. Picture sourced from NimB.

Private funding from non-governmental organizations (NGOs) like the Environmental Defense Fund, Fundación Colibrí, and Earth Justice

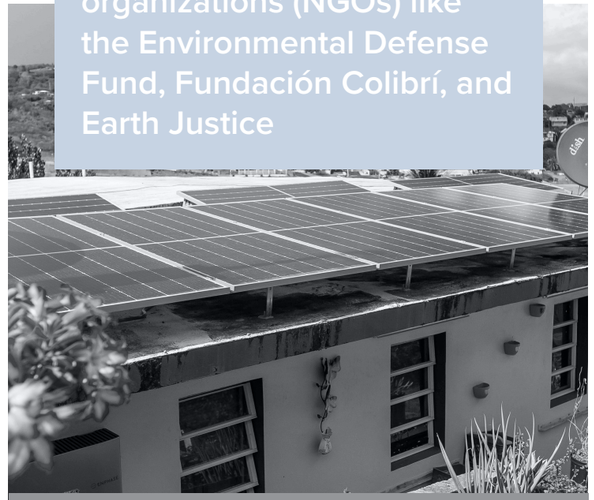
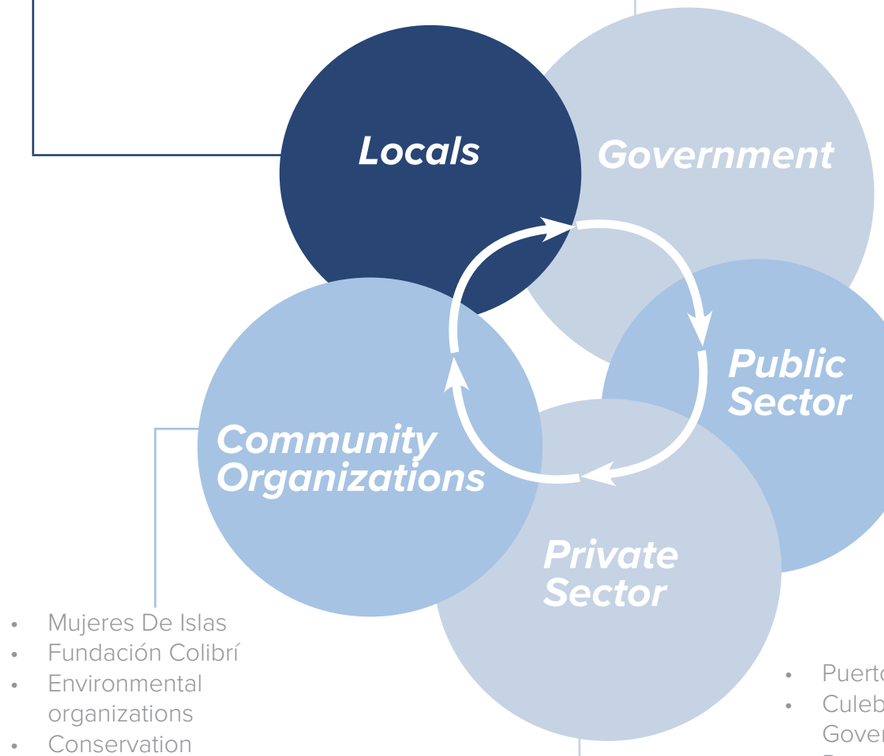


Figure 191: Community solar project funded by the Environmental Defense Fund. Picture sourced from the Advanced Energy Group.

Stakeholders

- Homeowners with solar panels
- Homeowners without solar panels
- Community-owned solar projects

- Federal Emergency Management Agency (FEMA)
- U.S. Department of Energy's State Energy Program
- Puerto Rico Department of Housing



- Mujeres De Islas
- Fundación Colibrí
- Environmental organizations
- Conservation and development organizations

- Puerto Rico Energy Bureau
- Culebra Municipal Government
- Puerto Rico Energy Resilience Fund

- LUMA Energy
- EarthJustice
- Environmental Defense Fund
- Tesla
- Energy Service Companies
- Renewable Energy Developers

Figure 192: Stakeholder map of the Energy proposals.

Historically, the Puerto Rico Electric Power Authority (PREPA) was the primary owner and operator of Puerto Rico's energy grid. The public company declared bankruptcy in 2020, after years of increasing debt, due partially to costly repairs and an antiquated grid after the 2017 hurricanes. PREPA is now considered a dissolved company, and with a fifteen-year lease of their assets and operations, the private company LUMA Energy now manages energy in Puerto Rico.

LUMA is run jointly by one American company and one Canadian company. They will determine how $10 billion of federal relief funds from FEMA will be spent. Resident support of LUMA has dwindled dramatically over the last three years, starting with lack of trust in the initial contract proceedings. Increasing prices of electricity, constant blackouts, and a lack of transparency has only fueled the fire, leading to a number of protests and demonstrations.

EarthJustice is a nonprofit, public interest, environmental law organization, which has released a statement in opposition of LUMA's contract, citing the company's poor performance and overpriced service. While debates on how to revitalize the main grid continue, non-governmental organizations like the Environmental Defense Fund have taken the lead on financing microgrid projects throughout Puerto Rico. In Culebra, specifically, they've funded solar panels and systems for almost 50 homes.

Lastly, the Department of Energy has recently begun a campaign to make Culebra the first solar-powered island in the world. Their study, PR100, is dedicated to investigating the potential of solar and wind energy on the island moving forward. Conversations with leaders in each of these organizations about the history of energy generation in Puerto Rico could yield valuable insights into the future of energy sovereignty for Culebra. Additionally, surveying residents could fill in the gaps and paint a picture of how distrust in LUMA has grown over the years.

Implementation Timeframe

Short-term Actions

2023: Preparation and research
- Conduct an assessment of the island's existing energy infrastructure and consumption patterns
- Identify key stakeholders to involve in the planning process
- Perform a comprehensive solar assessment to determine the island's solar energy potential
- Establish a dedicated team of experts to guide the development of the energy master plan

2024: Strategy development
- Develop a detailed inventory of suitable sites for solar installation, including rooftops, parking lots, and public land
- Create a phased approach to transitioning the island's energy supply to renewable sources
- Engage with key stakeholders to gather input on the proposed solar energy master plan
- Develop a regulatory framework to encourage private investment in solar energy

2025: Implementation and public awareness
- Finalize the solar energy master plan, incorporating stakeholder feedback
- Obtain necessary permits and approvals from local authorities for the proposed solar projects
- Implement an educational campaign to increase public awareness and support
- Launch energy efficiency programs to reduce overall energy demand and support the transition to renewable energy sources

Long-term Actions

2030: Construction and Inauguration
- Achieve 25% renewable energy generation - Expand the centralized solar farm and invest in decentralized solar power systems
- Develop storage systems, like batteries, to store excess and ensure a stable supply
- Strengthen the island's electrical grid to accommodate the increasing share of renewable energy

2040: Strengthen energy resilience
- Achieve 75% renewable energy generation
- Establish microgrids for critical facilities to enhance energy resilience
- Expand energy storage systems and develop innovative solutions to extreme weather events
- Invest in research and development to explore emerging renewable energy technologies
- Implement green building standards and encourage sustainable planning

2050: Achieve 100% solar energy
- Foster a culture of sustainability and innovation to ensure long-term resilience
- Share Culebra's success stories with other communities and support global efforts to transition to renewable energy
- Monitor and assess the ongoing impacts of renewable energy on the island's economy, environment, and quality of life

Figure 193: Privately-owned solar farm in Culebra. Picture taken by Dhwani Laddha.

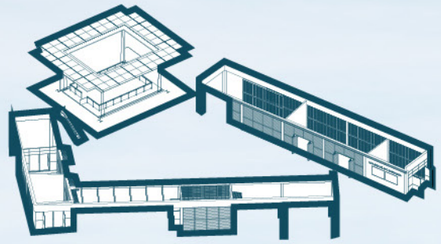
Outcomes

Figure 194: Diagram outlining outcomes achieved by the Energy proposals.

Energy

-Solar Hub

-Energy Masterplan





Outcomes

Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome02-A
Increase knowledge of sustainable forms of living

Outcome02-B
Disaster-resilient systems

Outcome03-A
Increase the affordability of resources

Outcome03-B
Reclaim territories

Outcome04-A
Push policy mechanisms

Outcome04-B
Community-led initiatives

Alimento

Project Team

Valentine Kalei
Urban Planning student with a background in architecture

Teonna Cooksey
Architecture and urban planning dual degree student

Project Stakeholders

Mujeres de Islas (Women of Islands)
This is a community organization running under our client Dulce del Rio Pineda, and it is focused on working hand in hand with the community towards a sustainable and self-sufficient agricultural path. The organization has established an agricultural educational project at their community center known as SEVA.

Culebra Fishers Association
Founded in 1967, the association sought to establishment of small no-take fishery reserves as a tool to recover local depleted fisheries in Culebra. Currently running under Nicolás Gomez Andújar, the association in collaboration with Mujeres de Islas, has achieved the approval of a proposal to address the promotion of food security of fish and seafood on the island. The project is committed to training and employment for the Villa Pesquera Fishery. In addition, it will support in the co-design and implementation of best practices to ensure quality and accessibility of sea products.

N
0 0.5 1 2 Miles

Proposal Vision

Our vision is to establish a sustainable and community-based circular food economy in Culebra, through fishing and agriculture. Ultimately, this will lead to a self-managed food production sector in Culebra enabling community education, socio-ecological research and multisectoral cooperation.

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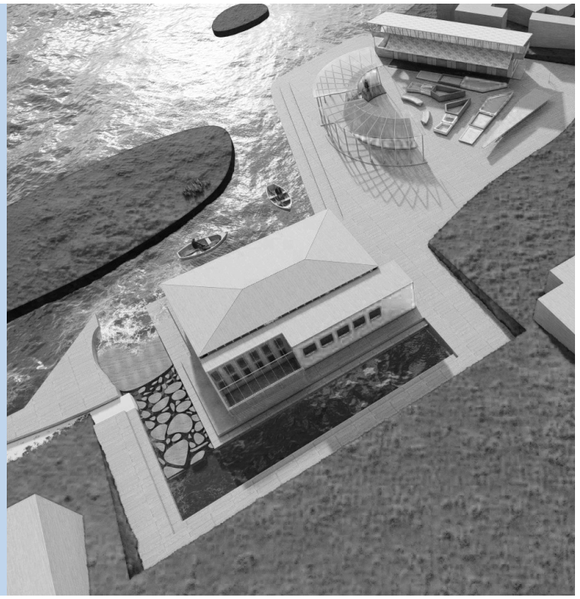


Food sovereignty is addressed through interventions in and around the villa pesquera or fishing village. The first approach is to propose a renovation of the Villa pesquera, by looking at the existing layout and proposing alterations where necessary.

The second phase is to expand the fishing villa into the dry dock site and propose interventions that would supplement the activities within the villa in an effort to address food insecurity in Culebra.

The visions of this master plan are implemented in timeline phases, 2030 and 2050. By 2030 the fishing village will host a public market where food vendors across the island can come and sell their food, and residents can commune. By 2050, the hatchery created in the backspace of the building will influence the cutting of land to expand the indoor hatchery to an outdoor wastewater treatment space and an outdoor learning space.

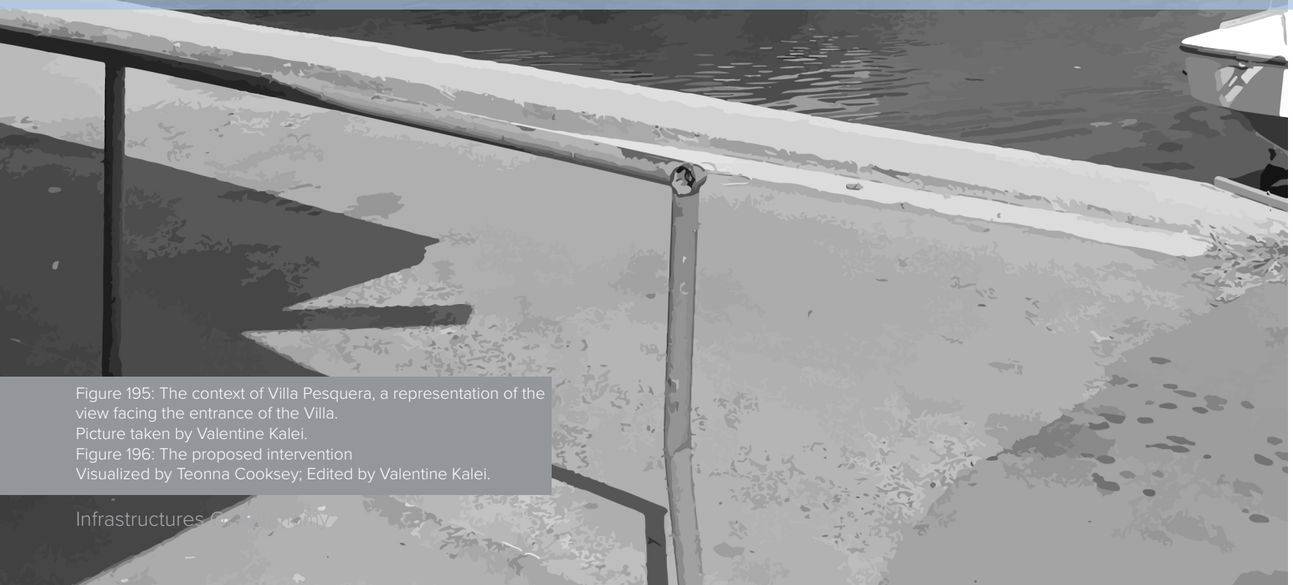


Figure 195: The context of Villa Pesquera, a representation of the view facing the entrance of the Villa.
Picture taken by Valentine Kalei.
Figure 196: The proposed intervention
Visualized by Teonna Cooksey; Edited by Valentine Kalei.

Key Objectives

Renovation of Villa Pesquera fishery
Completely renovating the reclaimed historical space and giving purpose to the new and innovative methods of creating seafood reliably

Activate the dock into a public market
Hosting a public market where food vendors across the island can come and sell their food, and residents can commune

Implementation of the educational component of the project via a tool kit
Incorporating fishing and agricultural activities in an educational capacity through a food tool kit

Key Outcomes

Reinforcing infrastructure to support community-led initiatives
Renovating the existing fishing villa in order to address the issues with the local small scale fisheries including food insecurity and sovereignty

Creating access to sovereign systems to empower the local community
Expanding the fishing villa to create a market to support local food production and distribution

Strengthening technical skills & promote intergenerational knowledge
Fostering culturally-appropriate spaces for the preservation of intergenerational knowledge

Historical Milestones

Fishing historical milestone

1936

Commercial Fishing
Puerto Rico's commercial fishing was regulated by Law No.83 which contained regulations pertaining to the conservation of fish resources. For instance, it banned dynamite fishing and use of nets in mouths of rivers

1967

Associations
The Culebra Fishers Association, founded in 1967, recommended since 1980 the establishment of small no-take fishery reserves as a tool to recover local depleted fisheries in Culebra, Puerto Rico

1970

Fishing facilities
The Puerto Rico government through the department of agriculture built docks and facilities for commercial fishers

1971

Increase in landings
There was an increase in fish landings observed from 4.9 million to 7.4 million after the increased investment in fishing activities by the Puerto Rico government.

1988

Decline of landings
Fishery landings decreased significantly from 7.4 million to 2.0 million pounds. The decrease in fishery landings was due to an exploitation of fishing resources

1998

Law No.278
The Puerto Rico government established Law No.278 also known as the fishing law. The law ordered the department of natural and environmental resources (DNER) to create additional regulations.

1999

Fishing reserve
As a tool to beging the recovery of fisheries, the Puerto Rico Planning Board designated the Luis Peña Channel Natural Reserve on June 11, 1999 as a tool to begin the recovery of fisheries.

2023

Small scale fishing
The scale of fishing in Culebra is small and the Fishers association is working to rescue the abandoned fishery to revive fishing activities.

Agriculture historical milestone

1890

Sugarcane
Sugar industries began to collapse across the carribean. Puerto Rico emerged as a primary sugar producer in the region and the US became the Island's loyal consumer buying 60% of the sugar followed by Spain which consumed around 30%.

1947

Industrialization
The Popular Democratic Party (PPD),passed the Industrial Incentives Act of 1947,officially launching Operación Manos a la Obra, which granted private companies a 10-year exemption on an array of taxes in order to incentivize them to set up shop on the island, was just the first step that solidified Puerto Rico's shift from agriculture to industrialization.

1970

Decline of agriculture
Local food production showed the Ilsland's markets remained constant or declining.

1990

Collapse of agriculture
Collapse of many agricultural sub-sections and the subsequent exacerbation of food importing trends, are an outcome of the major food and agricultural policies implemented in previous decades.

2012

Mass Exodus to mainland
Despite the mass exodus and a tightening economic crisis, those who stayed behind succeeded in temporarily reviving the island's neglected agricultural sector. Farm income grew by twenty-five percent between 2012 and 2014, totaling more than $900 million and creating over seven thousand jobs.

2013

Local groups
Alongside this farming boom, Comedores Sociales de Puerto Rico (Community Kitchens of Puerto Rico) emerged in 2013 as a local food distribution group.

2017

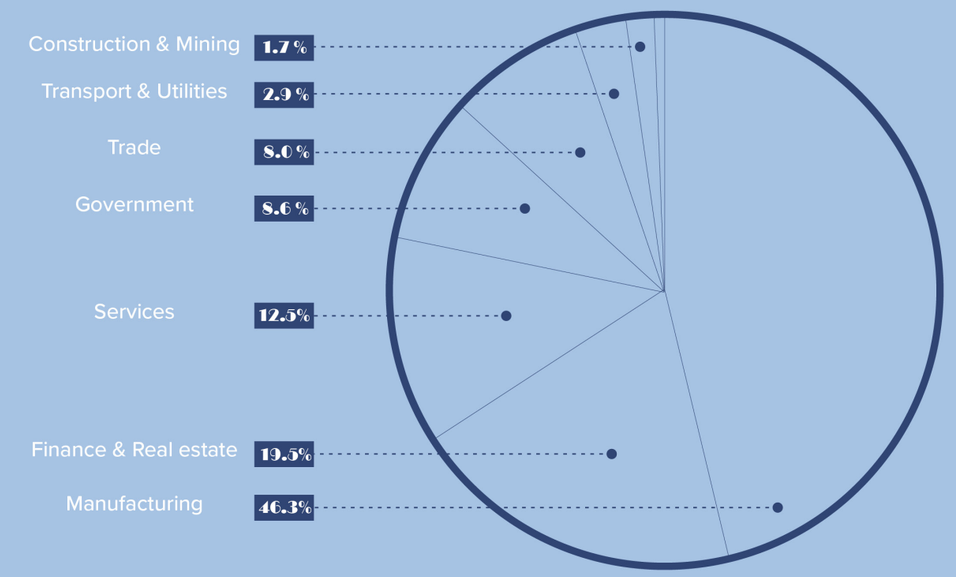
Hurrican Maria
Hurricane Maria struck Puerto Rico in September 2017, destroying the island's electrical grid, killing thousands, and wiping eighty percent of the island's crops.

2023

Collapsed agricultural sector
85% of food is imported with agriculture accounting for 2% of the GDP.

Current Conditions

Puerto Rico GDP by economic sector



85%

Imported food

0.6%

Agricultural production

2%

Employment in agriculture

The future of food security is one of the most significant concerns in culebra. Culebra being an offshore municipality of Puerto Rico relies on the island for services and among these is food. Puerto Rico was once a thriving agricultural hub thanks to its tropical climate, rich biodiversity and sustainable farming traditions as highlighted in the historical timeline above. Today less than 2% of the workforce is employed in agriculture and tens of thousands of acres of arable land either sit idle or have been developed for housing and other uses. Meanwhile 85% of the food eaten in Puerto Rico is imported. This means that a high percentage of food consumed in Culebra is also imported. Agriculture in Puerto Rico is less than 1% of the economy as shown above. With food importation comes restrictions outlined in the federal law known as the JONES ACT explained in the policy analysis section below. Production of local food in Culebra through agriculture and fishing is thus minimal limited to small scale. Agriculture is practised by a few residents, some of whom, grow crops in their backyards. Agriculture is also practiced in an educational capacity e.g at SEVA. There is also an existing fishery that is in the works of being renovated after years of being abandoned.

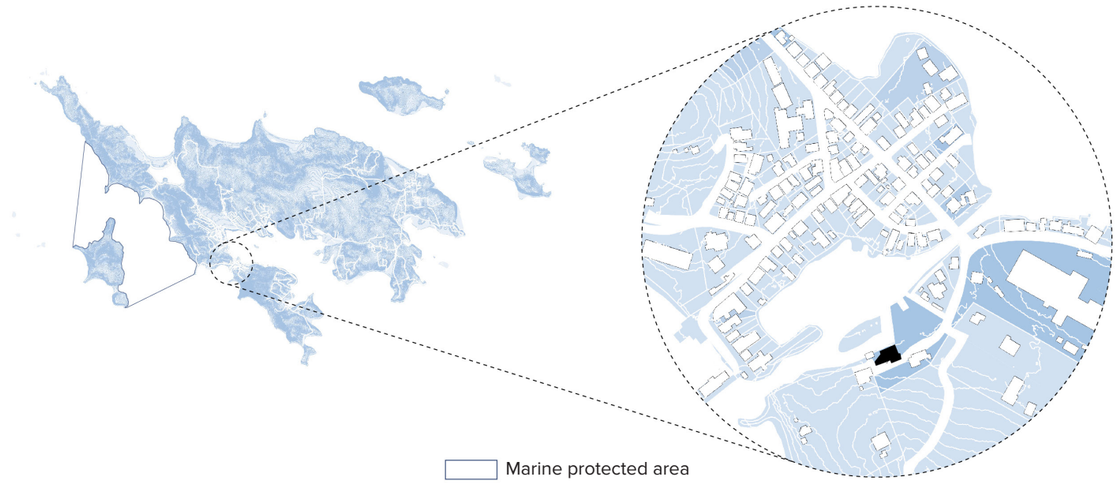




Figure 197: Current economical conditions
Figure 198: Current conditions of the Villa Pesquera, designed by Valentine Kalei

Policy Analysis

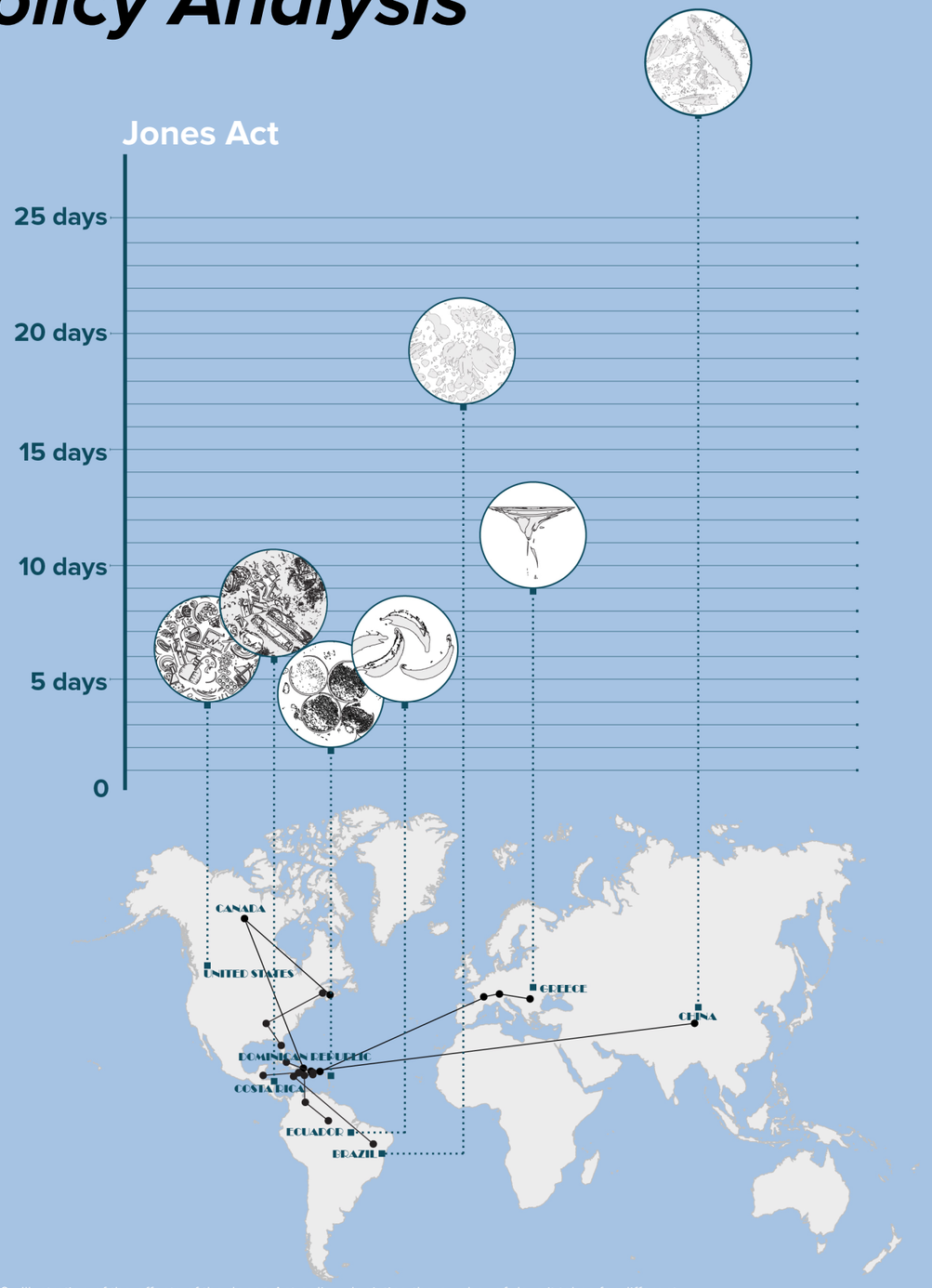


Figure 199 : Illustration of the effects of the Jones Act policy, depicting the number of days it takes for different food items to get to Culebra, designed by Teonna Cooksey editted by Valentine Kalei

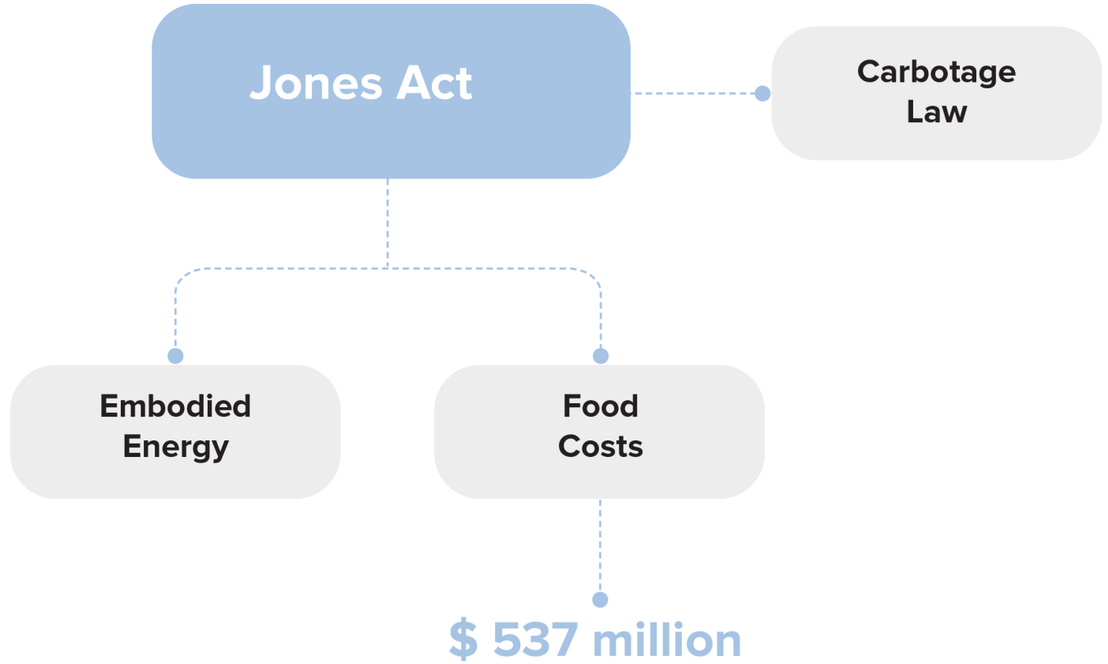


Figure 200: Illustration of the effects of the Jones Act, designed by Valentine Kalei

The United States Congress enacted Public Law 66-261, as amended, known as the Merchant Marine Act of 1920 (hereinafter the “Jones Act of 1920”). To this day, said Act regulates maritime transport between the United States and Puerto Rico. It is worth noting that both the spirit and effectiveness of the Jones Act of 1920, limit maritime transportation between the United States and/or its possessions and/or territories. This entails that any cargo transported between Puerto Rico or Culebra and any other ports in the United States must be shipped on vessels built and registered in the U.S. The essence is that all goods carried by water between the United States, its territories, and possessions must be shipped in vessels of the U.S. Merchant Marine Fleet documented under the laws of the United States or to which the privilege of engaging in coastwise trade was extended; and crewed by U.S. citizens. The Commonwealth of Puerto Rico is the only jurisdiction where the restrictions imposed by cabotage laws, regarding the shipping of goods, are fully implemented. It is worth noting that in 1980, cruise ships arriving in Puerto Rico’s ports were exempt from the Passenger Vessel Services Act of 1886 due to the economic crisis the Island was facing at that time. This means a precedent was established to amend United States freight and passenger preference laws for Puerto Rico. This resulted in an increase in the number of cruise ships, and other types of vessels, arriving in the Island, and, in turn, an increase in the economic activity of the Island. In addition, the vessels used to transport merchandise to and from the ports often double their expected useful life. The vessels burn fuel faster and less efficiently, and points out they are lacking in bulk cargo, petroleum, and natural gas transportation capacity factors that are inherent to Puerto Rico’s current fragile economic state. Undoubtedly, the elevated costs of goods traded in the Island, both in local and in megastores is questionable.

Community Engagement



Figure 201 : Community engagement at Villa Pesquera,



Figure 202: Community engagement with Nicolas and Megan
Picture taken by Teonna Cooksey

> Due to the environmental and social complexities of small scale fisheries, it's a tricky balancing act to design interventions that are socially just and also environmentally sustainable. This accelerator offered the tools to help me navigate the real-world experiences of leaders across the world (along with) out

Figure 204: Community engagement at Villa Pesquera
Picture taken by Teonna Cooksey



> The fish market is called the Villa Pesquera. We are currently rescuing this space after 20 years of either being abandoned or being used for other private uses that did not benefit the community.

Figure 203: Community engagement at Villa Pesquera with Nicolas
Picture taken by Teonna Cooksey



> Part of the vision of this space is to have a community supported fishery (CSF) selling program. This is basically a subscription program meant for residents to pay in advance and be able to access fresh seafood.



Figure 205: Community engage at Benjamin's house
Picture taken by Valentine Kalei

> We were able to recognize that sargussum, a seaweed is used to fertilize the soil in order to boost agricultural crop production. Benjamin collects the seaweed on his backyard and uses it for small scale crop production.

Figure 207: Community engagement at Benjamin's house
Picture taken by Valentine Kalei



> In the process of community engagement we were also able to identify ways in which agriculture can be incorporated in the project proposal as an educational capacity.



Figure 206: Community engagement at SEVA
Picture taken by Chris Kumaradjaja

> Rainwater is used to water the crops. Despite the meager rainfall, Benjamic collects rainwater when available to water his crops.



Figure 208 : Community engagement at Benjamin's house, picture taken by Valentine Kalei

Villa Pesquera

Objective #1: [Renovation of Villa Pesquera]

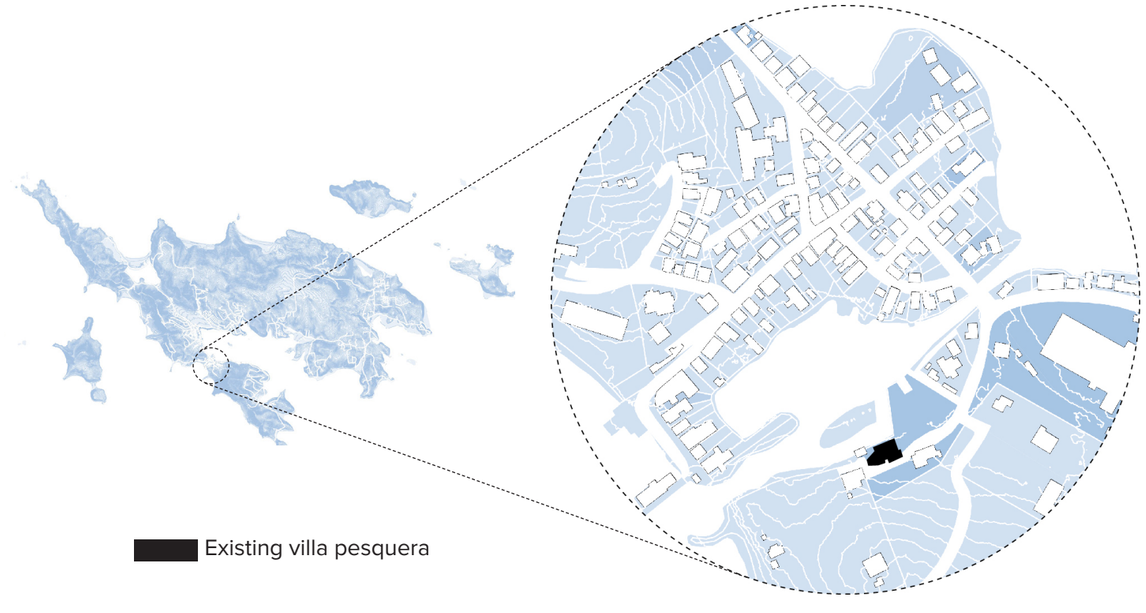


Figure 209 : Location of Villa Pesquera
Maps created by Valentine Kalei

Food sovereignty is addressed through interventions in and around the Villa Pesquera or fishing village. In response to the ongoing efforts of the local community in Culebra, this proposal outlines design interventions of the Villa Pesquera in achieving food sovereignty. The first iteration is to completely renovate the reclaimed historical space and give purpose to the new and innovative methods of creating sustainable and reliable seafood sources on the island. The Villa is the process of being rescued after being abandoned for 20 years and used for activities that do not benefit the community, as mentioned earlier. Part of the vision of the space is to have a community supported fishery selling program. This is basically a subscription program meant for residents to pay in advance and be able to access fresh sea food. The community supported fishery, aims to incentivize fair-trade practices that increase food insecurity. Modeled after a similar approach for small-scale agriculture, this model aims to provide market alternatives and social resilience when faced with systematic shocks such as COVID-19. The model is built on solidarity between fish-workers, and leverage more fair market relationships by engaging directly with end-consumers, often in the local community. As such it aims to provide better prices for fish, making the fishing economy viable. This model also aims to lead to more sustainable harvesting at the local level. The model encourages fishing under-utilized species and “quality over quantity” which aligns with the need to not over-pressure alternative seafood species.

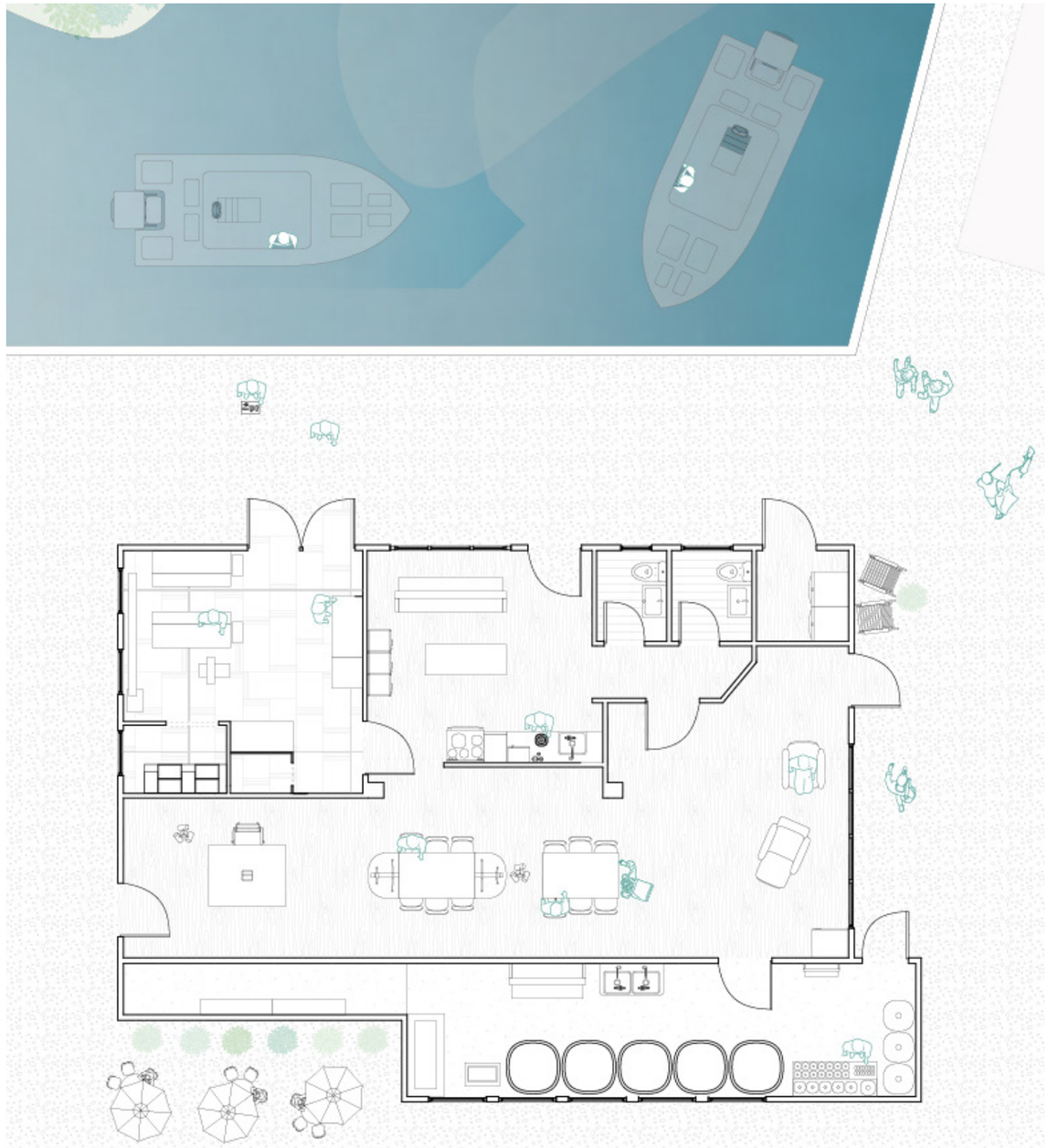


Figure 210 : Renovated floor plan of Villa Pesquera,
Designed by Teonna Cooksey

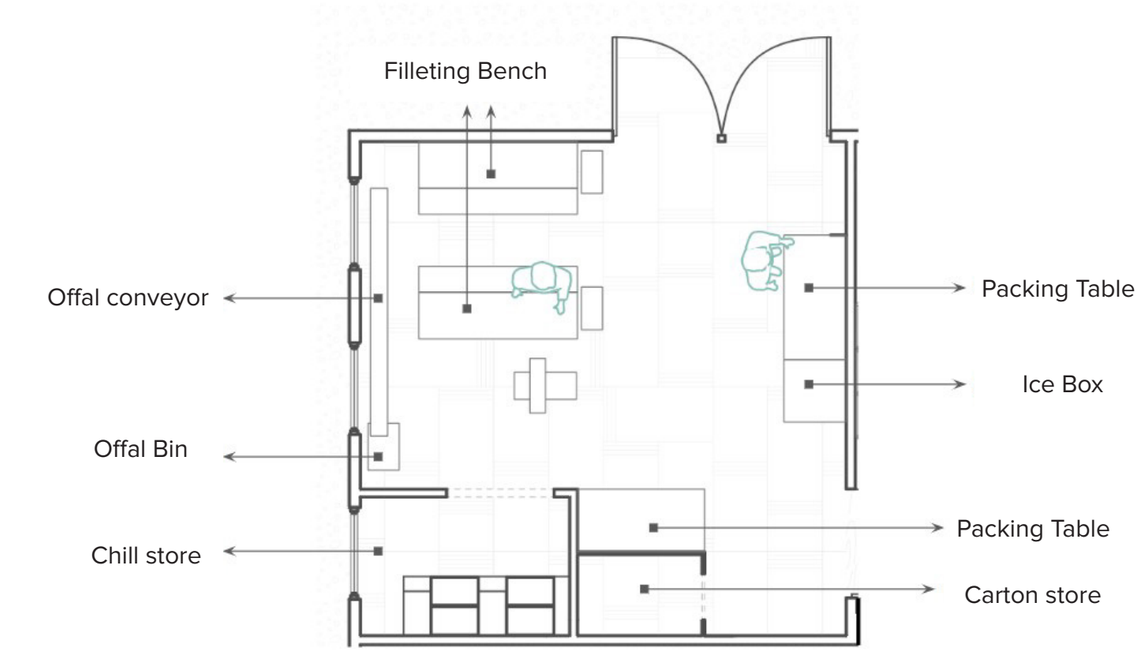
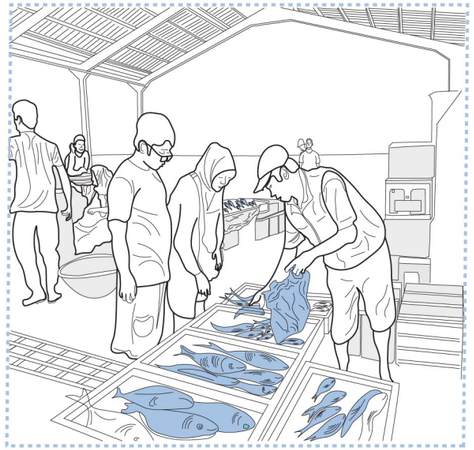
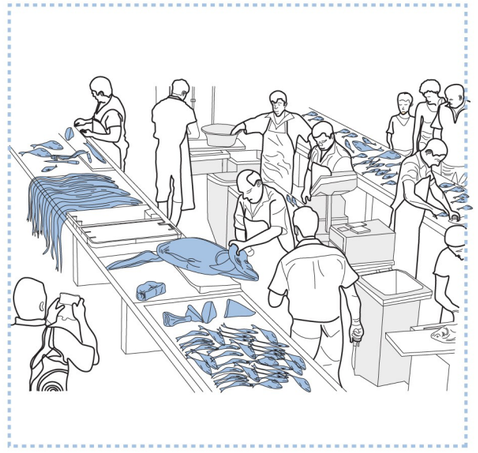


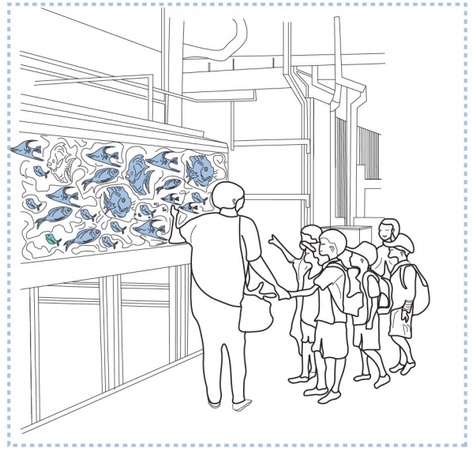
Figure 211 : Renovated floor plan of Villa Pesquera,
Designed by Teonna Cooksey



Figure 212 : Renovated Villa Pesquera,
Visualized by Teonna Cooksey







The program of the fishery aims to create a marketplace for selling fish and fish products. It can be dedicated to wholesale trade between fishermen and fish merchants, or to the sale of seafood to individual consumers or to both. The fishery also serves as a public space where people can gather to see how fish is prepared, cooked and served. The program will accommodate storage facilities for the fish products. Dry fish to be stored in a cool and dry environment and fresh fish will be kept in freezers to control the temperature for growth of spoilage organism in the fish. Storage is important to prevent over flooding of the local market with fish which may result in reduction of market prices. The program will also accommodate a sorting area to categorize fish products into groups using the characteristics of size, color, species and weight. The sorting of fish will depend on the form in which they are processed. For instance, dry fish can be sorted into full or cut fish. This enables easy grading, handling and marketing. Fish products will also be graded through price allocation and this will be determined by the market demand and value. This would prevent arbitrary costing that may lead to loss or inability to sale. It will enable the fishermen to estimate the prices of the fish products.

Figure 213 : Diagramatical representation of Villa's Pesquera activities,
Drawn by Valentine Kalei

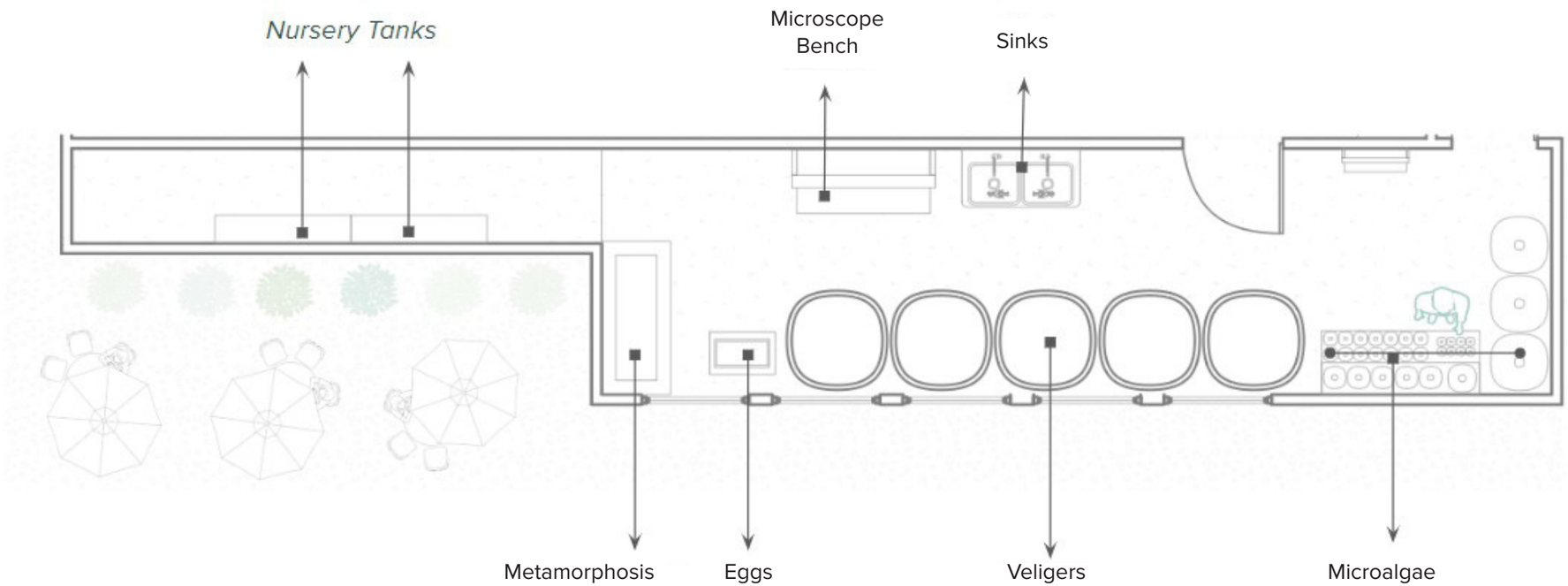


Figure 214 : Floor plan of the hatchery, Villa Pesquera
Designed by Teonna Cooksey

Packaging and Labelling are also important components of the program. This involves putting together and wrapping of fish products in certain materials or containers in readiness for storage or sale. It is also the loading of fish products into containers in readiness for storage or sale. The fishery is renovated in anticipation that fishing activities will be revived and continue to expand in Culebra in an effort to achieving overall food sovereignty. In addition the fishery is redesigned to accommodate a hatchery where cultivation and breeding of a large number of fish will take place. This will eliminate the need to find fish in the wild or rather in the sea, providing for some species outside their natural season and avoiding the depletion of the ecosystem. Overall, the renovation of the villa will revive the conversation of fishing in Culebra and be the first step the Island takes to produce local fresh food and in the long-run facilitate an economy that spills out of the Island.

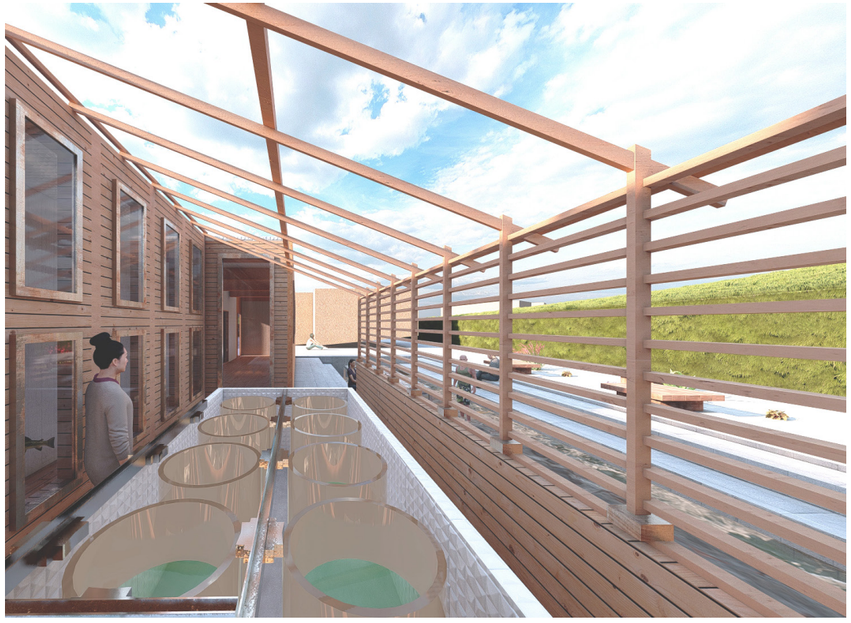


Figure 215 : Extenal hatchery system, Villa Pesquera
Visualized by Teonna Cooksey



Figure 216 : Renovated Villa Pesquera
Visualized by Teonna Cooksey

Mercado municipal de culebra

Objective #2: [Activation of the dock into a public market]



Figure 217 : Design of the public market
Visualized by Teonna Cooksey

The second goal of the proposed project is to activate the dry dock site by transforming it into a market that can accommodate the anticipated expansion of the revitalized fishery operations and any other activity that will contribute to the achievement of food self-sufficiency in Culebra. Presently, the Puerto Rican government owns the site, while the municipality of Culebra owns Villa Pesquera. The dry dock area is presently being underutilized and littered with boats that require repair. Originally, the dry dock site was used to repair boats to generate income for the fishing operations at Villa Pesquera. To achieve the project's second objective, the unused dry dock site will be repurposed into a market that will cater to the growing needs of the fishery and other food-related industries in Culebra. By transforming the site into a market, the project aims to create a space where local farmers and fishermen can sell their products to the community while also promoting sustainable practices. This will ensure that the market operates smoothly and provides a consistent source of income for the local community. By activating the dry dock site, the project will not only provide a new source of income for the community but also contribute to the overall goal of achieving food sovereignty in Culebra. The market will create a stronger local food system. This will reduce the dependence on imported food and promote the consumption of locally grown produce and fresh seafood. Furthermore, the market will provide an opportunity for local businesses to expand and thrive. By offering a variety of products and services, the market will attract visitors to the area and promote economic growth in Culebra. This will help to create a sustainable community that is capable of supporting itself and its residents, and in the near future. In summary, by repurposing the site, the project aims to create a space that promotes sustainable practices, provides a new source of income for the community, and contributes to the overall goal of achieving food sovereignty.

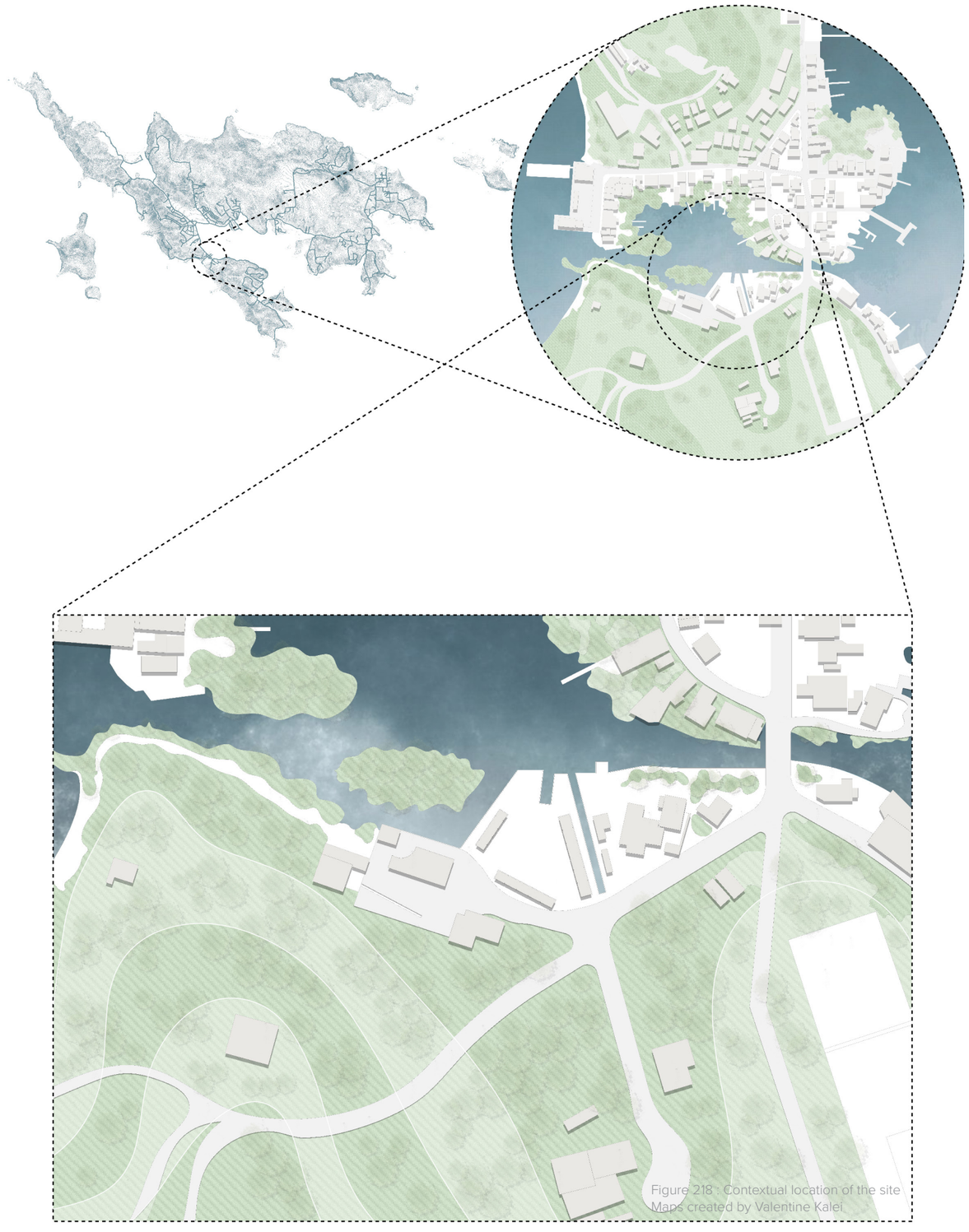


Figure 218 : Contextual location of the site
Maps created by Valentine Kalei

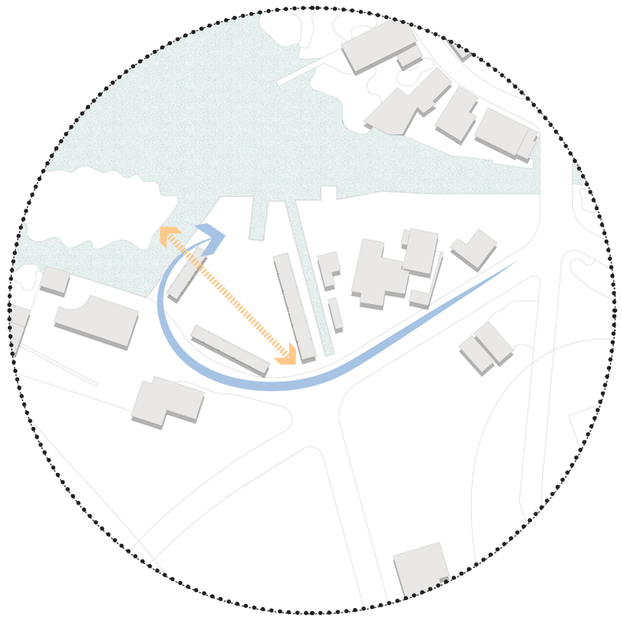


Figure 219 : Masterplanning concept development 01
Drawn by Valentine Kalei



Figure 220 : Masterplanning concept development 02
Drawn by Valentine Kalei



Figure 221 : Masterplanning concept development 03
Drawn by Valentine Kalei



Figure 222 : Designed masterplan for the dry dock site
Designed and visualized by Teonna Cooksey

Several iterations were made to develop a master plan that connects Villa Pesquera and the dry dock site. The first step involved identifying the main axis that would be used to organize the site. The existing road created a curvature that resulted in two curved structures on the site that serve as sitting, relaxation, and eating areas. The main axis divided the site into two sections, from the main entrance to the waterfront. Two additional axes separated the vendor spaces from the sitting areas, with a central square or gathering space. The minor axes provided a clear separation between the existing buildings and the new market buildings, while at the same time integrating everything into one cohesive waterfront promenade. Overall, the master plan aimed to create a functional and attractive space that could accommodate a variety of activities and businesses. By strategically dividing the site into different zones, the plan provided ample space for vendors, customers, and visitors to move around freely and enjoy the amenities offered.

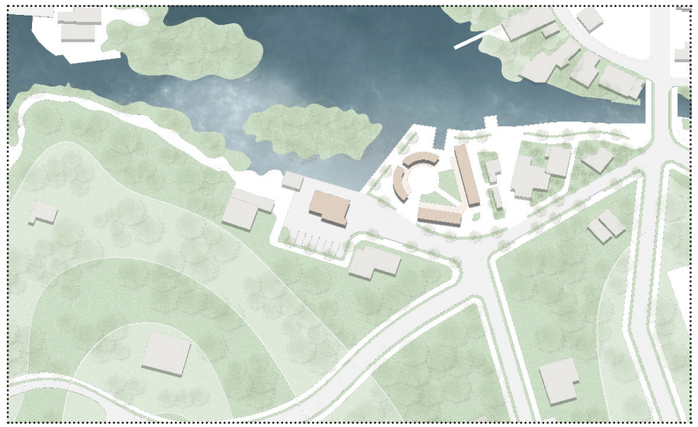


Figure 223 : Sitting and relaxation area
Visualized by Teonna Cooksey



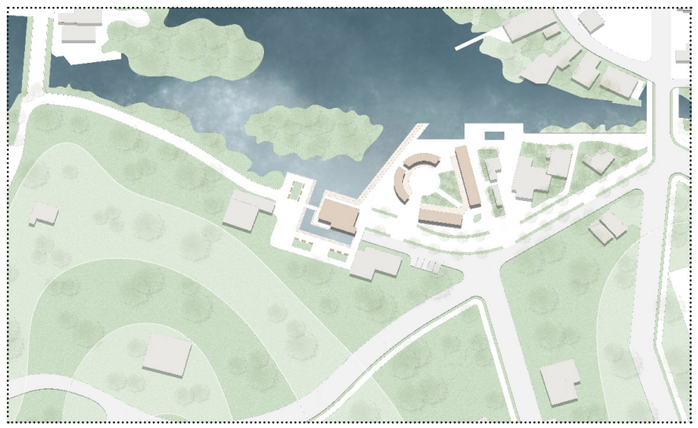
The first iteration, as depicted in the masterplan, involves renovating Villa Pesquera to include programs and spaces that facilitate fishing activities. The objective is to transform the building into a functional space that supports the needs of the local fishermen and promotes sustainable practices.

Figure 224 : Masterplanning phase 01: Renovation of Villa Pesqeura, Designed by Valentine Kalei



The second phase of the masterplan proposes converting the underutilized dry dock site into a vibrant public market. The design includes vendor spaces, open spaces for community gathering and circulation, and seating areas to enjoy waterfront views. The site is fully pedestrianized, and a parking area is designated for Villa Pesquera.

Figure 225 : Masterplanning phase 02; Public market, Designed by Valentine Kalei



The third phase of the masterplan involves redesigning the waterfront area to expand the ecosystem and connect the foot bridges to the promenade for accessibility. The design includes cutting into the land to create more space for the ecosystem, benefiting existing areas like the hatchery.

Figure 226 : Masterplanning phase 03, Designed by Valentine Kalei



Figure 227 : Relaxation area within the dry dock site

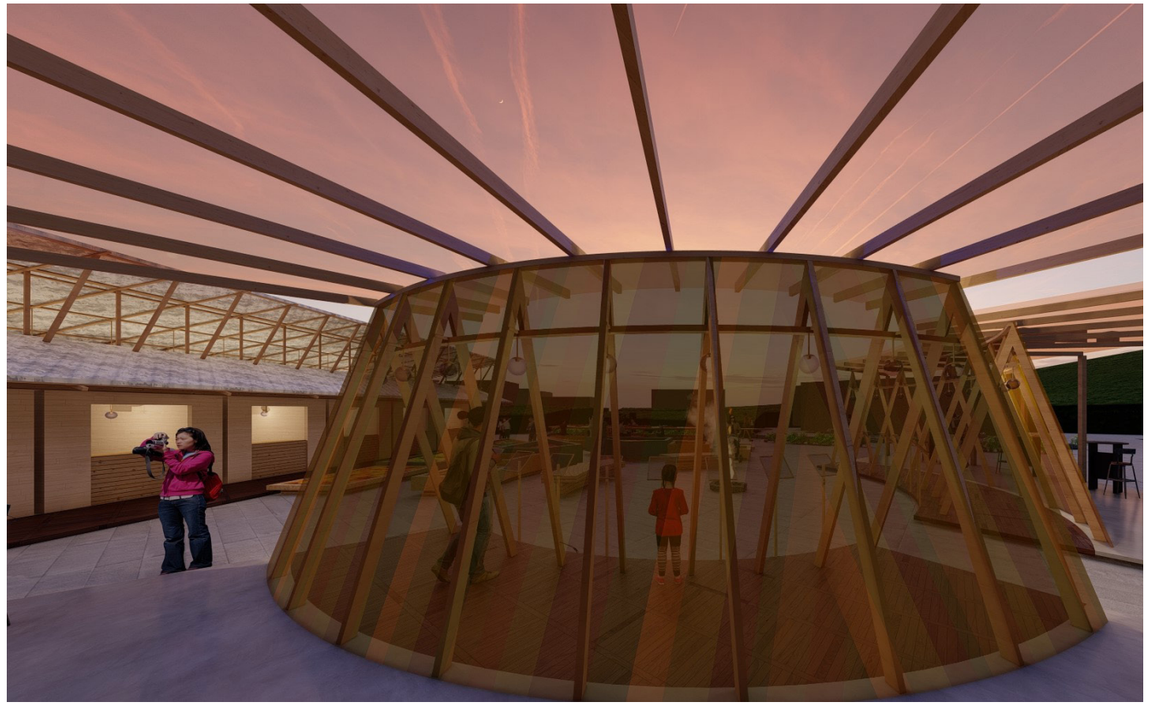


Figure 228 : Public market on the dry dock site

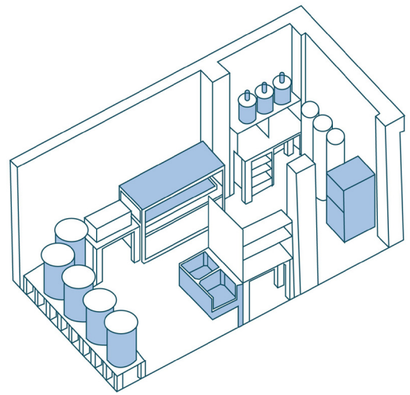
Food Toolkit

Objective #2: Activation of the dock into a public market]

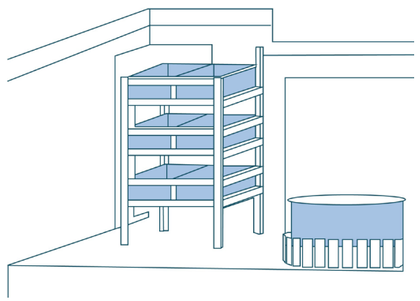


Figure 229 : Renovated Villa Pesquera with a hatchery expansion
Designed and visualized by Teonna Cooksey

This project aims to tackle the issue of heavy reliance on imported food in Culebra by introducing a food toolkit that promotes sustainable local food production. The toolkit advocates for aquaculture systems to be incorporated into the sustainable food production system to avoid further depletion of the local ecosystem. The project highlights that fishing has been a significant part of the Caribbean community, particularly in Puerto Rico, but overfishing has led to a decline in fish populations. To address this, the Culebra Fishers Association was founded in 1967, and they recommended the creation of small no-take fishery reserves to help restore depleted fish populations in the area. The proposed aquaculture systems aim to provide a solution that supports fishing activities in a sustainable way, preserving the natural resources for future generations. The first system of aquaculture is the hatchery system which is already an objective of the Villa Pesquera renovation, community initiative. Though small scale in nature, the system will be used to artificially breed fish and other aquatic organisms. The system provides a controlled environment for fish eggs to hatch, larvae to grow and fingerlings to be raised until they are ready to be released into the wild or used for stocking fish in bodies of water. The second aquaculture system is wasterwater aquaculture, a model adapted from a community in India, known as bheri aquaculture. This system involves several steps. The first step is to prepare the ponds by draining and drying the pond beds. The second step is primary fertilization where waste water enters the ponds and is left to settle for 20 days. meanwhile lime is added to the water to control the PH of the bottom soil. The ponds are then stocked with fish followed by secondary fertilization, as pre-treated waste water continues to be fed into the ponds at regular intervals. An ongoing stocking and harvesting of fish occurs periodically. A separate nursery system exists within the wetlands for the rearing of fish stock, LoTek - Kolkata, India (2017). This system is viable because waste water currently flows into the Villa Pesquera site.



Hatchery



Nursery

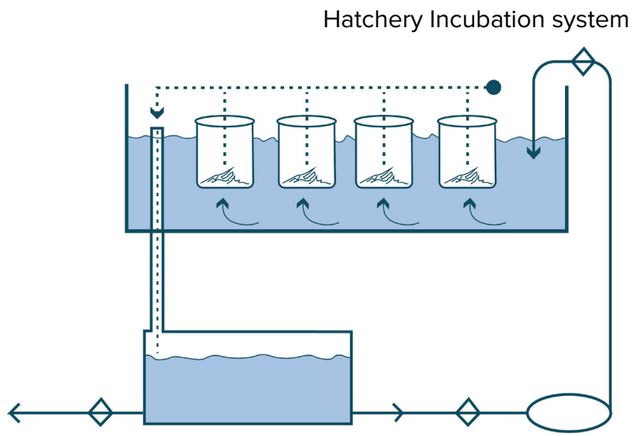


Figure 230 : Proposed hatchery system at Villa Pesquera

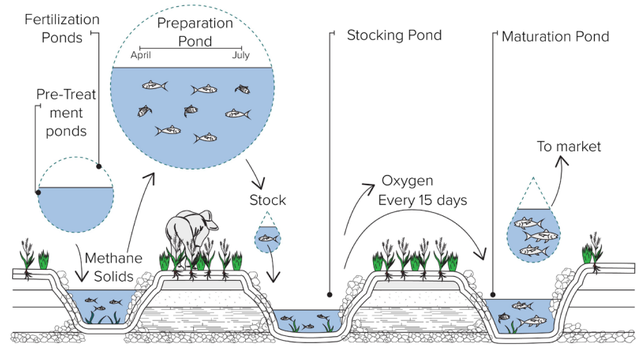
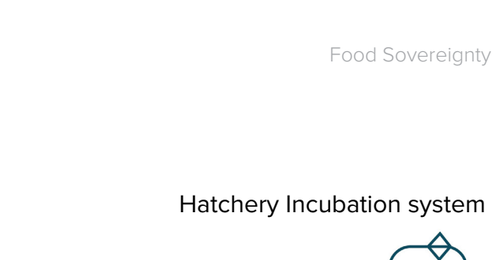
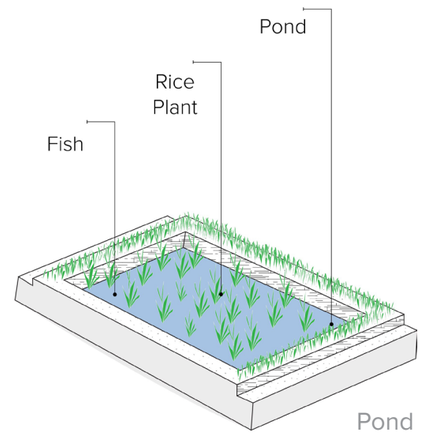


Figure 231 : Proposed wasterwater aquaculture
Visualized by Teonna Cooksey



Ponds; Wetlands



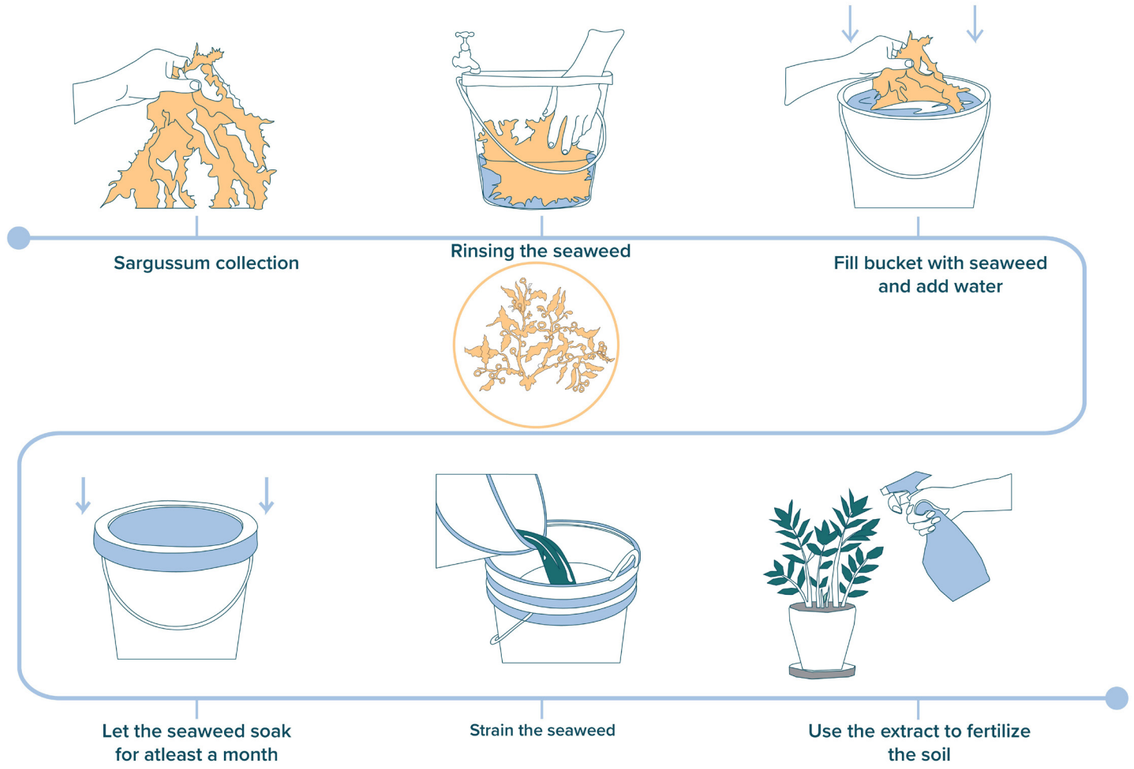


Figure 232 : Diagramatical representation of the use of sargussum for soil fertilization
Visualized by Valentine Kalei



Figure 233 : Public Market
Visualized by Teonna Cooksey



Figure 234 : Public Market
Visualized by Teonna Cooksey

The food kit also advocates for sustainable ways of growing crops. The environmental conditions in Culebra limit extensive agricultural production. For instance, Culebra soils are formed in moderately fine-textured to fine residual material derived from basic volcanic rocks. These soils are shallow, well-drained, and strongly sloping to very steep. The soils of this association are used for pasture. They have severe limitations for farming, recreation, and urban uses because they are shallow to bedrock, lack sufficient moisture, are steep, and are susceptible to erosion. The water resources of the island are limited due to the island's small land mass, meager rainfall, and high evapotranspiration rates, in addition to the limited Ground-water resources. Currently the demand for freshwater on the island is met by a pipeline from the main island – Puerto Rico. Despite this, crop production is possible, even though small scale in nature. This food kit informs on how sargassum can be used to fertilize the soil and produce fresh food. Despite the meager rainfall, residents, specifically, Benjamin, collect rain water when it rains and use it to facilitate small scale crop production.

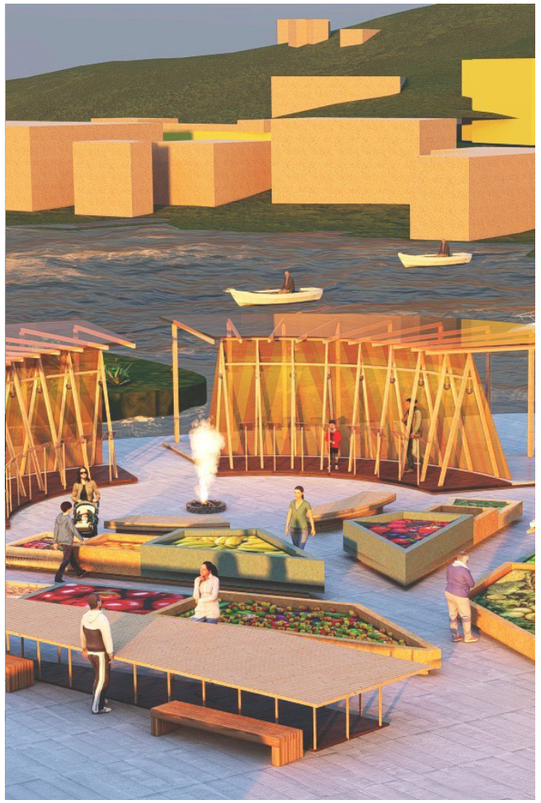


Figure 235 : Public Market
Visualized by Teonna Cooksey

Funding Sources

The funding sources for Villa Pesquera are federal, state, municipal and community-based. At the moment, Culebra's fishers association has applied for grants from the United States Department of Agriculture (USDA) and National Oceanic and Atmospheric Administration (N0AA). The association has also received three philanthropic awards. As for other government mechanisms, there are low-interest loans by both the USDA and Department of Agriculture, Puerto Rico, however, these are not considered favorable. Disaster insurance for fishing activities does not exist in Puerto Rico and Culebra. However, there will be standard public liability and equipment damages insurance. The amount of funding varying. For instance, the association has been able to get grants amounting to $24,000, $55,000 and $85,000. In addition the association has applied for grants, as mentioned earlier, amounting to $250,000 and $500,000 from the United States Department of Agriculture (USDA) and National Oceanic and Atmospheric Administration (N0AA). There are also other non-governmental organizations, such as the Open Society Foundation which supports young Puerto Rican leaders working to elevate climate justice and food sovereignty, promote human rights, and decolonization efforts in Puerto Rico. In 2023, the organization recognized eight recipients from all over the island focusing on a wide range of issues. Among the fellows' projects include, teaching young people about food sovereignty, community farming, archival initiatives aimed at documenting the histories of the archipelago, strengthening support for trans and nonbinary people, and an art project around menstrual and HIV awareness. Nicolás X. Gómez Andújar, the head of facilitating renovation of Villa Pesquera, is part of the cohort recognized this year. He will facilitate the self-management of an inclusive, educational, and cooperative space through the Culebra Fishing Association to address the problems of the fisherfolk on the island. Lastly, the other form of funding is through subsidy in terms of building rent from the Municipality for the community services that the association through the Villa will provide.

United States Department of Agriculture



Figure 236: USDA Logo
Sourced from USDA website

National Oceanic and Atmospheric Administration



Figure 237: NOAA Logo
Sourced from NOAA website

Puerto Rico, Department of Agriculture



Figure 238: Puerto Rico government
logo. Sourced from PR, government

Open Society Foundation



Figure 239: Open Society Foundation
logo. Sourced from OSF website

Stakeholders

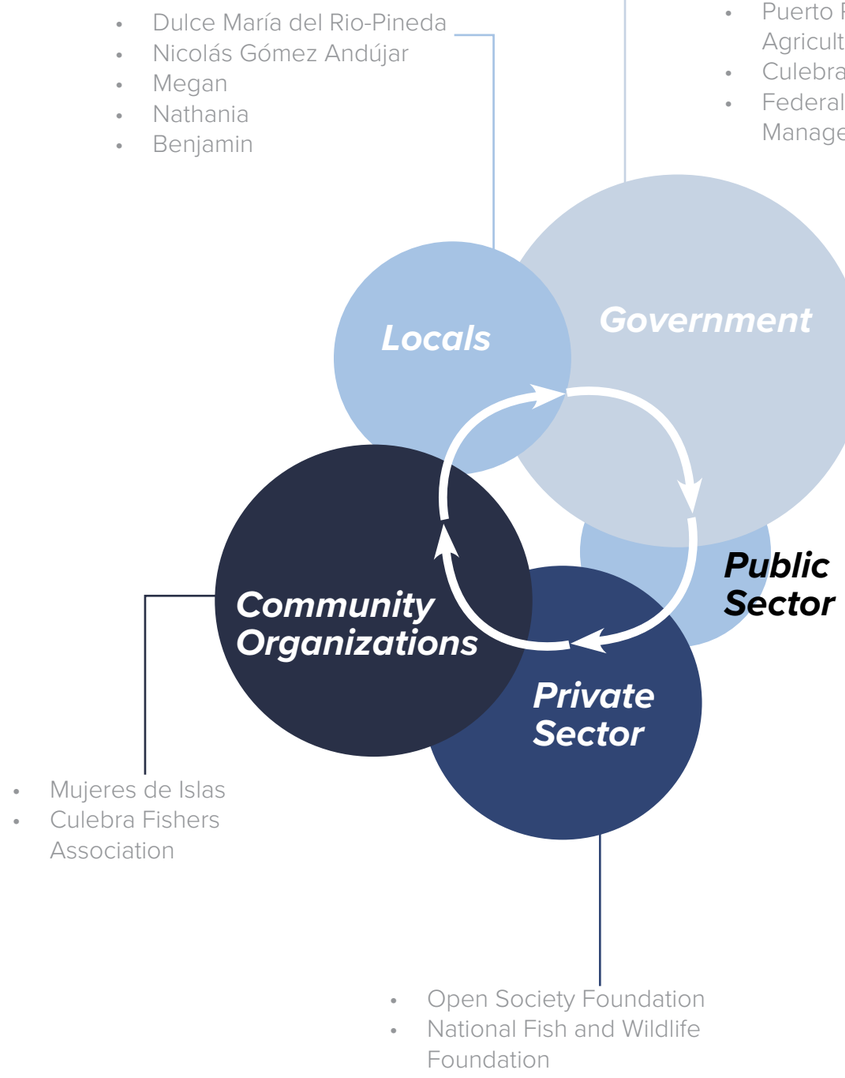


Figure 240: Stakeholder map of the Food sovereignty team's proposals.



Figure 241: Entrance to the public market, Visualized by Teonna

There are various stakeholders that are or have been involved in addressing the issue of food insecurity in Culebra. To begin with, we have the government which includes the United States Department of Agriculture (USDA), a federal government agency responsible for developing and executing federal laws related to farming, forestry, and food, National Oceanic Atmospheric Administration (NOAA), a scientific agency within the United States Department of Commerce that focuses on monitoring the conditions of the ocean, atmosphere, and climate, as well as managing coastal and marine resources, Puerto Rico Department of Agriculture, Culebra's Municipality and the Federal Emergency Management Agency (FEMA), a government agency of the United States that is responsible for coordinating and responding to disasters and emergencies, through provision of financial assistance to individuals and families, supporting state and local emergency management agencies, and coordinating the delivery of resources such as food, water, and medical supplies. As mentioned these government entities are involved in supporting and funding the Island of Culebra in efforts to achieving food sovereignty. Another major stakeholder is the community organizations which include, Mujeres de Islas and Culebra Fishers Association. These organizations are involved in spearheading the production of local food in Culebra, via and agricultural educational system and renovation of a fishery, respectively. The locals, some of whom are part of the community organization also play a part in this proposal. Lastly, Private non-governmental organizations such Open society Foundation and the National Fish Wildlife Foundation take part in this proposal through the provision of funding to realize the projects.

Implementation Timeframe

Short-term Actions

Renovation of Villa Pesquera
This proposal suggests design interventions for Villa Pesquera to achieve food sovereignty, in response to the ongoing efforts of the local community in Culebra.

Seawater fishing
As a short term action, fish for Villa Pesquera will be sourced mainly from the sea, with alternative systems to be developed later to prevent depletion of the ecosystem.

Establishment of a hatchery
As a response to the ongoing community initiative, a small-scale hatchery system will be located in Villa Pesquera as an alternative to fishing from the sea.

Long-term Actions

Public market
The second aim of the proposed project is to redevelop the dry dock site into a market that supports the expanded fishery operations and promotes food self-sufficiency in Culebra.

Hatchery expansion
One long-term goal is to increase fish production sustainably without harming the natural resources, and this will be achieved through the expansion of the hatchery.

Wastewater aquaculture
A sustainable fish production solution in response to the existing waste water flow on site is the long-term a wastewater aquaculture system.

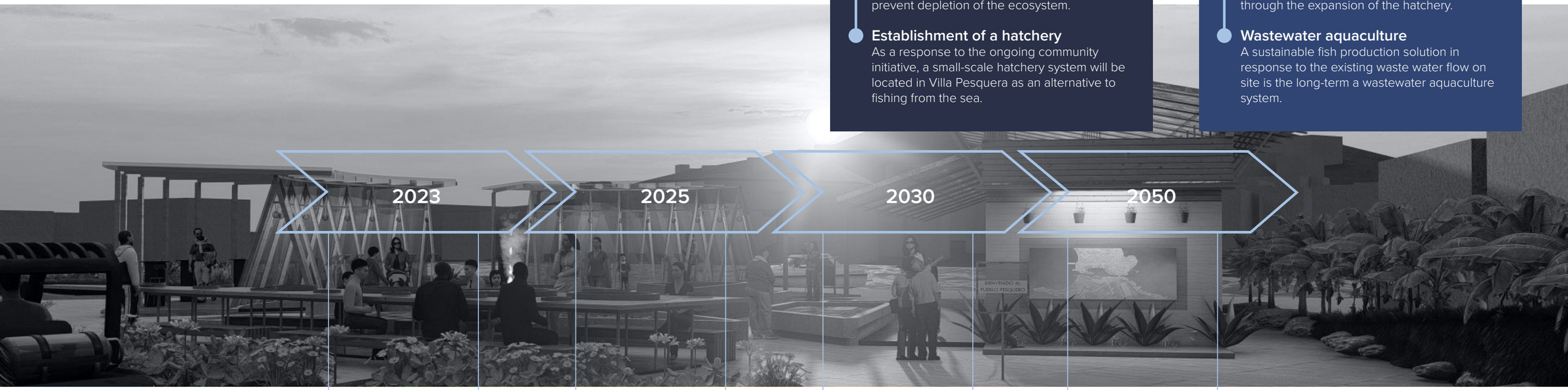
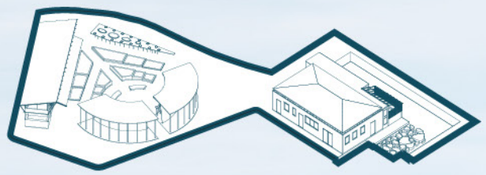


Figure 242: Render of the food market.
Figure 243: Implementation timeline for the food proposals.

Outcomes

Figure 244: Diagram outlining outcomes achieved by the Food proposals.



Food

-Pesquera (fishery) Renovation/Market

-Dock Masterplan & Food Tool kit



Outcomes

Outcome01-A
Promote career training opportunities

Outcome01-B
Foster culturally appropriate spaces

Outcome02-A
Increase knowledge of sustainable forms of living

Outcome02-B
Disaster-resilient systems

Outcome03-A
Increase the affordability of resources

Outcome03-B
Reclaim territories

Outcome04-A
Push policy mechanisms

Outcome04-B
Community-led initiatives

Conclusion

Project Prioritization

04

This studio worked with Mujeres de Islas and the community of Culebra to develop proposals and tools that support the needs and ideas of the Culebrenses. The Culebrenses have shown resilience throughout their history, and the proposals prioritize strengthening technical skills and promoting intergenerational knowledge sharing, as well as increasing local climate preparedness, to help them achieve a better future. The interdisciplinary studio's proposals are a combination of design and planning tools that support Mujeres de Islas' ongoing initiatives and pillars for a sustainable and resilient Culebra.



Figure 245: View from the dock at Dewey. Photo taken by Ubaldo Escalante



Figure 246: Mangroves in Culebra. Photo taken by Ubaldo Escalante



Figure 247: Community garden at SEVA facilities. Photo taken by Ubaldo Escalante

Project Prioritization

	Memory	Coastal Resilience	Housing	Energy	Food
Memory		• Damage to beaches • Unexploded mines • History of hurricanes • Craters on the beaches • Navy pushed people to build houses in the mangroves • Tourism • Opportunity for education • Physical damage of the past (restoration) • Privatization	• Land tenure • Housing informality • Displacement from marine occupation • Planning of San Ildefonso • Construction methods and how they can be implemented in a sustainable way • Historical events impact construction techniques • Memory and identity is built in housing	• Connection between hurricanes and blackouts • History of island electrification and impacts on the dependence on the mainland for energy • Displacement affected infrastructure • Programs to understand how people lived and how that affects energy consumption • Cradle of the Borincano sun	• Colonnial legacy of locals being taught not to grow their own food or eat locally-grown foods • Island-wide history of fishing for self-sufficiency • Reclaiming the narrative around food • Impacts of the Jones Act • Loss of fishining as food substance and generational knowledge
Coastal Resilience			• Privatization • Illegal categorical exclusion • Development (runoff, illegal construction, illegal construction methods) • Doral reef damage due to development • Opportunity for informing where development can occur and establishing criteria of where buildings can/cannot occur	• Sargassum for fuel • Renovation of fishermen's villa with solar panels • Solar power for aquaponics and energy-intensive infrastructure • Wave energy for aquaponics/hydroponics	• Erosion and runoff also affects the resource of fishing/reef life • Docks and fishing (land privatization and collaboration for public good) • Oyster farming and nurseries
Housing				• Solar power in homes • Policies for regulating new construction to meet a certain level of sustainability and to have solar panels • Toolkit to help people understand what appliances are more energy-efficient • Climate preparedness and making houses resilient to hurricanes • EDF funding ~45 housing projects to have solar panels	• Toolkit for farming and gardening at home • Having communal spaces for food production • Policies that provide communal land outside of homes for agriculture • Collecting food waste for compost
Energy					• Food waste for energy • Community-owned microgrid approach of not just putting solar panels on homes but also in communal spaces that can also house farming • SEVA's community kitchen powered by solar power • Regulation on what appliances to add to kitchens in homes for energy-efficiency
Food					

Figure 248: Overlapping areas between the five research areas.

This studio acknowledges all the support and guidance from Mujeres de Islas and the community of Culebra. Their input and knowledge was crucial for the development of each one of the proposals. And, as stated before, our approach was designed in collaboration with them, and has resulted in proposals and tools that will support the Culebrenses' needs and ideas.

It is also important to remark that the Culebrenses have always been resilient and our hope is that this report further reinforces their strength and perseverance. The Culebrenses, the proud inhabitants of the beautiful island of Culebra, have demonstrated unwavering resilience throughout their history, facing numerous challenges with determination. Despite the adversities they have encountered, their indomitable spirit has remained unbroken, serving as a beacon of hope for their community and beyond.

As an interdisciplinary studio, the urban planning and architecture fields have come together, further complementing their strengths. The proposals were the combination of a comprehensive approach of design and planning tools that will support Mujeres de Islas' ongoing initiatives and pillars for a sustainable and resilient Culebra.

Understanding Culebra's current conditions, this studio proposes the prioritization of two out of the four outcomes to help the Culebrenses achieve a better future:

- To strengthen technical skills and promote intergenerational knowledge sharing, because there's a wealth of knowledge and community assets on the island that pose themselves as opportunities for the rapid implementation of projects;
- And, to increase local climate preparedness, because it's a pressing need for the community given the increasing frequency and intensity of natural disasters.

Appendix

Travel Itinerary
Bibliography

05



Figure 249: Morning view from the dock. Photo taken by Claudia Kohn Avila.

Travel Itinerary

Day 1 | Sunday, March 5, 2023
Arrival to the island of Culebra

Day 2 | Monday, March 6, 2023
10:00 am - 12:00 pm: Site visit around the island, transportation will be available
12:00 pm - 1:00 pm: Lunch break- will be provided by Mujeres de Islas. Grounding in expectations and agenda walkthrough
1:00 pm - 3:00 pm: Visit Asociación Pesquera Nathania, Nicolás y Megan from Mujeres de Islas team accompanied the visit
3:00 pm - 5:00 pm: meeting with Mujeres de Islas at SEVA and facilities tour by Nathania followed by a Conversation with AmeriCorps Group
5:00 pm: end of the day

Day 3 | Tuesday, March 7, 2023
9:00 am - 12:00 pm: Group specific agenda:
Coastal Resilience: Meeting with Protectores de Cuencas and SAM Organization. The meeting will be accompanied by Megan and Alfredo Montañez.
Housing and Memory: Visit Valentina at her sister's house and tour her parcel accompanied by Nathania from Mujeres de Islas.
Energy: Phone call with Abimarie from Fundacion Comunitaria and tour of the solar power farm and ecological school accompanied by Ana, Abigail and Javier.
12:00 pm - 1:00 pm: Lunch break
1:00 pm - 3:00 pm: Visit PRIDCO warehouse followed by a visit to the Local Municipality where the group met Richard, Land Use Planning Office Director.
3:00 pm - 5:00 pm: Virtual meeting with Genesis from Centro para la Reconstruccion del Habitat.
5:00 pm: end of the day

Day 4 | Wednesday, March 8, 2023
9:00 am - 12:00 am: Meeting with Digna at a local shop followed by Benjamin's house visit and meeting where the studio met community activists Doris, Paulino and Benjamin.
12:00 pm - 1:00 pm: Lunch break
1:00 pm - 3:00 pm: Visit to Culebra's museum "El Polvorin".
3:00 pm - 5:00 pm: Reflection meeting with Dulce and Mujeres de Islas team
5:00 pm: end of the day

Day 5 | Thursday, March 9, 2023
9:00 am - 12:00 am: Individual working time
12:00 pm - 1:00 pm: Lunch break
1:00 pm - 5:00 pm: Pin up with Mujeres de Islas at SEVA Facilities
5:00 pm: Goodbye dinner with all the team

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