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Jiquilisco Bay Mangrove Restoration Center

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Cummings School of Architecture

Master of Archictecture
Spring ‘23

arch.641 Thesis Design Studio

Jiquilisco Bay
Mangrove Restoration Center
Puerto El Triunfo, Usulutan, El Salvador

arch.641 Graduate Thesis Design Studio

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Master of Architecture ‘23
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Spring 2023

Submitted in fullfillment for the requirements of the Master of Architecture Degree

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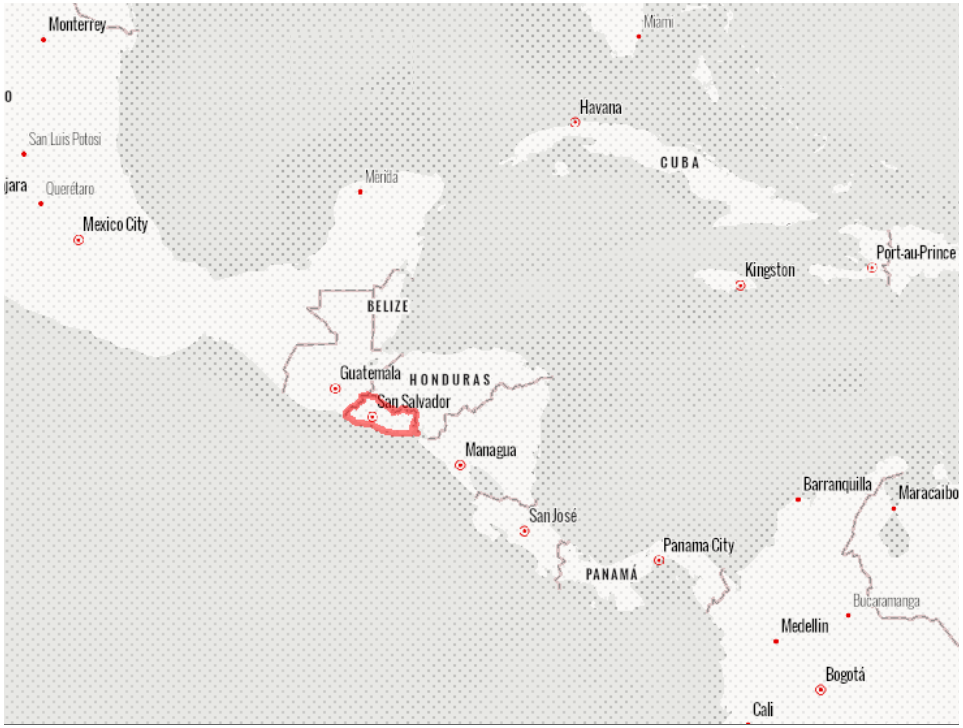
Jiquilisco Bay Mangrove Restoration Center

Table of Contents

Abstract

Due to advanced degradation of mangroves, local ecosystems and social structures suffer. Non-profit organizations, consisting of community volunteers and researchers from abroad, are on the forefront of these restoration practices. Protecting these forests prevents local families from starving and keeps their homes from flooding. Applying research-based thinking to create a lab and education space for better implementation of restoration policies on a site-by-site basis was crucial, and the result was a low-tech space with serious material considerations based on local construction and best practices based on improvements in relatively low-tech seismic and water impermeable technology. The result is a celebration of local material and methodology reinforced by the rigor and passion of the local people who are adamant on keeping their forests thriving. A holistic approach to the current, past, and present users of the site result in a community-oriented development that addresses as many intersections as possible.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Maracaibo
San José
Panama City
PANAMÁ
Bucaramanga
Medellin
Bogotá
Cali

Project Statement

Source: https://news.mongabay.com/2017/05/communities-band-together-to-protect-el-salvadors-last-mangroves/#:~:text=Black%20mangrove%20(Avicennia%20germinans)%2C,all%20grow%20in%20Jiquilisco%20Bay.

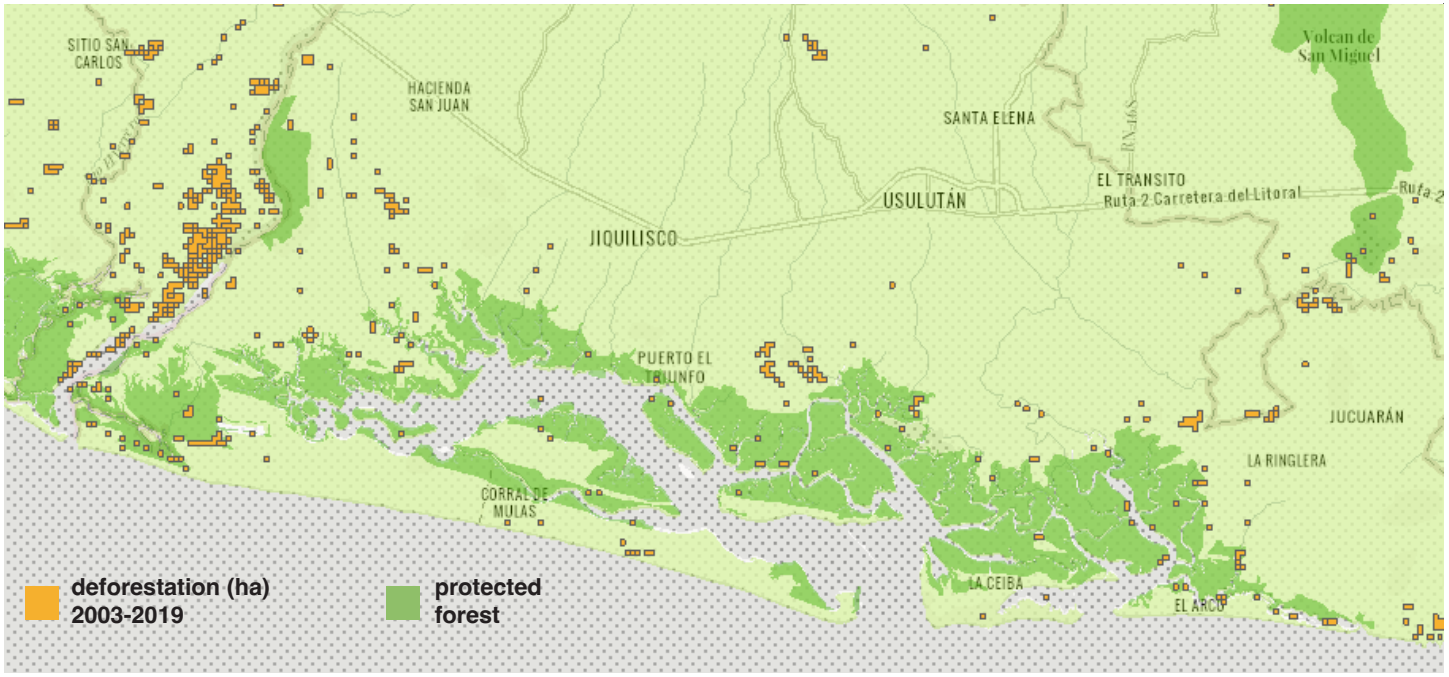
Sugarcane

Areas to explore can be material sourcing and research into world-wide indigenous and local building methods, energy sourcing, agricultural sourcing, waste management and recycling, and the adaptability to a hurricane-vulnerable site. All of these aspects have an architectural component, especially in organization of space for specific systems to function on a specific site. Enclosure can manifest itself in ways that can seem unfamiliar to many, but extremely traditional to others. It can be worth exploring the ways site and rain forest restoration can work hand in hand. An ecological relationship in the design process is crucial in developing ways of sourcing materials and spatial values in a smart manner. Removing the person from the control and ability to create their house on their own land with their own hands is also a major disservice to the community whose social priorities have always been of sustainable local means and general knowledge of things such as carpentry, brick-making, fishing and gardening. Coastal areas can benefit from adaptable models of community oriented housing and gathering spaces that enhance relationships with nature and the traditional building methods and life values. Various volunteer community groups and organizations have sprung up all over the world defending and restoring ecosystems at great physical and personal expense despite many local

El Lloron

geo-political issues. These groups are at the forefront of environmental degradation from erosion and deforestation, using indigenous knowledge of forest growth while partnering with worldwide experts to grow and create new forest growth. Spaces where these groups can gather resources and commune and live for periods of time would be an essential element to a continuous, uninterrupted progression in rain forest growth. A commune that centers on ecological values can act as an educational space to showcase local building knowledge.

Problem Statement



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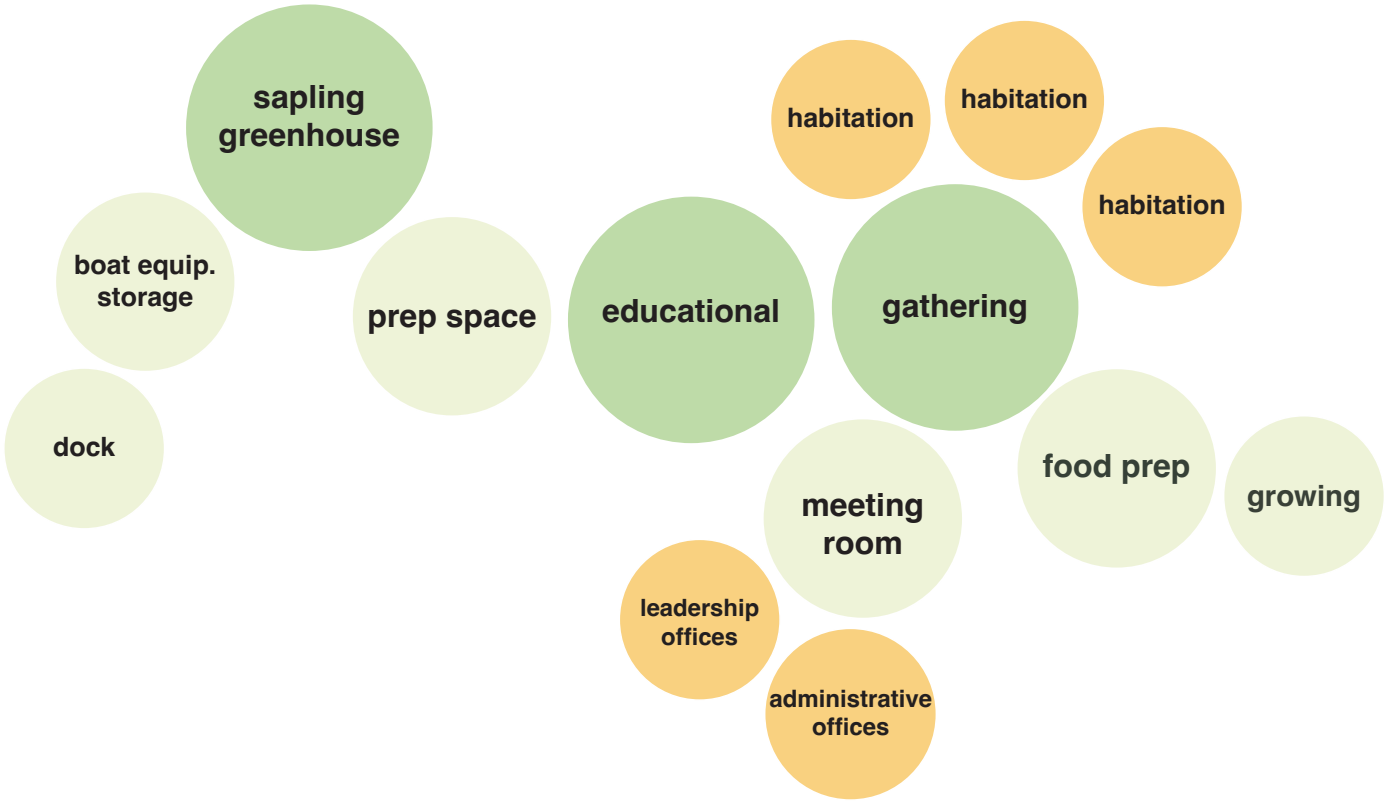
Jiquilisco Bay (Source: Esri)

Rain forest loss is a problem facing the world as a whole. These forests act as massive carbon sinks and provide the world with constant conversion of carbon dioxide into oxygen. Rain forests and mangroves also house countless organisms and ecosystems that are the foundation to the food sources of many rural communities all over the global south. There are forests that have shrunk at an unprecedented rate due to wood harvesting, farmland creation, or urbanization. Natural factors such as increasing storm intensity, erosion, and frequent flooding are proving too much for man-made barriers to withstand. The pursuit of housing and employment doesn't have to come at the cost of the rain forest or the breakdown of local traditional values. There are ways natural systems work that humanity interrupts with industrial, urban and agricultural activity, but with re-evaluating this relationship, we can learn to adapt our use of resources to work with ecological systems. Developing nations have poor populations at the mercy of what the government mandates to be housing and enclosure, which normally is expensive for most rural communities to implement. Reintegrating environmental stewardship into the housing model while enhancing traditional values can help create a new housing type for regions that are suffering from degradation.

Program Outline



Integration of ecological thinking and sustainable practices has been formed in vernacular thinking over centuries, in every culture. The creation of these places also encompassed the sourcing of locally available and abundant materials. Rain forests are shrinking all over the underdeveloped world while their governments keep promoting damaging building practices. Environmental volunteers, like the Asociación de Manglares comprising 80 communities, defend the mangrove forest in the Bajo Río Lempa Delta Region of El Salvador. They are community members that integrate restoration in their daily traditional community routines. Interrupted by violence, they can go long stretches without working due to fear. A location that groups like these can call home and where communities can gather to store materials needed, and even be housed, is something worth looking into. The commune can integrate models of self-sustaining lifestyles using indigenous and world-wide strategies which can double as models for the surrounding communities.

Area Allocations

Program:

- **Administrative Personnel -**
  - President of Directive
  - Executive Director
  - Agroecologic Project Coordinator
  - Agroecologic Specialist
  - Youth Program Coordinator
  - Kenoli Foundation Coordinator

  10’x10’ offices: 6
  30’x20’ meeting room / lobby: 1
  30’x50’ educational space: 1
  Total Area: 2760 sq ft.

- **Agro-Ecologic -**
  - 1 Coordinator
  - 1 Specialist
  - 30 max. Volunteers

  10’x30’ food greenhouses: 2
  20’x60’ sapling greenhouse: 2
  10’x20’ prep space: 1
  30’60’ boating equip storage: 1
  15’x15’ amphibious fishing platforms: 2
  20’x20’ amphibious sapling transport platforms: 3
  Total Area: 5570 sq ft.

- **Habitation -**
  - 4 Non-executive Staff Members
    - Food Prep
    - Gathering Space

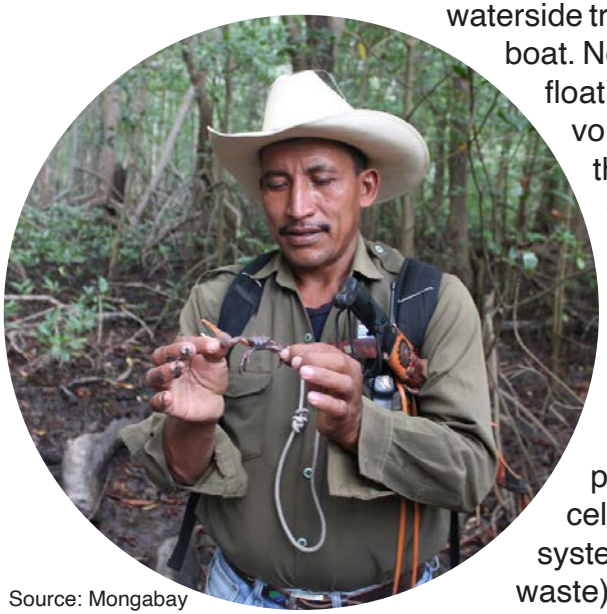
  15’x15’ habitations: 4
  15’x10’ communal food prep space:1
  30’x30’ central covered gathering space: 1
  Total Area: 1950 sq ft

Total Built Area: 10,280 sq ft.

Interrelationships

The central space could be a large covered gathering space that emulates the local 'town center' typology of local Salvadoran towns. These spaces are traditionally used for weddings, town meetings, or market space, but more importantly as a central hub and way-finding device. Other larger spaces would be a space where mangrove and other sapling species would be grown and then stored and prepared for planting, suitable for volunteer and waterside transport of material by boat. Near the dock would be floating platforms where volunteers can traverse the ricers to fish, install crab populations or plant saplings in a mode of transit alternative to a motor boat. Another separate space on land would grow local produce, prepared and cooked to feed the population of the group for short term planting periods, hosting celebrations, as well for emergency long-term stay. Outdoor systems to integrate waste management (for organic and human waste) would need service space and a few volunteers to manage as well as energy production depending on the source, which brings us to the housing aspect of the commune. The model of housing and work space coexistence would be derived from study of vernacular methods from Central America and other global tropics, integrating an ideal layout for volunteers and their families. The number of volunteers would vary, and Asociacion Mangle is known for hosting large celebrations where gatherings occur under traditional gazebos in a central plaza. How the program falls on the site must be derived from the actions of the inhabitant. Waterway, car and bus access assures the facility welcomes any community member.

Puerto El Triunfo
Source: Google Earth



Source: Mongabay

Source: Mongabay

Client / Users

https://asociacionmangle.org/medio-ambiente/

Jiquilisco Bay, El Salvador. The small nation has lost 50% of its mangrove forests, the most impacted is the largest forest in the Bajo Lempa Delta. These areas have been home to many hundreds of communities which depend on the diverse ecosystem for seafood and the green buffer for hurricane flood protection for hundreds of years. Members of the Asociacíon de Manglares are concerned citizens that are impacted emotionally and financially by this loss in biodiversity and organize extensive mangrove restoration projects all over the region. The community comes together to trench artificial fresh water flows and plant saplings to restore biodiversity that was interrupted by agriculture or erosion. A location between the communities near the delta coast is chosen to set up the restoration center, focusing on growing and planting saplings, restoring local disturbed shellfish populations, and restoring fresh water flows. The center can house many volunteers overnight if they pack supplies, and they can plant for weeks on end while making a living.

https://mangroveactionproject.org/
demonstraciones-cbemr/

The center can be laid out like a small town. The road leads up to the central covered area where there are gatherings and deliveries of saplings. Volunteers split into groups, headed for the gardens, or the composting house, the waste management, sapling growing house, restoration platforms, or the housing units for the volunteers staying overnight. Being tasked with mangrove planting, the planter would head to the grow and storage houses to help load the saplings onto the large square platforms floating near the dock. The covered platforms are for fishing, and the wider flat ones serve to lay saplings out easier on all four sides. Once loaded, the platforms get rowed down the streams to a bare mud pit in the edge of the mangrove forest. The volunteers jump off the platform and trudge it through the mud into the suitable spot for planting. Then planting begins. Motorboats and other platforms come to transport lunches and people back and forth, while covered ones can be seen closer to the ocean boundary harvesting shellfish and casting fishing lines. Coming back to gather with the rest of the groups at the end of the day and be able to smell the cooking seafood and other food grown on site would be the traditional integration part of this type of program to the local heritage.

Themes / Intentions

Puerto El Triunfo - Source: Google Earth

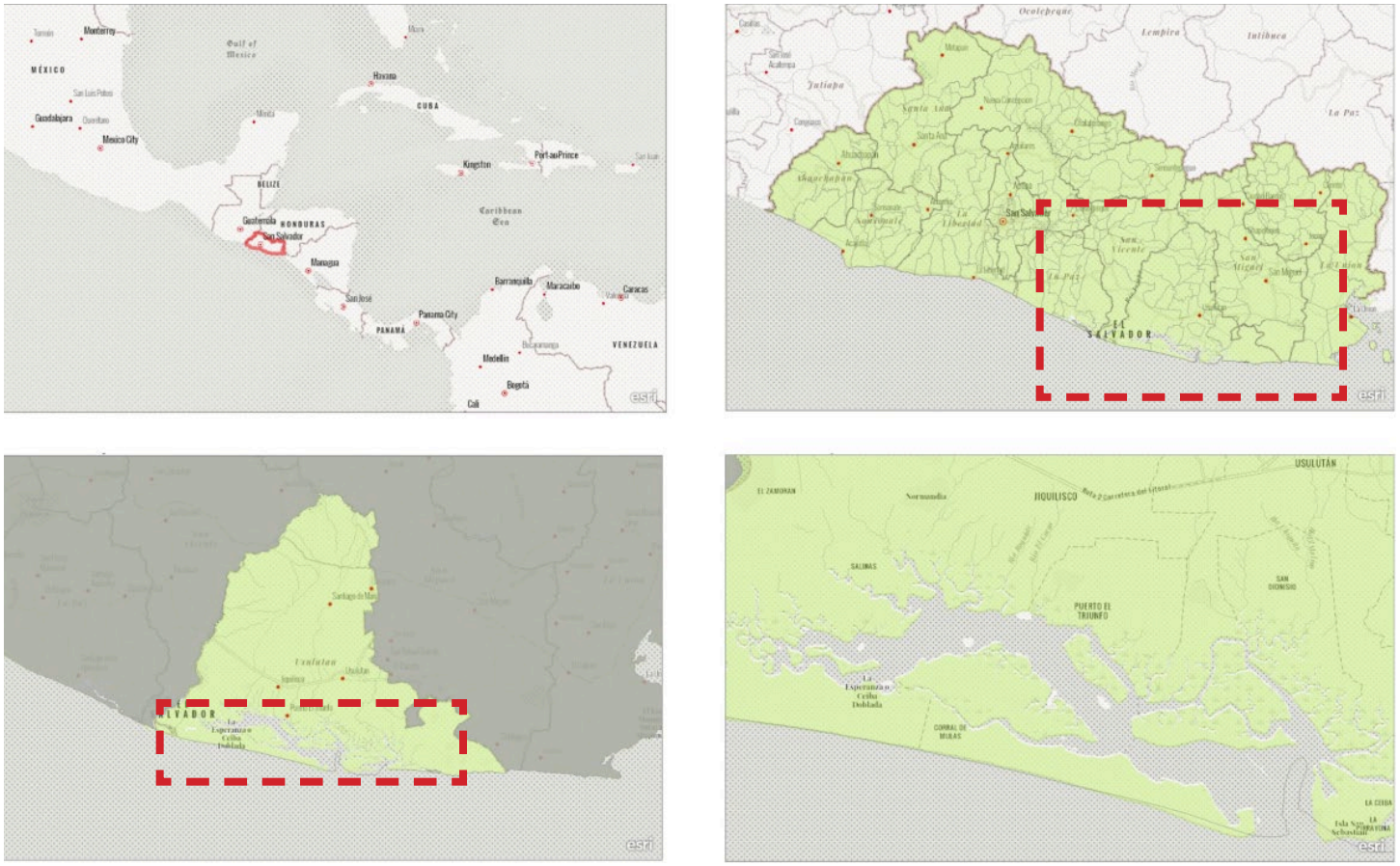
Many fled the Jiquilisco Bay area to avoid war, violence, and extreme poverty. The displacement of Salvadorans from this area would understandably leave behind trauma and sadness but many of these migrants moved to neighboring Central American nations. El Salvador, being such a small nation, has collectively felt the loss of so many, so much so that a monument was erected in San Salvador called 'Hermano Lejano' or 'Distant Brother.' As the war ended and neo-liberal globalized economies rapidly grew, so did Salvadoran industries in commerce, agriculture and manufacturing[1]. As refugees returned home to El Salvador, the country was indeed not at war, but was still suffering from gang threats, violence, and poverty. Paid low wages under harsh conditions, not unlike what it was like before the war, many Salvadorans still found it better to make a life in another country, like the United States. Some, like the countless volunteers that aid Jiquilisco Bay's Asociacion Mangle, have decided to stop fleeing, organize, and make the best of their ancestral lands. The population is incredibly proud of their land and the Asociacion Mangle websites include extensive documentation their mission and vision. This group truly brings self sufficiency to the forefront of the conversation. The public actively engages in this dialogue because they recognize the degradation of their land is the erasure of their culture.

[1] Andries, Delia M., Cecilia Arnaiz-Schmitz, Pablo Díaz-Rodríguez, Cristina Herrero-Jáuregui, and María F. Schmitz. 2021. "Sustainable Tourism and Natural Protected Areas: Exploring Local Population Perceptions in a Post-Conflict Scenario" Land 10, no. 3: 331. https://doi.org/10.3390/land10030331

El Salvador houses ruins of various Indigenous groups, including Mayan stone temples embedded into the earth. Central American is home to various techniques of traditional building methods, tried through generations of use, that can provide insight into less resource-intensive building practices. Like many nations in the tropics, El Salvador has historically been a large sugar cane exporter, which is a huge economic crop, but all too often are deplorable conditions present on plantations. While human rights groups fight to address labor injustice, agronomic waste from various plantation industries are also being looked further into. According to studies, integration of sugarcane waste fiber into traditional mud and adobe brick not only uses agro waste, but adds tensile stability[2]. Strategies that use cyclic-thinking and addresses lifetime uses of differing materials not only increases recycling and empties landfills of carbon waste, but increases availability of cheap construction material. While El Salvador has seen incredible economic development since its Civil War, there is community responding to rural deforestation and degradation that hopes to enhance clean living practices, self sufficiency, and avoids the destruction of their way of life. The built shouldn't contribute to these overarching issues while attempting to address it, and it is the community who can teach the builder that.

[2] Bock-Hyeng, Christian, Andrea N. Ofori-Boadu, Emmanuel Yamb-Bell, and Musibau A. Shofoluwe. "Mechanical properties of sustainable adobe bricks stabilized with recycled sugarcane fiber waste." International Journal of Engineering Research and Application 6, no. 9 (2016): 50-59.

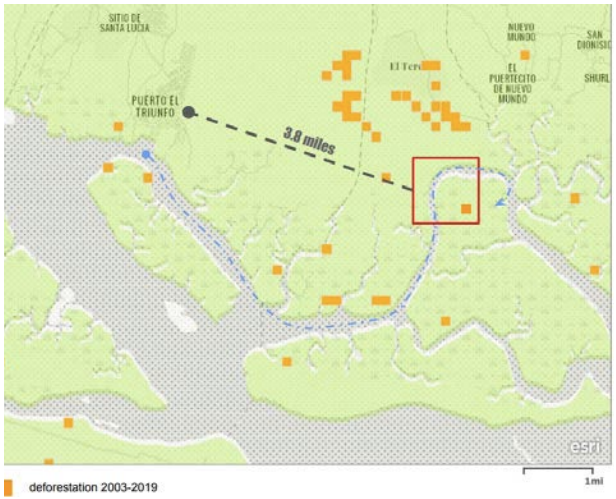
Context



Source: Esri

El Salvador is located on the Pacific coast of Central America and is home to a large bio reserve in Jiquilisco Bay. The area is impacted by degradation in mangrove density which in turn intensifies water erosion and soil mineral depletion. Mangroves provide crucial shielding to this delicate marine ecosystem from the harshness of the open ocean. Community organizations all over the area organize to maintain rain forest growth and sustainable means of farming and harvesting seafood.

Sites that were considered are all primarily along the coastline of Jiquilisco Bay, territory known for being intensely involved dependent on the wellness of the local waterways and rain forest for food sources. The larger, denser cities of Jiquilisco and Usulutan are close to the coastal area and are connected by Panamerican highway systems. These sites offer a centralized and easily accessible location for coastal community members to commune.

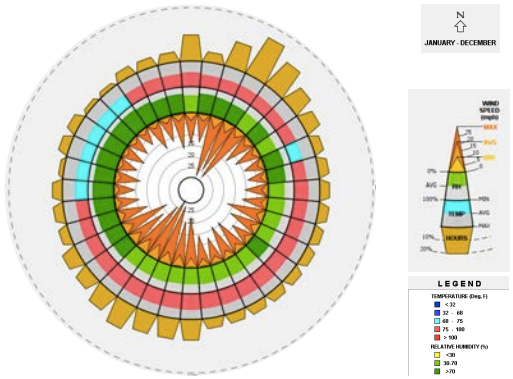


Source: Esri

Santa Catarina Island in Jiquilisco Bay houses a dried up, algae covered, shrimp farm, suggesting abandonment due to lack of shrimp cultivation, or the ban on farming on natural reserves. The scar on reserved natural land prompts questions about restorative efforts that could take place here, such as what program is necessary for Asociacion Mangle to effectively address deforestation in the immediate area. The adjacent riverbed on the Western side The proximity to Usulutan, Puerto El Triunfo, and Jiquilisco makes it a central coastal location for the communities of the bay area to gather and organize community restoration efforts. The proximity to the airstrip, docks, and tourist attraction provides opportunities for multi-modal transit using traditional boat/canoe and/or for heavy material shipments, the airstrip and roads can be used.

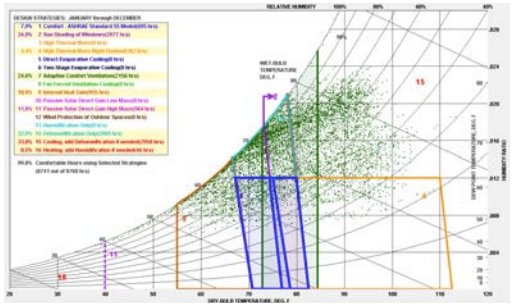
Climate

Numerical climate data was made into three types of charts by Climate Consultant© , the eastern part of El Salvador has on average more days with prevailing wind direction in the SW and NE directions. In this region, the average highs are in the upper 90's with night-time lows in the 70's January through May. June through December sees daily highs range from lower 90's to mid 80's with night-time lows staying in the 70's. Humidity levels exceed comfort zone limits on average between June and November. This can inform the design of the building by suggesting an orientation that works with prevailing wind directions that better circulate air through the building on as many days of the year as possible. Temperature and humidity of the region require a careful treatment on air circulation but as well as envelope, enclosure, and materials. The psychrometric charts spreads the average yearly temperatures on a grid to strategize methods to address days with uncomfortable weather. One strategy Climate suggests covering windows, cooling 34% of hours analyzed as uncomfortable.

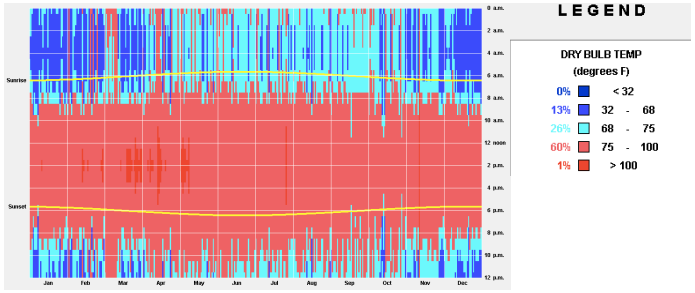


wind direction/intensity diagram

data from : san miguel - aeropuerto el papalon - climate consultant
long./lat. : 13.43 ° north, 88.12 ° west
elevation: 262 ft



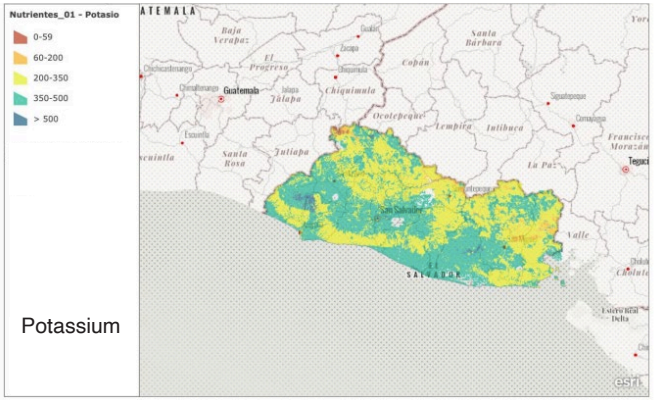
psychrometric chart and recommended passive strategies



temperature timetable plot (dry bulb temperature)

Maps

El Salvador, despite being about the size of Massachusetts, is still home to 12 volcanoes, various tropical biomes, rural nature preserves, as well as dense urban and suburban hardscapes. The southern Pacific Coast is the lowest area of the country, but according to the erosion map generated by ESRI with data from the General Directorate of Statistics and Census, Jiquilisco Bay experiences Low Risk erosion exposure, presumably due to the current mangrove cover. Despite this, the area remains at moderate threat of soil degradation, meaning the stripping of nutrients needed to sustain crops and native species. Treatment of storm water and retention of valuable nutrients at the local agricultural level could address this problem. The presence of nutrients for plant life such as phosphorous and potassium is especially rich in the Jiquilisco Bay Area throughout the extents of the rain forest area.



Potassium

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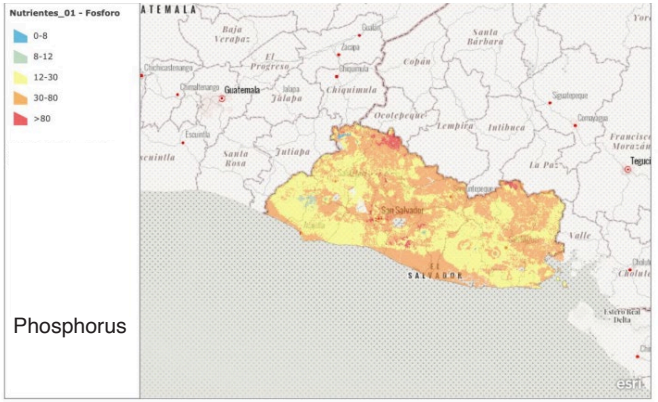

Phosphorus

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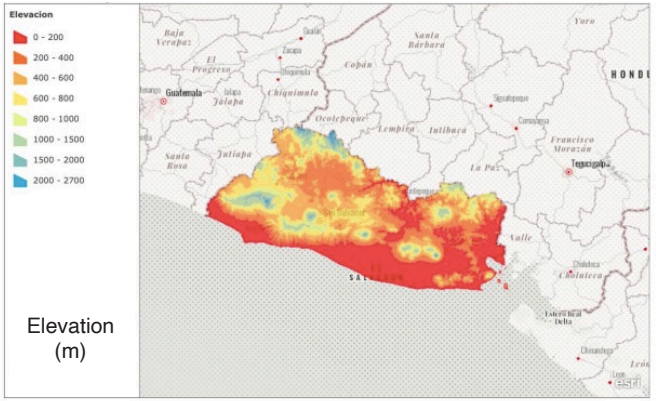

Elevation (m)

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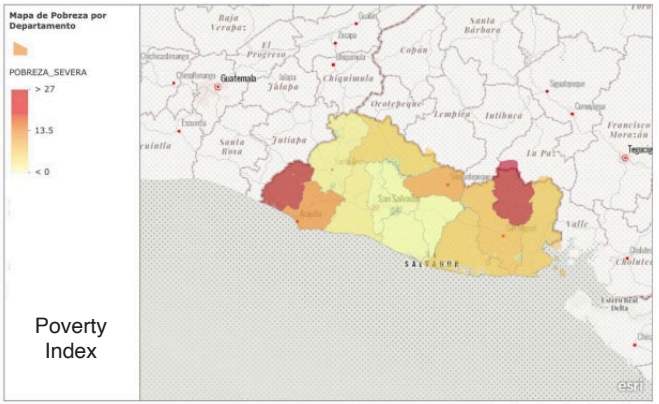

Poverty Index

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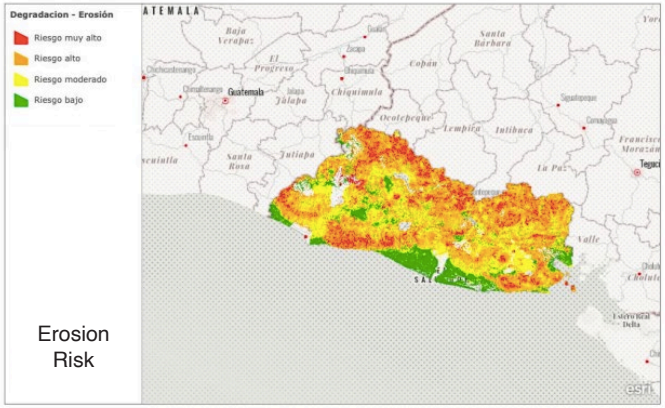

Erosion Risk

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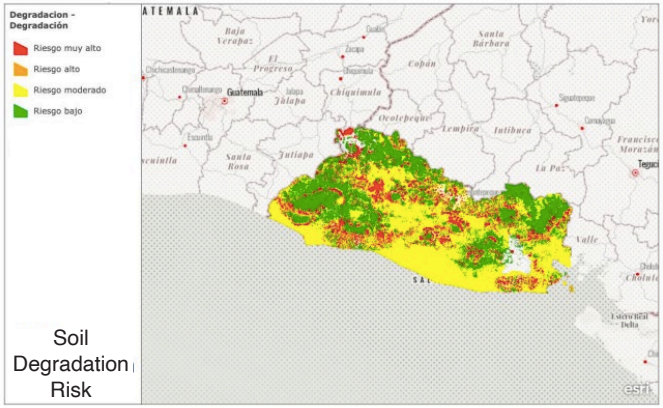

Soil Degradation Risk

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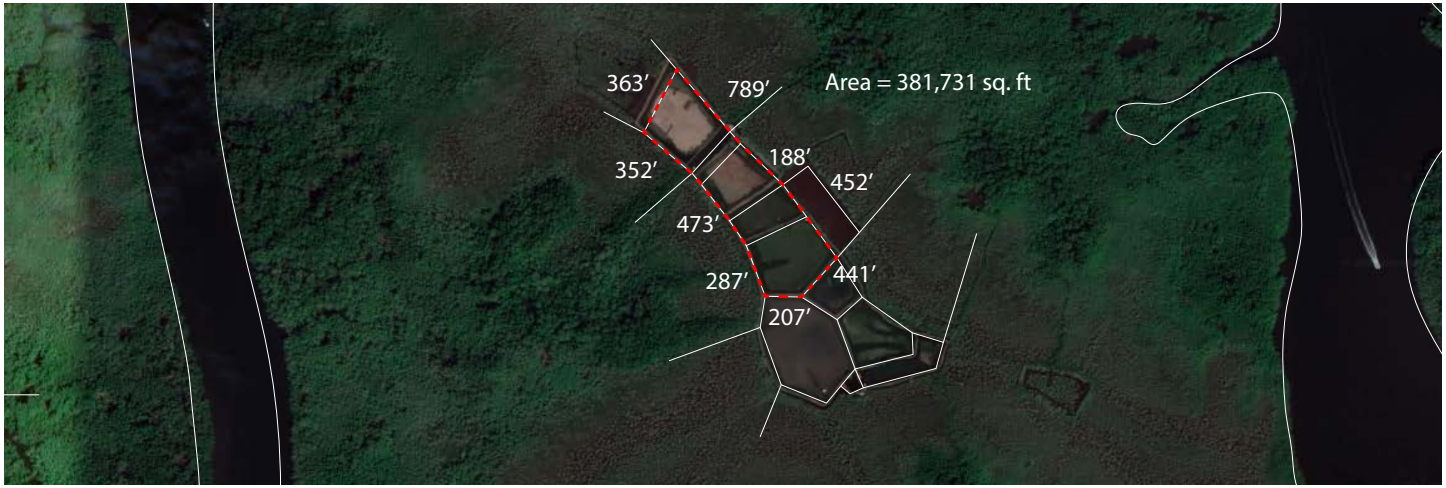
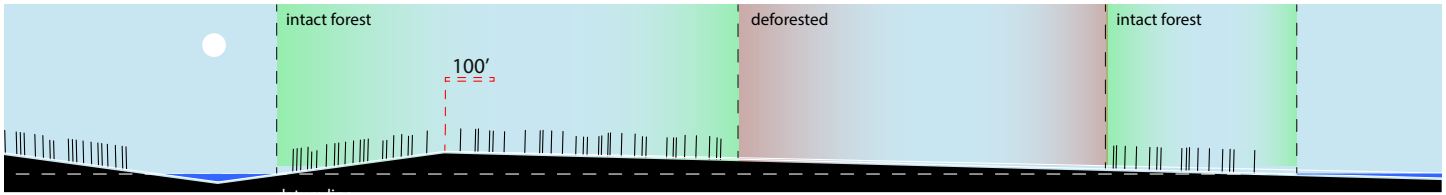
Sites

El Salvador is located on the Pacific coast of Central America and is home to a large bio-reserve in Jiquilisco Bay. The area is impacted by degradation in mangrove density which in turn intensifies water erosion and soil mineral depletion. Mangroves provide crucial shielding to this delicate marine ecosystem from the harshness of the open ocean. Community organizations all over the area organize to maintain rain forest growth and sustainable means of farming and harvesting seafood.

The sites considered are all along the coastline of Jiquilisco Bay, territory known for being transitional as a result of the many waterways. The main highway that connects the larger cities of Jiquilisco and Usulutan branches downward toward the coastal communities. These sites offer a centralized and easily accessible location for community members to commune.



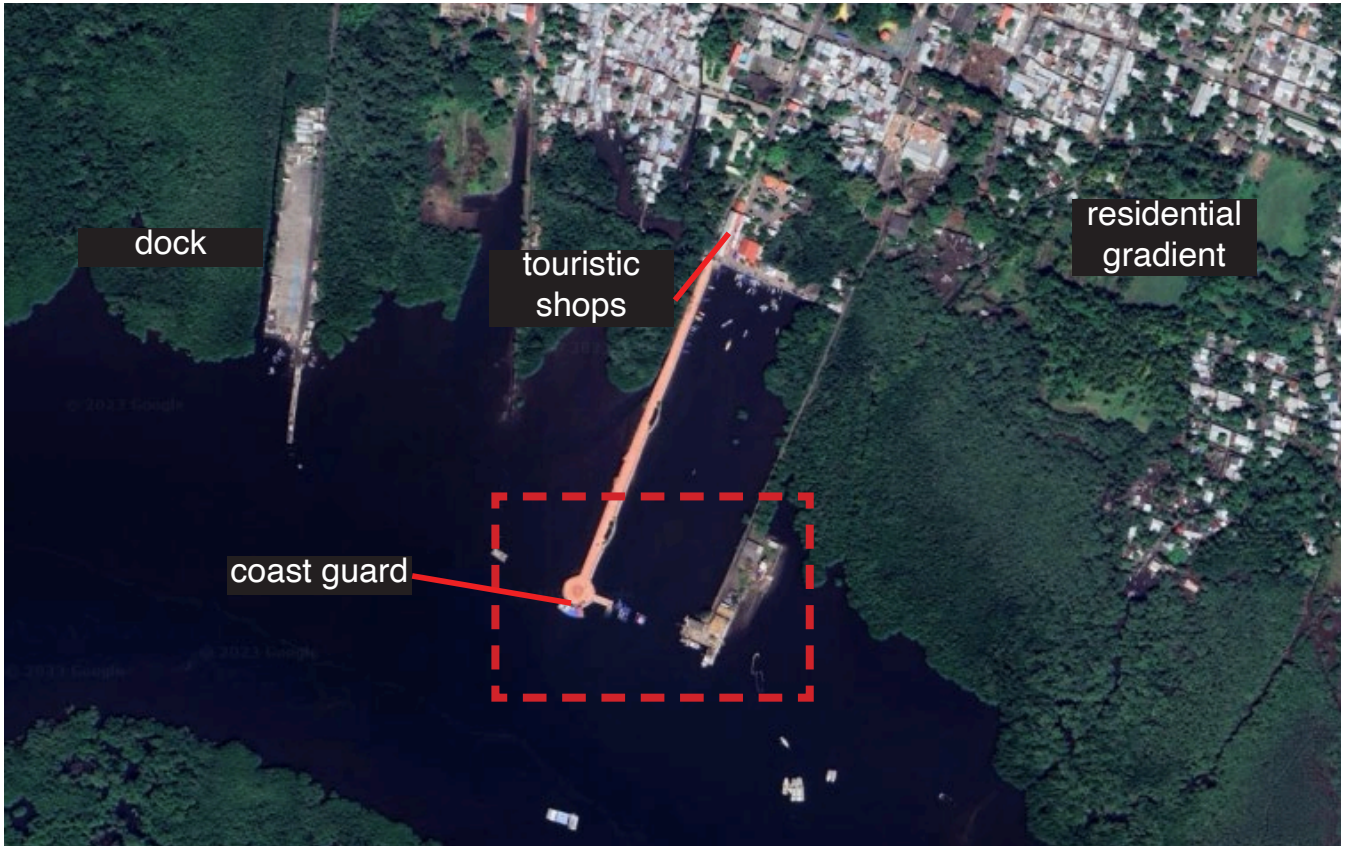


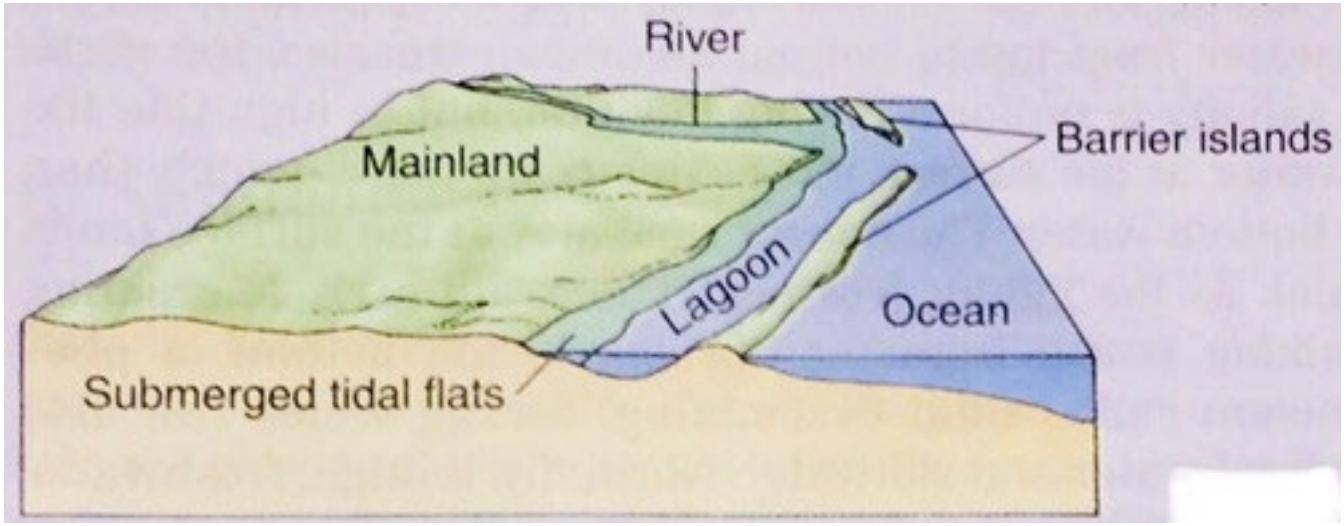
The site on Santa Catarina Island in Jiquilisco Bay houses a shrimp farm that seems to be eroding away, suggesting that it is abandoned due to lack of shrimp population, or the ban on farming on natural reserves. The scar on the land offers a unique footprint in the otherwise dense mangrove forest where the program can start to form. The proximity to Usulutan, Puerto El Triunfo, and Jiquilisco makes it a central coastal location for the communities of the bay area to gather and organize community restoration efforts. The proximity to the airstrip, docks, and tourist attraction provides opportunities for multi-modal transit using traditional boat/canoe and or for heavy duty transit for material, the airstrip can be used. Buildings nearby as well as other coastal examples use stilts to prevent water intrusion during storms. Water damage is a major problem for mud and adobe housing, this entices owners to build with more expensive water impermeable material like sheet metal. Although, inclusion of sugarcane waste material into mud brick has shown to increase durability while in contact with water[3].

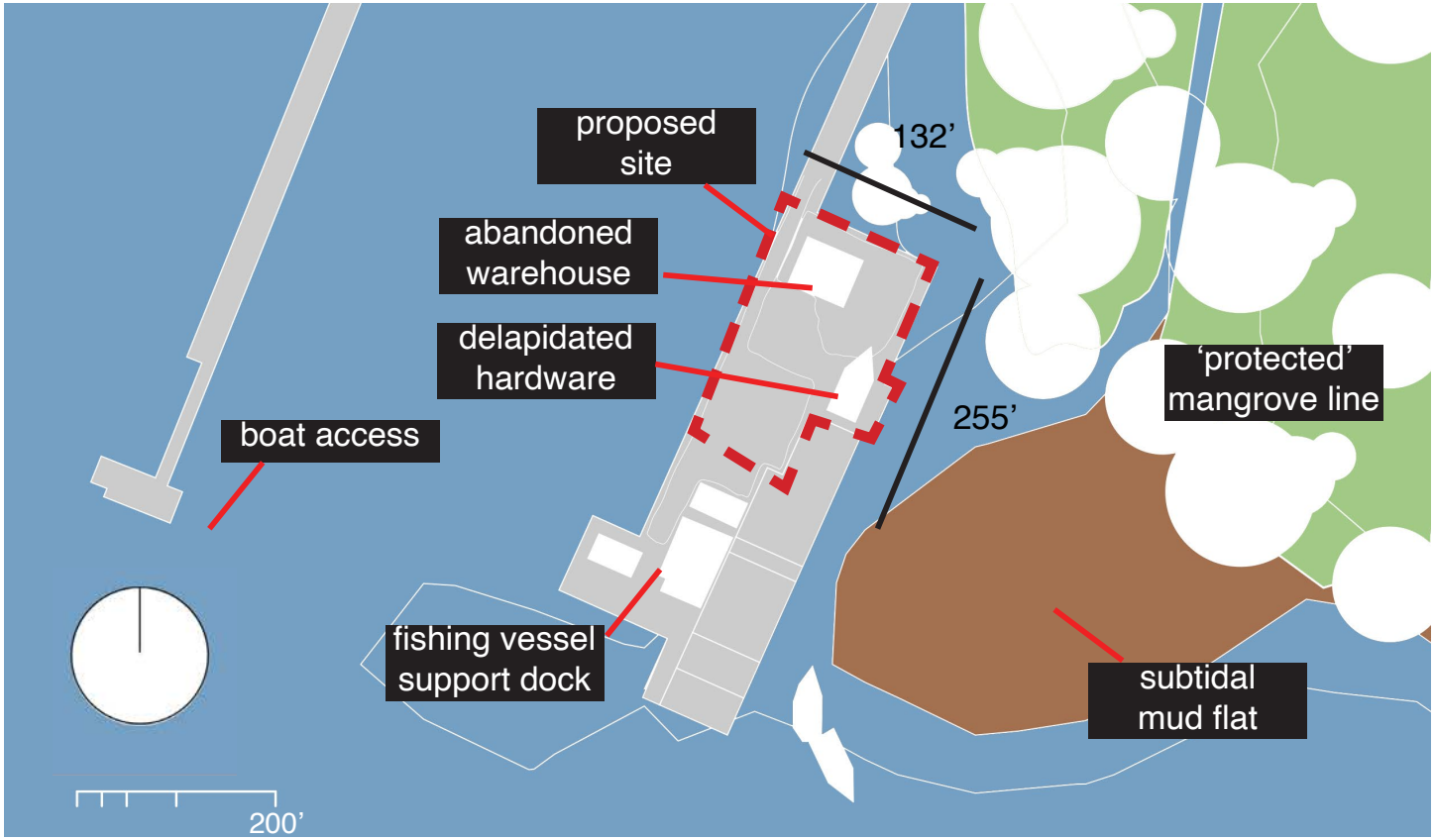
[3] D.M. Dowling, 2004. “Adobe housing in El Salvador: Earthquake performance and seismic improvement”, Natural Hazards in El Salvador, William I. Rose, Julian J. Bommer, Dina L. López, Michael J. Carr, Jon J. Major

Through further consideration, the temporary nature of mangrove decimated areas doesn't warrant the need for an on-site building, rather a centralized station that has easy land and water accessibility would be ideal. A small underused fishing dock in nearby Puerto El Triunfo provided infrastructure for such ecological restoration to be supported as well as a rich and powerful symbolic history within the intersections of El Salvador's socio-economic and historic landscapes. Biologically, the site is right on the border of RESESCO protection boundaries, which are often ignored. This proximity to increased agricultural and housing deforestation could be a critical aspect as to how an architectural method and relationship can reflect a more cyclic model of construction that takes into account natural regeneration and importance of mangrove habitats to other economic sectors, a practice already promoted at community levels but can benefit from tangible built explorations.

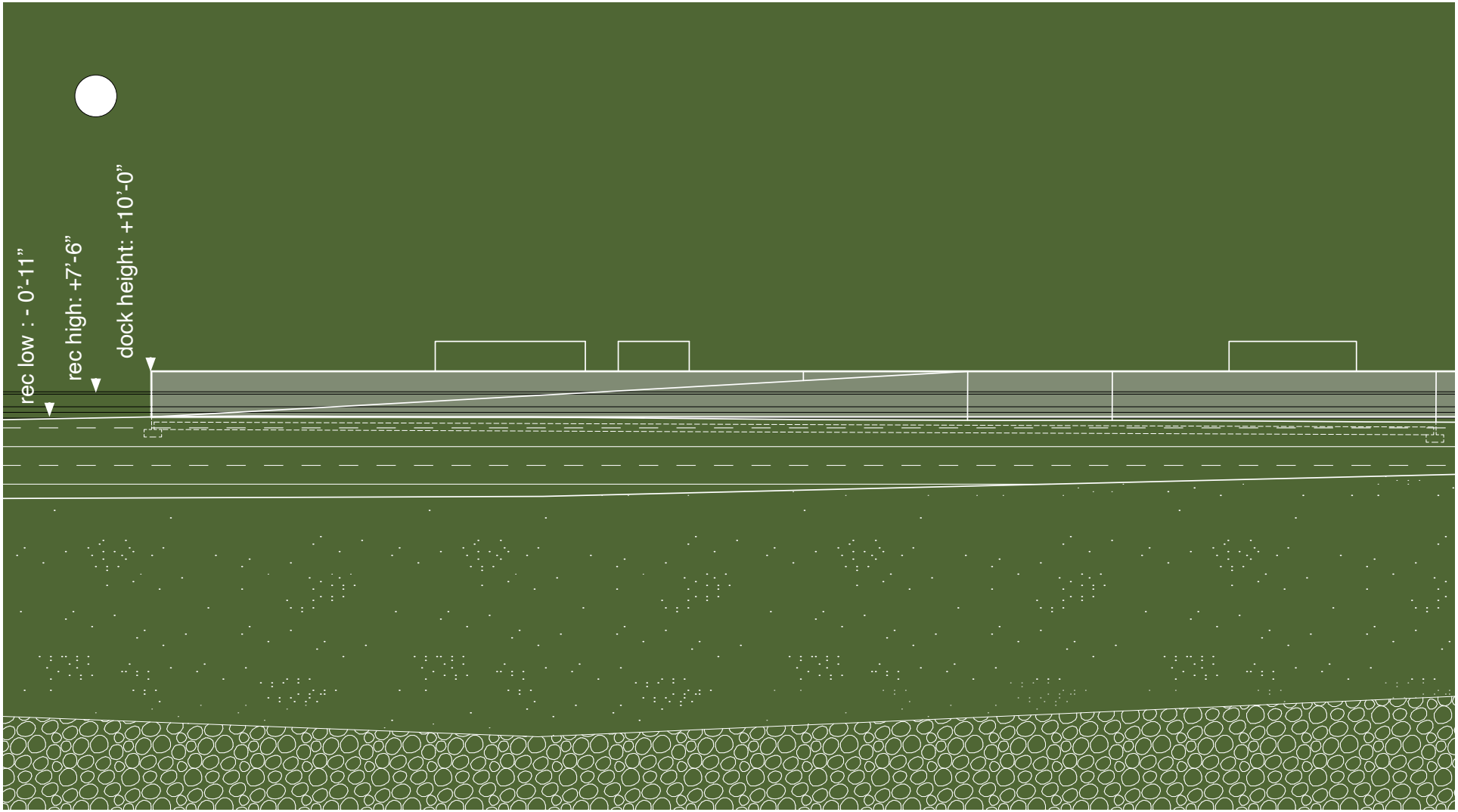
The site rests on the edge of a tidal mud flat within the Jiquilisco Bay Estuary, elevated by a concrete dock on top of fill, and buffered by a barrier island,







providing enhanced flooding prevention, ideal for post-disaster scenarios. The existing artisinal fishing activities have historically been on the decline and mostly serves local needs, therefore integrating the fisherman culture and knowledge was inherent in designing the program. Key geological aspects, such as an active tidal plane, restricts abilities to expand coastal mangroves in the immediate area, but allow for easy transport to coastal and agriculturally affected inlands sites both along the estuary and the exterior coast. However, the extreme proximity to an at-risk mangrove provides first hand educational opportunities on the effects of a shrinking ecosystem. While existing policies and protected boundaries does little to enforce deforestation, changing mental models through active models of ecological regeneration at the local and community level is central to the development of program for this project.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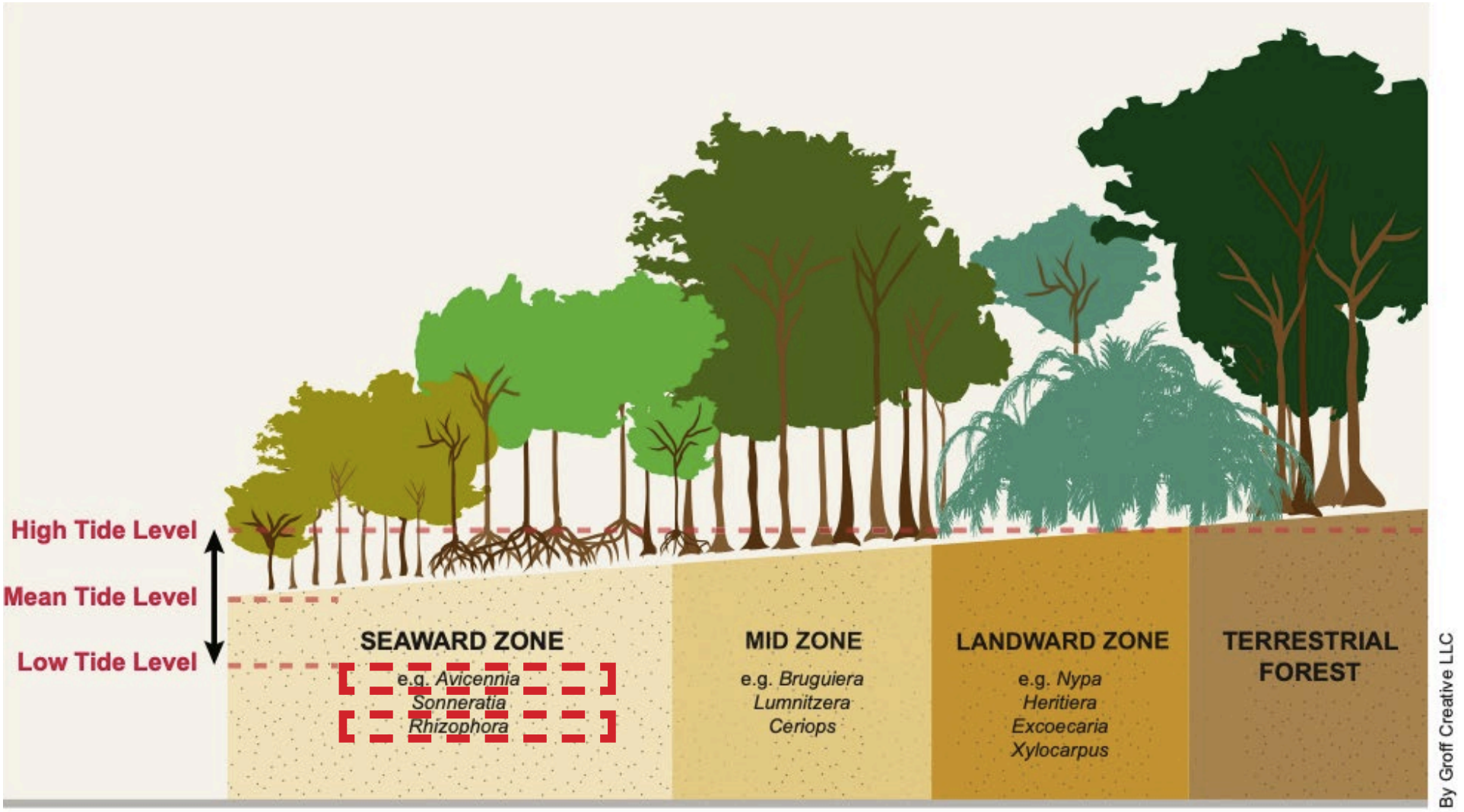
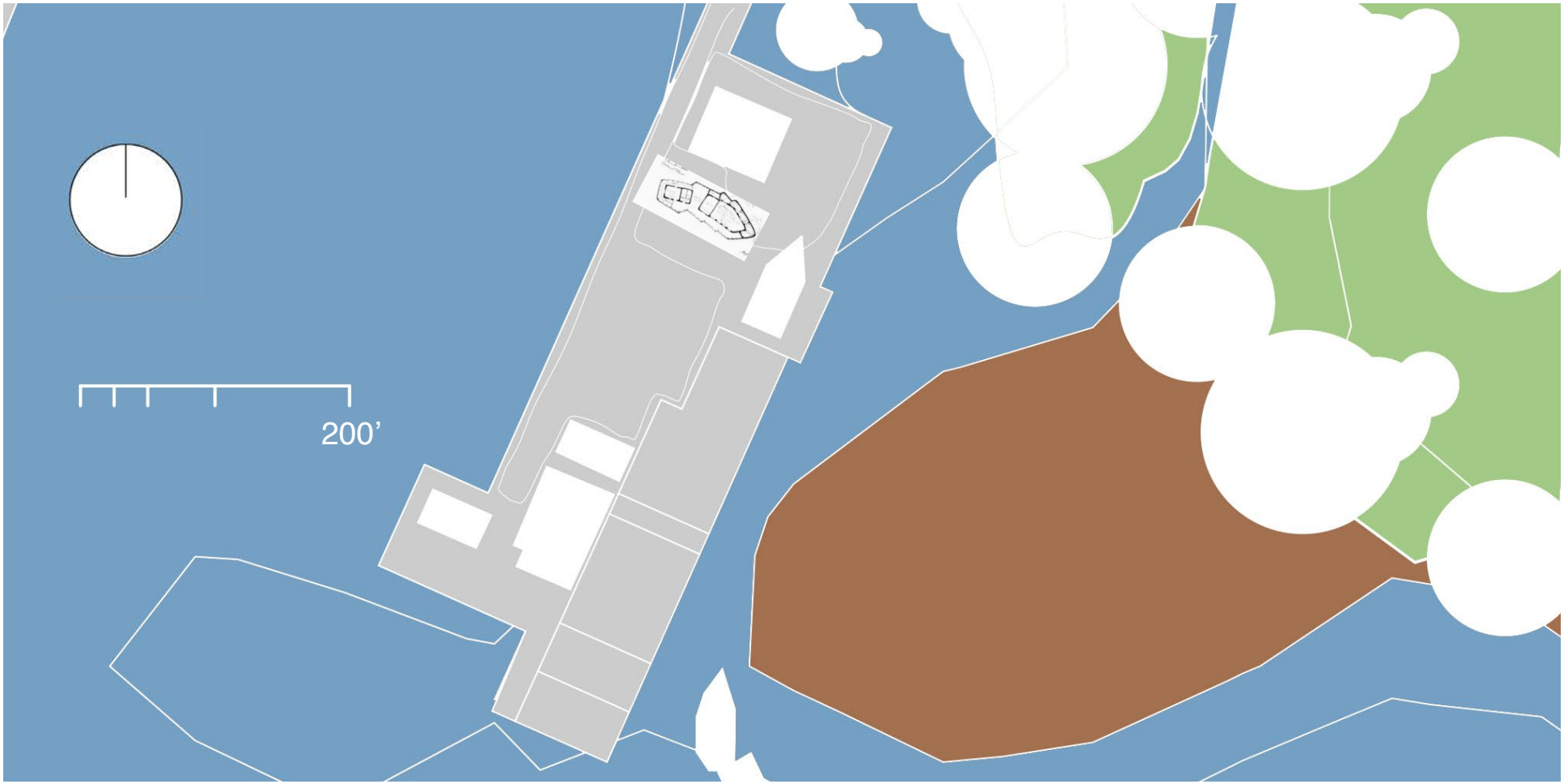


Ellison, Joanna, Jonathan Cook, and Jason Rubens. *Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems Monifa Fiu WWF South Pacific with Support from Ii I Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems.*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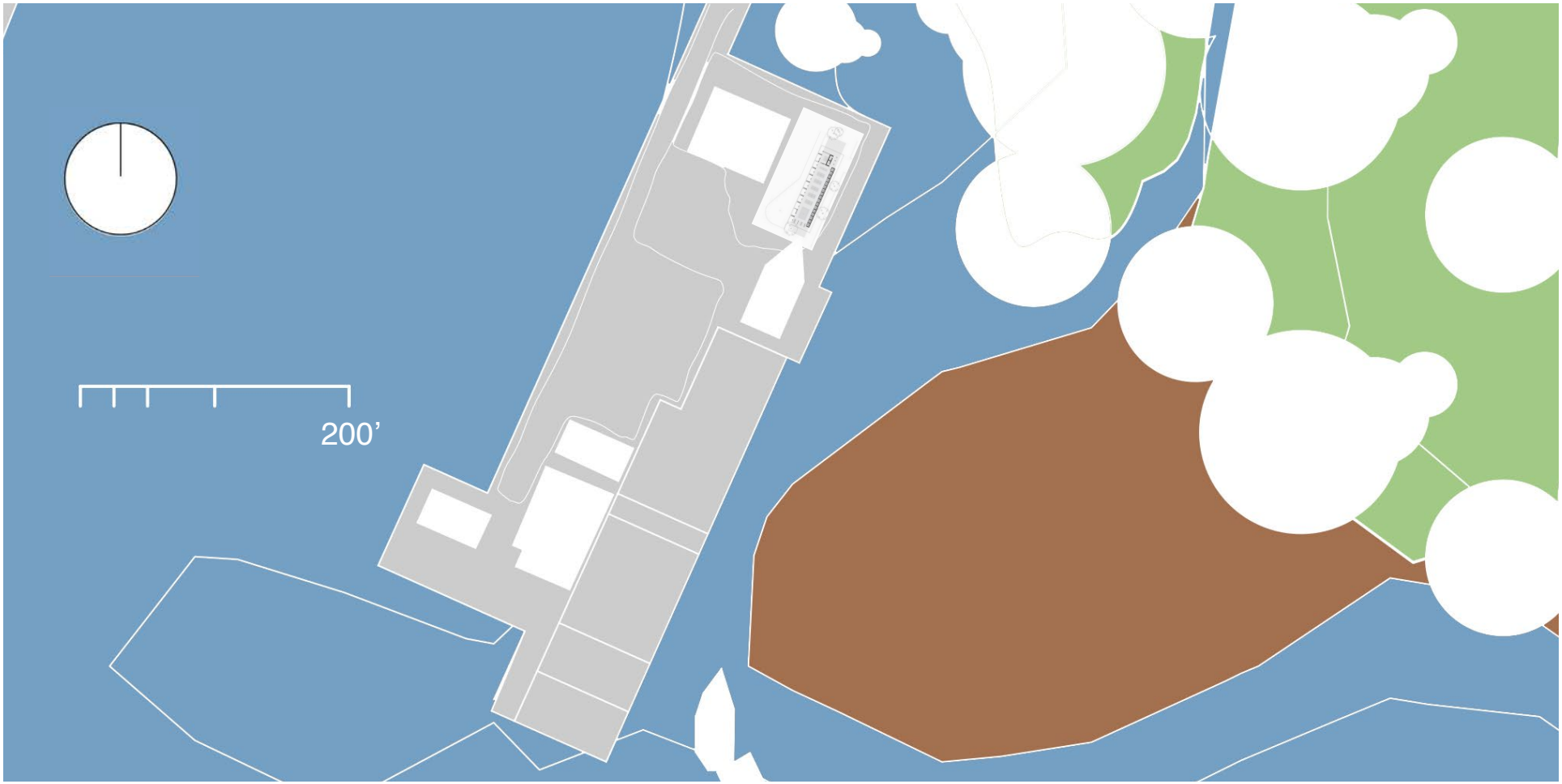
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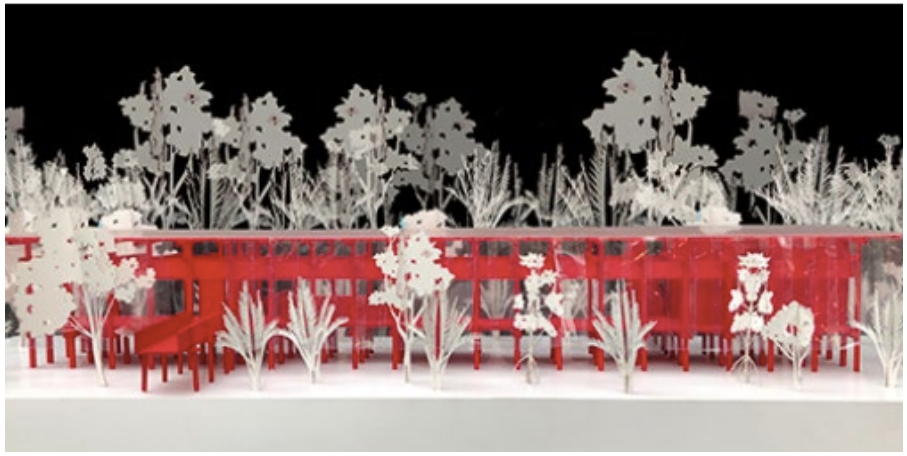
Precedents

Project: Mangrove Forest Conservation Learning Center, Thai Red Cross
Architect: Bangkok Project Studio
Location: Samut Prakan Province, Thailand



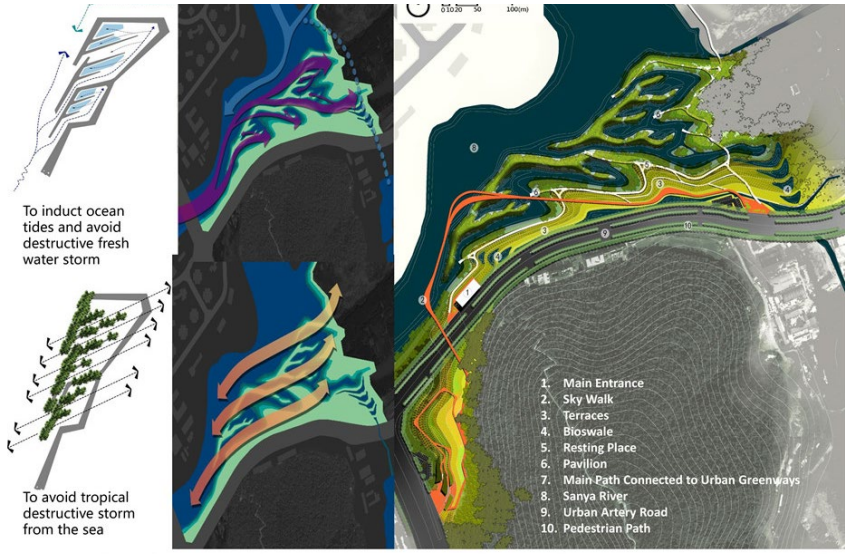
The Thai Red Cross tasked the architect to design an elderly rehabilitation center on a 48,000 m^2 site in the Gulf of Thailand in the Samut Prakan Province. This area is home to lush mangrove forests that have been degraded due to industrial development. The Thai Red Cross wanted restoration of the acquired site to be a focus, mirroring the overall health goals of the facility, Bangkok Project Studio responded with differing program sprawled across the forest floor connected by a 450-meter-long walkway that acts as a therapeutic exercise tool. The structures are assembled nearby and placed above the ground to preserve top soil and will be constructed using fly-ash cement which is lightweight and resists the sulfates found in seawater. The rehab center places a cafe, meditation space, reception hall, gallery and more among the tree lines and between the barrier of man-made and natural for a rehabilitative experience.

Project: Fisherman's Refuge / Santay Observatory
Architect: Juan Carlos Bamba / Natura Futura Arquitectura / the community
Location: Babahoyo, Ecuador

Babahoyo is an area of Ecuador with a rich history in floating homes, fishing, and river transit that predates Hispanic integration. Although practical for centuries, two collaborating firms focused on retaining the vernacular while introducing sanitation, recycled materials, waterproofing, and renewable energy sources. What started as a humble 9 m^2 shed used by local Don Teodoro to sleep and work along the banks of the river, was expanded with the help of the community. New wood trusses were integrated alongside expanded decks for increased work space, both sourced from laurel wood, a local material. Recycled plastic was used to make the platform float, allowing it to move up and down with the tides and along the river as a mobile fishing platform, as has been traditional in this area for centuries. The Santay Observatory was a later project that expanded on this community effort by creating a larger flexible space from scratch for education and community gathering.

Project: Sanya Mangrove Park
Architect: Turenscape
Location: Sanya City, Hainan Province, China

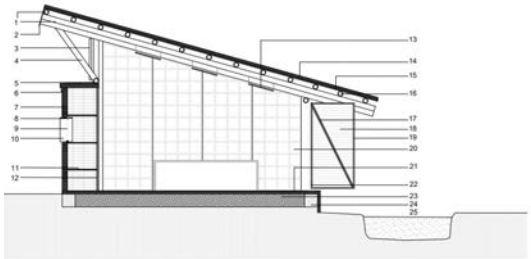
In Sanya City, a large parcel of land used as fill for a flood wall has been converted to a lush wildlife habitat that mimics natural mangrove structures. The firm Turenscape was tasked by the city government to turn this 10 hectare site into a public park. The site used to have natural mangroves before heavy flood wall construction wiped them out, therefore the landscape architecture firm decided to focus on four major considerations while restoring it; wind from heavy monsoons, flooding from storms and understanding its behavior, protection from urban pollution, and integration with the community. The result is a terraced, multi-level park with filtration bio-swales and plantings native to the area that thrive in salt-fresh water boundary conditions. The interlocking 'finger' design is an example of bio-mimicry, in this case mangrove structures were studied to create landforms that soften strong waves in storm events and protect habitats and urban space.



01 Site plan: form follow processes. The designed ecotones of inter-locked fingers help to induct ocean tides, avoid the fresh water flush and destructive tropical storm

Project: Amairis Sewing Factory
Designer: RUTA4 Architectura
Location: Puerto Caldas, Pereira, Colombia

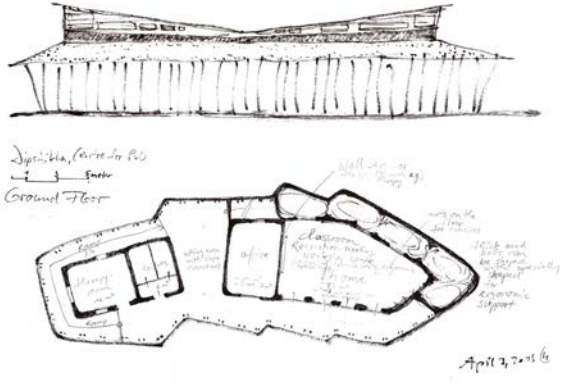
In San Isidro Village, Colombia, a community group led by craftswomen led the construction of a community sewing fabrication facility. The project instills 'local symbolic networks' into its design by integrating the self-built craft knowledge from local municipalities, including native wood work, ceramics, and brick making, making the result distinctly Colombian. The narrow configuration and pitched roof of the building allows intentional integration of light to increase mood and productivity for the needs of a community workspace.



1. Bamboo Beam (Angustifolia Kunth) - D:13 cm Approximately.
2. Metal sheet 4mm.
3. Bamboo vein lattice and metal angle 1 X 1 X 1/8.
4. Bamboo diagonal (Angustifolia Kunth) - D:13 cm Approximately.
5. Concrete slab, slope 2%.
6. Drip edge.
7. Brick Load-bearing wall.
8. Metal angle window (1 X 1 X 1/8.)'.
9. Plain glass 4mm.
10. Metal sheet frame.
11. Wooden furniture.
12. Door in bamboo vein lattice and metal angle 1 X 1 X 1/8.
13. Led panel 0.6m x 0.6 m.
14. Clay Tile.
15. Ceiling in 'esterilla' of bamboo and plastic coating (insulating).
16. Bamboo Beam (Angustifolia Kunth) - D:11 cm Approximately.
17. Metal angle 1 X 1 X 1/8 Diagonal.
18. Bamboo vein lattice (Approximately).
19.Metal sheet frame (1 X 1 X 1/8).
20. Pivot door made in metal angle 1 X 1 X 1/8 and plain glass 4mm.
21. Clay paver.
22. Base of the column in metal cylinder, density 10mm.
23. Tamped earth, density: 15 Cm
24. Foundation beam in concrete (35x 35cm).
25. Lake.

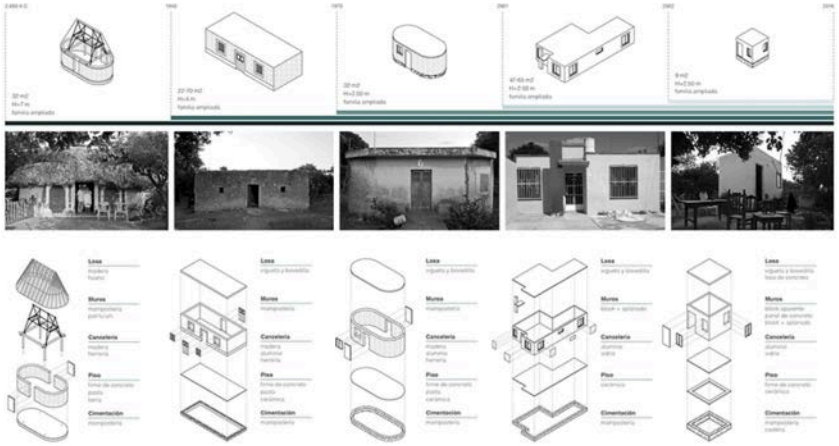
Project: The Anandaloy Building
Designer: Studio Anna Heringer
Location: Rudrapur, Bangladesh

Housing a women's textile non-profit organization as well as a disability rehab center, Germany-based Studio Anna Heringer's center was constructed on a site managed by local mud and bamboo craftsmen. The project hoped to encompass the original intention of wellness and rehabilitation for disabled peoples, a group severely overlooked in Bangladesh. The building used ramps, bamboo, and 'cob' mud construction to integrate local expertise and public inclusivity. This is in an effort to bring a larger community together especially in the context of a complex underlying social issue. The use and construction of materials that have an inherent generational knowledge within the local populace is in itself an integrative aspect of the project.

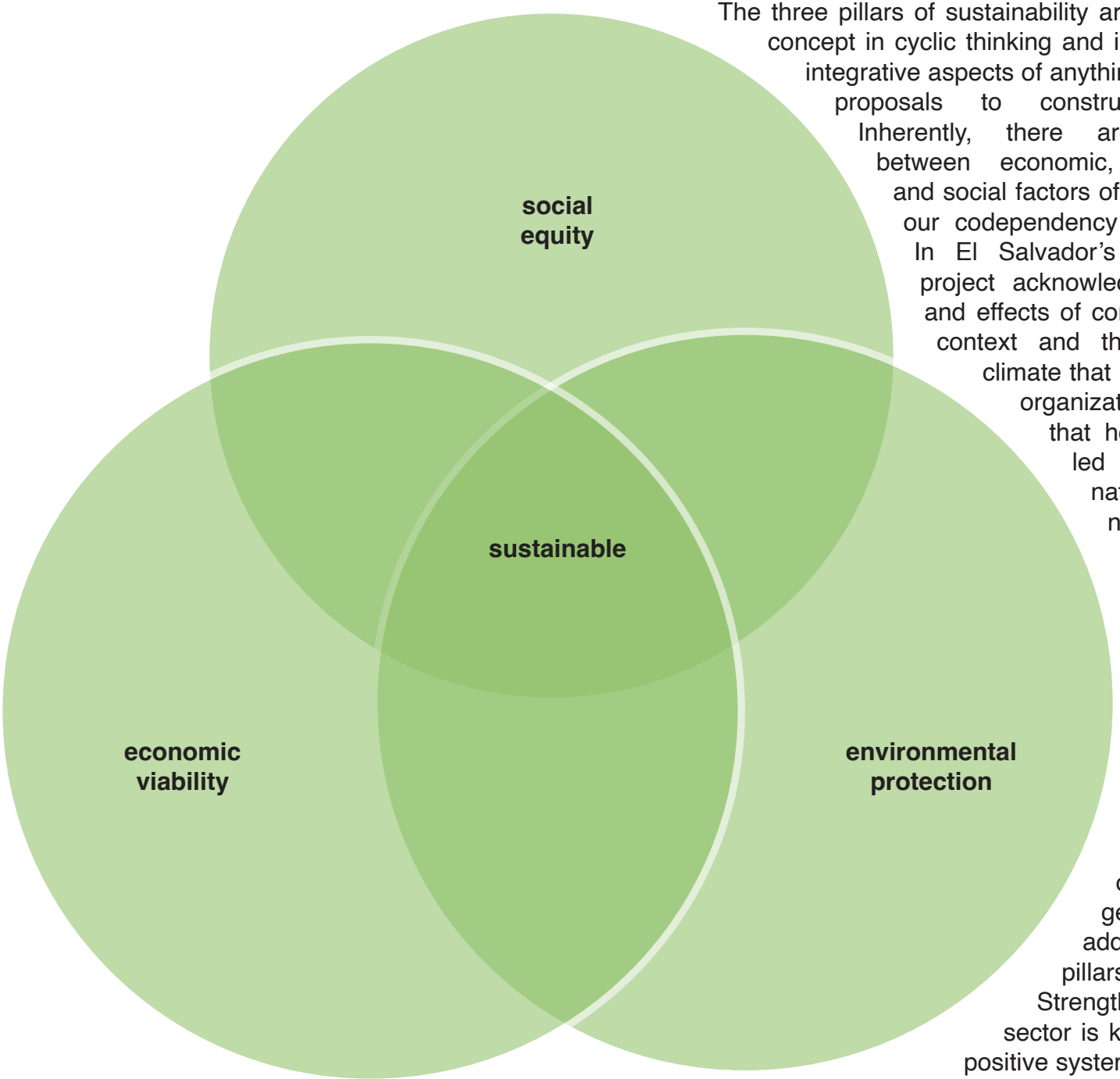


Project: Rural Housing Model Study: From Territory to Inhabitant
Designer: Taller Communal
Location: Yucatan, Mexico

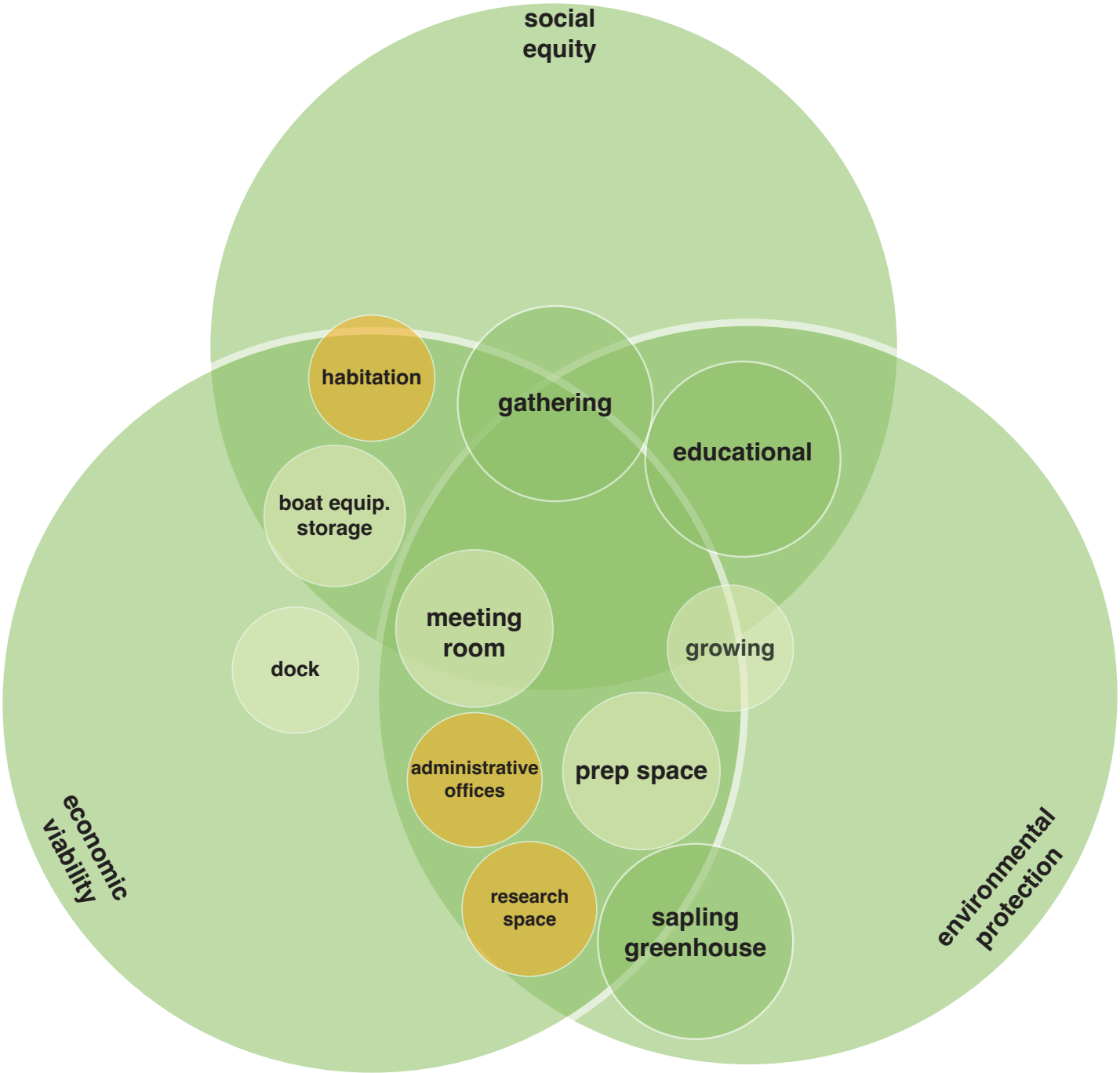
The architecture firm Taller Communal did a study on rural housing that takes advantage of local knowledge, materials, and passive strategies to basically create architecture that 'auto-produces.' The firm made it clear that architecture of the home should involve the creativity and individuality of each and every user, especially in rural areas where the public generally still have the means to construct their own homes using traditional methods, particularly in this area of Mexico where Ancient Mayan housing typologies still exist.



About Restoring...



The three pillars of sustainability are a fundamental concept in cyclic thinking and in assessing true integrative aspects of anything from business proposals to construction projects. Inherently, there are relationships between economic, environmental, and social factors of society, such as our codependency on each facet. In El Salvador's case, a good project acknowledges the cause and effects of construction in any context and the socio-political climate that may inform it. An organization of buildings that hosts community-led research into natural processes in nearby degraded land while reinforcing struggling local economic sectors that are inherently tied to the biodiversity and well-being of a mangrove is an example of an endeavor geared at addressing the three pillars of sustainability. Strengthening each sector is key in developing positive systemic relationships, even at the programmatic level.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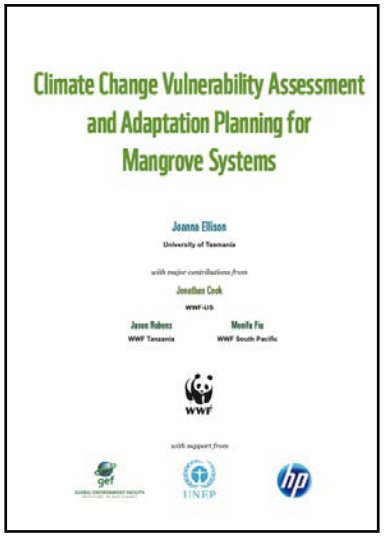
Mangrove Action Project

Community-Based Ecological Mangrove Restoration

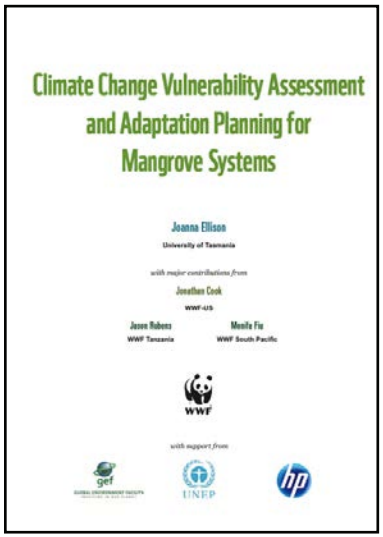


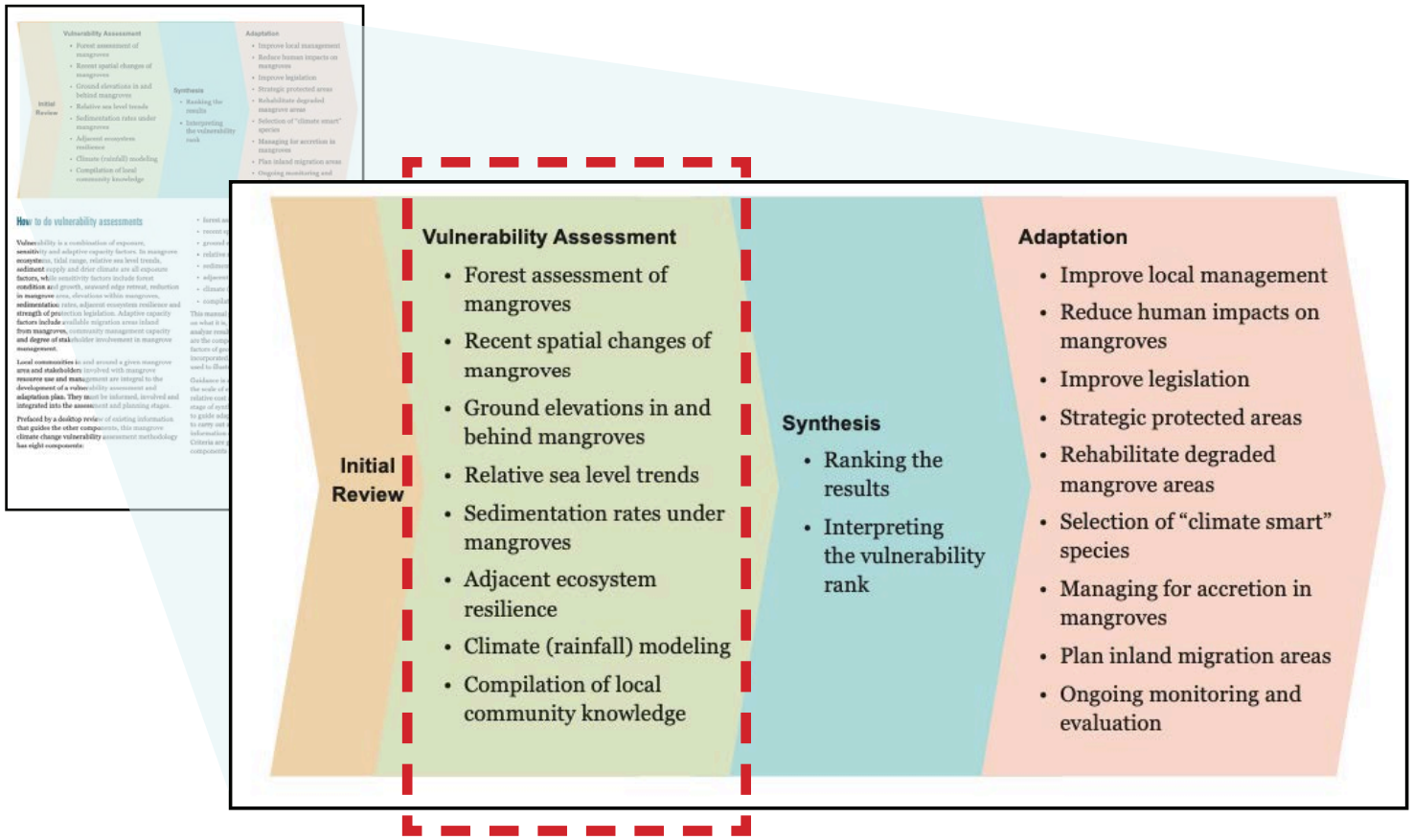
Ellison, Joanna, Jonathan Cook, and Jason Rubens. *Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems Monifa Fiu WWF South Pacific with Support from Ii I Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems.*

ASOCIACIÓN MANGLE

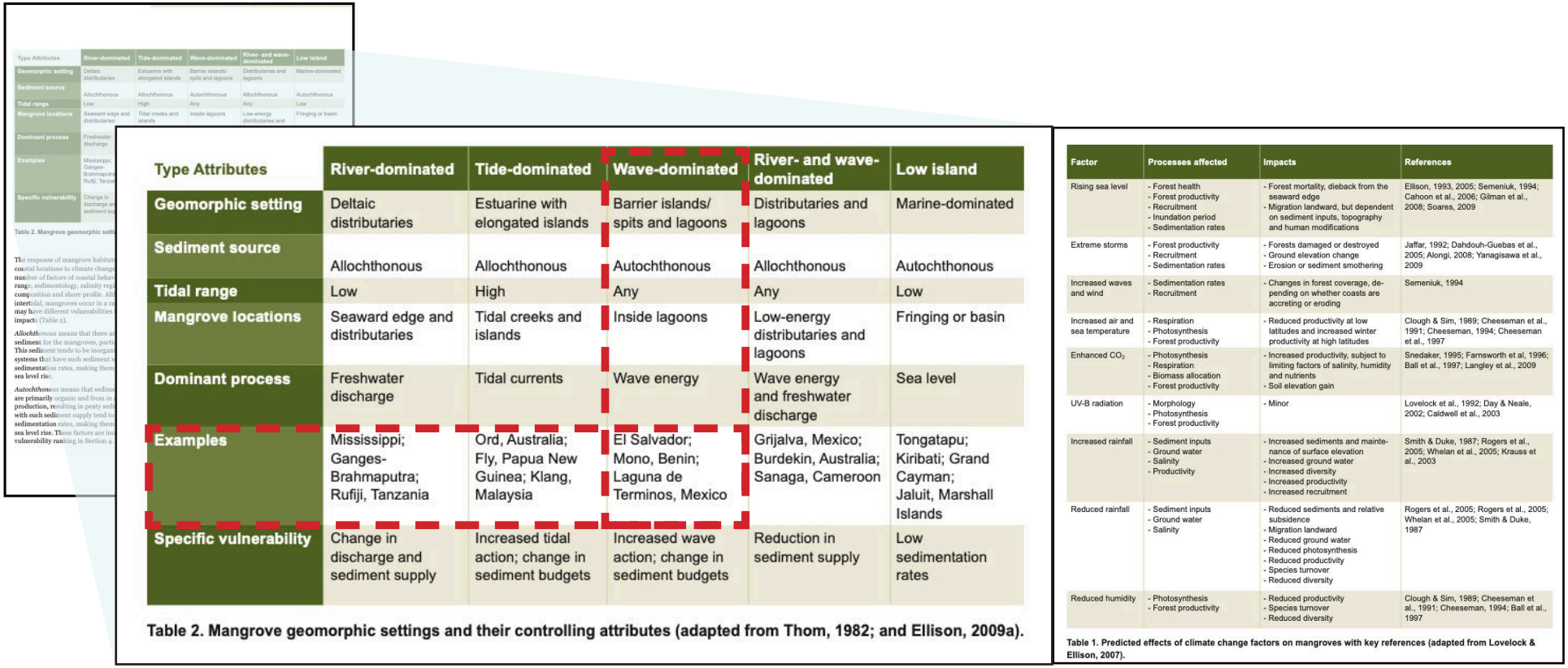
https://mangroveactionproject.org/demonstraciones-cbemr/

Luckily, The Mangrove Action Project has been involved with many organizations throughout the world and El Salvador, including Asociacion Mangle. It was through Robin Lewis' effective CBEMR method that an increase in forest cover was seen in the El Lloron case. The CBEMR method employs data-led methods at restoring mangroves in varying settings and locations with an emphasis on the inclusion of the local populace in regaining confidence in their abilities to restore critical environmental areas that in turn benefit them economically. This method has documented success through the Mangrove Action Project, who also lists the Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems by the World Wildlife Fund as a key guiding piece in scientifically assessing individual mangrove sites for quantitative data on health and productivity to then be able to assess solution methodology. This document spells out each step in assessing vulnerability of a mangrove site with supporting case studies to demonstrate the process. This document not only informs scientists, but can also demonstrate the infrastructure, materials, and space needed for a research center that centrally addresses many mangrove sites and can potentially protect and enforce policy in the future.





From a scientific standpoint, degraded mangrove ecosystems have to be dealt with on a site-by-site basis. Even locally, there are varying stressors that affect each mangrove site. The hydrology or soil accretion in site A might be different from site B and site B might have differing seawater blockage and weak seagrass. With this in mind, there are a series of scientific evaluations that enable a data-led appraoch to each site, and these processes have need for administrative and research space to both quantify and analyze data, as well as organize and meet to better coordinate community efforts. A community trying to restore mangroves that is effectively evaluating every stressor needs program that can facilitate and host these processes, and it is definitely possible to integrate hollisitc community beliefs and economies for an inclusive outcome. While organizations like Asociacion Mangle have offices, there is a real lack of central community space accessible by mutiple modes and central to coastal degradation areas. Permanent and dedicated space would validate community interest and act as a point of organization and management of all current and future sites, as well as facilitation for expansion sites. This report underlines how this can be done locally and with minimal funds, so housing these efforts is the main priority.



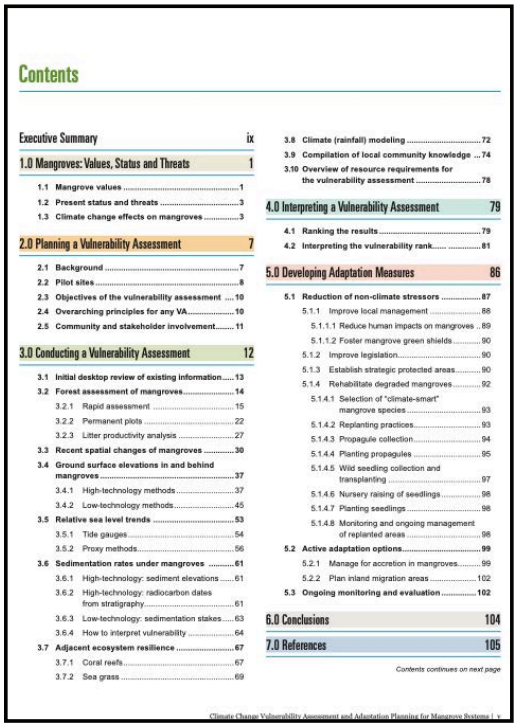
Type Attributes	River-dominated	Tide-dominated	Wave-dominated	River- and wave-dominated	Low island
Geomorphic setting	Deltaic distributaries	Estuarine with elongated islands	Barrier islands/ spits and lagoons	Distributaries and lagoons	Marine-dominated
Sediment source	Allochthonous	Allochthonous	Autochthonous	Allochthonous	Autochthonous
Tidal range	Low	High	Any	Any	Low
Mangrove locations	Seaward edge and distributaries	Tidal creeks and islands	Inside lagoons	Low-energy distributaries and lagoons	Fringing or basin
Dominant process	Freshwater discharge	Tidal currents	Wave energy	Wave energy and freshwater discharge	Sea level
Examples	Mississippi; Ganges-Brahmaputra; Rufiji, Tanzania	Ord, Australia; Fly, Papua New Guinea; Klang, Malaysia	El Salvador; Mono, Benin; Laguna de Terminos, Mexico	Grijalva, Mexico; Burdekin, Australia; Sanaga, Cameroon	Tongatapu; Kiribati; Grand Cayman; Jaluit, Marshall Islands
Specific vulnerability	Change in discharge and sediment supply	Increased tidal action; change in sediment budgets	Increased wave action; change in sediment budgets	Reduction in sediment supply	Low sedimentation rates

Table 2. Mangrove geomorphic settings and their controlling attributes (adapted from Thom, 1982; and Ellison, 2009a).

Factor	Processes affected	Impacts	References
Rising sea level	- Forest health - Forest productivity - Recruitment - Inundation period - Sedimentation rates	- Forest mortality, dieback from the seaward edge - Migration landward, but dependent on sediment inputs, topography and human modifications	Ellison, 1993, 2005; Semeniuk, 1994; Cahoon et al., 2006; Gilman et al., 2008; Soares, 2009
Extreme storms	- Forest productivity - Recruitment - Sedimentation rates	- Forests damaged or destroyed - Ground elevation change - Erosion or sediment smothering	Jaffar, 1992; Dahdouh-Guebas et al., 2005; Alongi, 2008; Yanagisawa et al., 2009
Increased waves and wind	- Sedimentation rates - Recruitment	- Changes in forest coverage, depending on whether coasts are accreting or eroding	Semeniuk, 1994
Increased air and sea temperature	- Respiration - Photosynthesis - Forest productivity	- Reduced productivity at low latitudes and increased winter productivity at high latitudes	Clough & Sim, 1989; Cheeseman et al., 1991; Cheeseman, 1994; Cheeseman et al., 1997
Enhanced CO_2	- Photosynthesis - Respiration - Biomass allocation - Forest productivity	- Increased productivity, subject to limiting factors of salinity, humidity and nutrients - Soil elevation gain	Snedaker, 1995; Farnsworth et al, 1996; Ball et al., 1997; Langley et al., 2009
UV-B radiation	- Morphology - Photosynthesis - Forest productivity	- Minor	Lovelock et al., 1992; Day & Neale, 2002; Caldwell et al., 2003
Increased rainfall	- Sediment inputs - Ground water - Salinity - Productivity	- Increased sediments and maintenance of surface elevation - Increased ground water - Increased diversity - Increased productivity - Increased recruitment	Smith & Duke, 1987; Rogers et al., 2005; Whelan et al., 2005; Krauss et al., 2003
Reduced rainfall	- Sediment inputs - Ground water - Salinity	- Reduced sediments and relative subsidence - Migration landward - Reduced ground water - Reduced photosynthesis - Reduced productivity - Species turnover - Reduced diversity	Rogers et al., 2005; Rogers et al., 2005; Whelan et al., 2005; Smith & Duke, 1987
Reduced humidity	- Photosynthesis - Forest productivity	- Reduced productivity - Species turnover - Reduced diversity	Clough & Sim, 1989; Cheeseman et al., 1991; Cheeseman, 1994; Ball et al., 1997

Table 1. Predicted effects of climate change factors on mangroves with key references (adapted from Lovelock & Ellison, 2007).

It is important to note the varying nature of mangrove restoration and the wide applications that can be employed to restore each site as well as long term goal setting. The World Wildlife Fund's publication describes El Salvador's geomorphic character as having varying tidal rangers as well as having increased wave actions and shifting sediments as present threats in similar barrier island/spit/lagoon setting. The publication also provides a chart of predicted increases in stressors, all of which affect El Salvador's mangroves, and particularly worrying would be decrease in rainfall and changes in hydrology, which is currently present.



Contents

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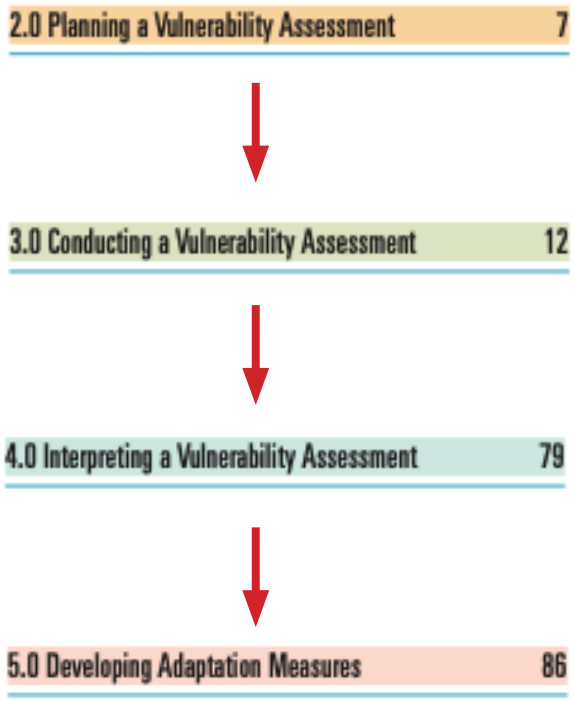
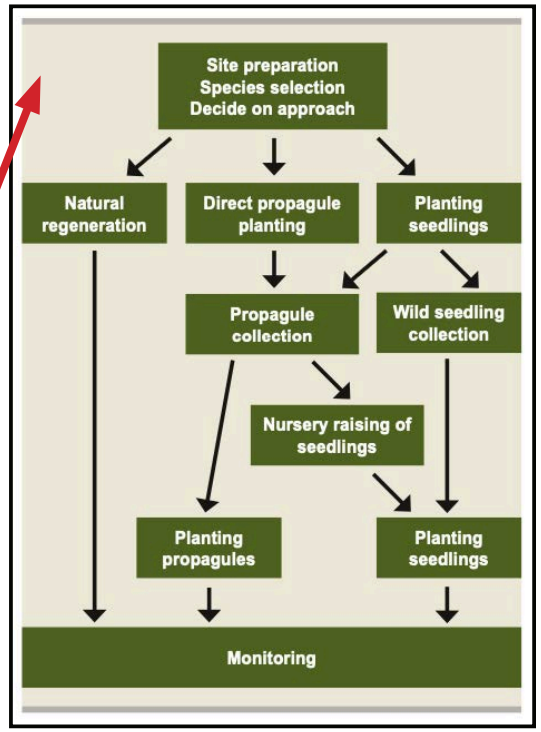




Equally as important as being capable of conducting vulnerability assesments on corresponing sites is being able to carry out restoration and monitoring efforts form the data, whether it consists of enabling natural regeneration, propagule planting, or seedling planting. This may manifest as small scale sapling farms that can be placed on the tidal bed to be distributed once ready. Therefore these two organizational and administrative aspects are critical to the effectiveness of this proposed thesis as a restorative center that seeks to actively engage in community restoration efforts.

3.10 Overview of resource requirements for the vulnerability assessment

Section 3 has described eight components of data gathering for a mangrove vulnerability assessment, following an initial review of existing information. Table 24 summarizes these components as rated in terms of the scale of expertise and technology required, time needed to do the work, cost and relative contribution to the VA synthesis, as will be discussed in Section 4. These ratings come from the summaries at the beginning of each subsection in Section 3. The cost factor is dependent on the size of the mangrove area and the logistics of fieldwork there.

The final column on the relative contribution of each component to the overall vulnerability assessment allows prioritization by those planning to go ahead with a VA. **Those components most critical to a VA are forest assessment by permanent plots and analysis of recent spatial change, relative sea level trends and sedimentation rates.**

Component	Approach	Expertise/ Technology needed	Time taken	Cost	Contribution to VA
Initial review of existing information	Desktop	2	2	1	4
Forest assessment of mangroves	Rapid	2	3	2	4
	Plots	3	4	3–4	5
	Litter	3	5	3	2
Recent spatial changes	GIS	5	3	3	5
Ground surface elevations	dGPS	5	2	5	4
	Water level	2	2	2	4
Relative sea level trends	Tide gauge data[5]	3	2	1	5
	Stratigraphy/ pollen analysis	4	4	4	3–5[6]
Sedimentation rates under mangroves	Tables	5	3	5	5
	Stratigraphy	4	2	4	4
	Stakes	2	2	2	3
Adjacent ecosystem resilience	Coral reefs	4	4	4	3
	Sea grass	2	2	2	3
Climate (rainfall) modeling[7]	Available projections	3	2	1	2
Local community knowledge	Workshops and questionnaires	2	2	3	5

Table 24. Relative comparison of the different VA components. Note that cost is scale-dependent upon the size of the mangrove forest. Key to scales: 1–Low; 2–Some; 3–Moderate; 4–Rather high; 5–High

	Problem listing	Root cause analysis	Potential solution
Land	Freshwater shortage in dry season	Drought affects agricultural productivity and seasonality of traditional agricultural calendar Shift in the planting of traditional crops and increasing dependence on purchased food (with limited income)	Increase water storage capacity and improve delivery of water in district Increase understanding of alternative, more climate-smart crops
	Extreme rainfall events	Roads become impassable; breeding of mosquitoes and rise in waterborne diseases (dengue, diarrhea and skin diseases)	Increase school attendance flexibility Improve roads Develop better local income-earning opportunities Improve community health education
	Sediment deposition in the intertidal areas Increasing shallowness of rivers and loss of wetlands near waterways Deeper areas in the tidal zone becoming shallow	Logged pine forest areas associated with periods of heavy rain experiences landslides and soil erosion Absent buffer zones between pine forests and the river exacerbate siltation within the river system	Improve catchment management, such as logging in the dry season and use of riparian buffers Increase understanding that sediment supply to the mangrove area is important for mangrove resilience to sea level rise
Tidal	Coastal flooding and erosion	Encroachment of the high tide mark inland, as compared to the past	Improve survey points in the village to allow accurate comparison of land levels with MSL levels Raise bases of houses
		Mangroves encroaching into previously exposed salt pans mean loss of cultural heritage (the art of traditional salt making for which the district is renowned)	Gain funding for and build a more secure salt making facility on the highest section of the salt pan close to the village, also to facilitate tourism
	Excessive removal or cutting of mangroves from shoreline	Need for wood; Inadequate surveillance and community education	Appoint mangrove monitors for surveillance and reporting to resource management committee and require those who cut mangroves to replant them Improve the traditional practice of bark harvesting so it does not damage tree health Rehabilitate and replant mangroves
Coral reef	Coral bleaching events observed	Correlation with ENSO events such as in 2000	Develop partnership with a local dive shop for sea surface temperature monitoring on the barrier reef
	Increased crown-of-thorns incidence during drought years	Unknown	Increase observation and communication among lagoon users to allow monitoring, reporting to resource management committee
	Fish spawning seasonality uncertain (compared to historical timelines)	Changed climate and coastal conditions	Banning of commercial fishing in the marine protected areas Improve communication among fishers to pool community knowledge on fish spawning patterns

Table 23. Community consultation results from Tikina Wai, Fiji and adaptation solutions.

The World Wildlife Fund's manual outlines the minimum capabilities to be able to conduct effective data-led research activity. Important to note is the rating system for efficiency, meaning these systems can be improved upon. Main considerations are desk spaces to be able to work on data, meeting space to coordinate within the research team and other groups, as well as extensive storage for the various lab materials and data samples, some taller than a person (sediment poles). Space for sapling growing when needed is also important as well as taking into account root causes and proposition of solutions, soecufucakky as it pertains to future mangrove restoration efforts.

Avicennia germinans

Black Mangrove

height: 40’

above hight tide line

Aguncularia racemosa

White Mangrove

height: 59’

well above hight tide line

Conocarpus erectus

Buttonwood Mangrove

height: 66’

brackish water to high lands, commerical

Rhizophora racemosa

Mangrove

height: 100’

above hight tide line
wind pollination

Schematic Design

Jiquilisco Bay, like many fishing towns all over the world, has adapted to its surroundings over time with a command over the water in the form of canoes, motor boats, fishing vessels, floating restaurants, docks, and water access points. This creates a rich maritime culture that has become synonymous with Puerto El Triunfo, making it an extremely valuable destination for locals and tourists. The economic potential and environmental significance is a significant intersection that often contradict, therefore this thesis hopes to approach economic stimulation with environmental enhancement simultaneously in mind.

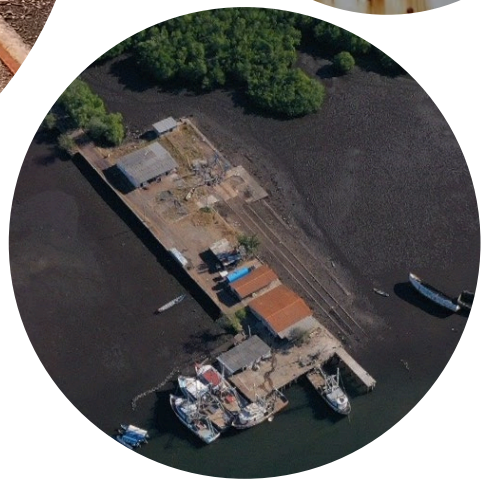


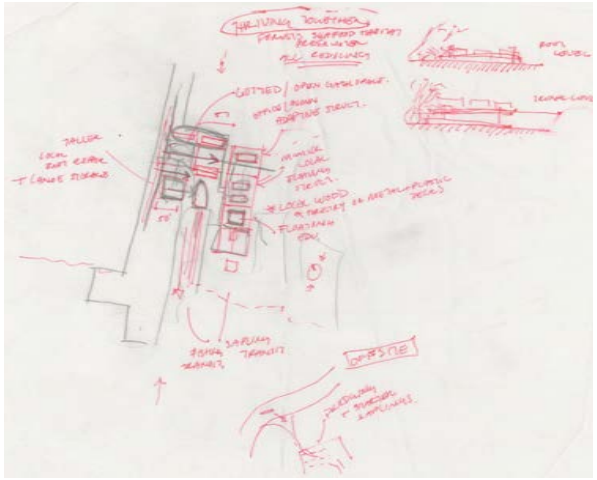


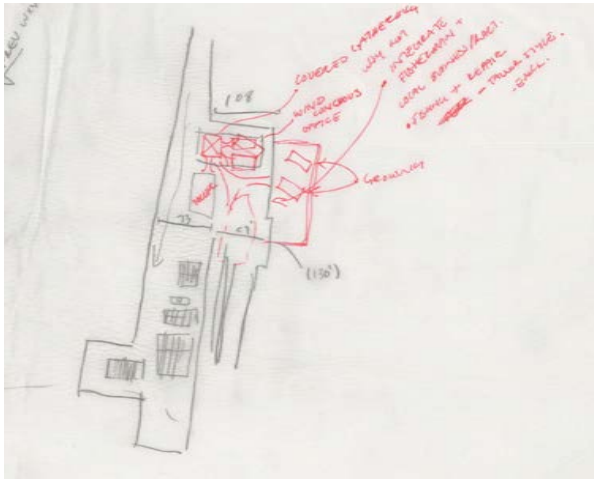


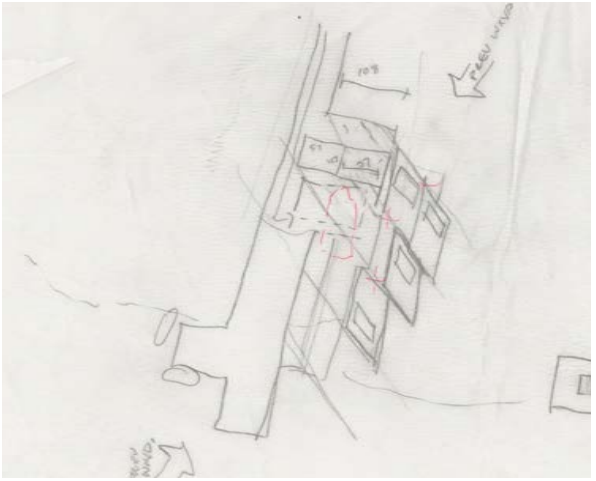


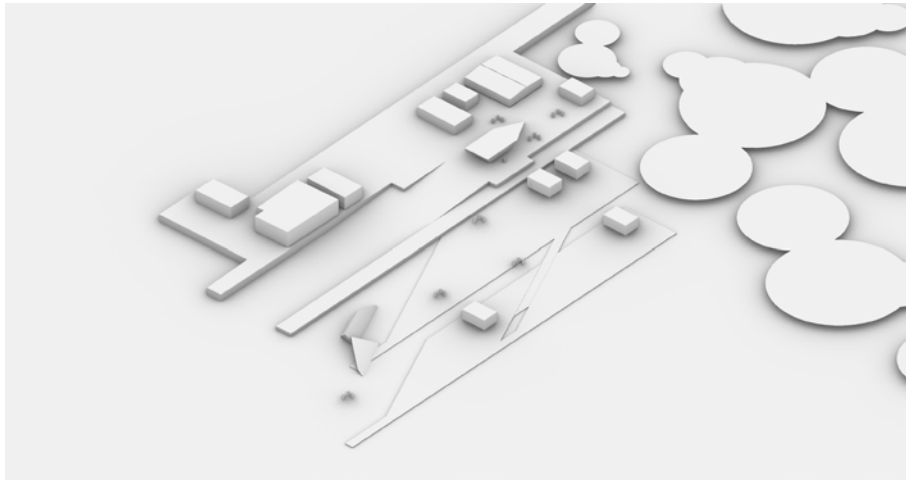
PROTEO



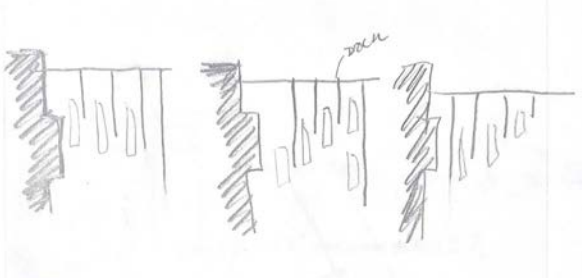



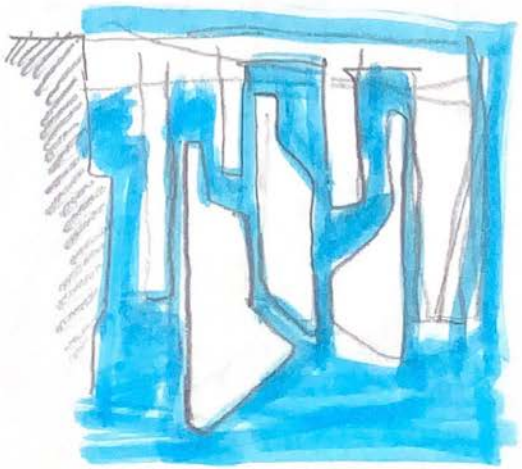


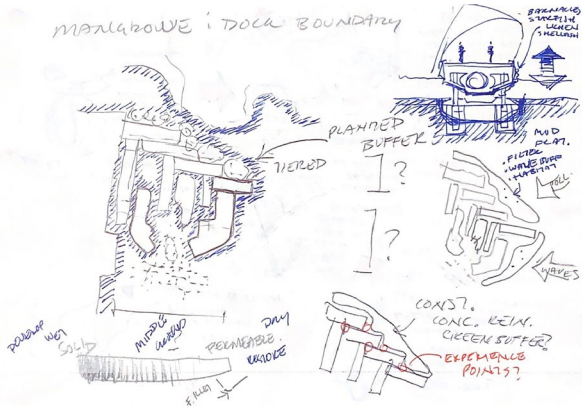


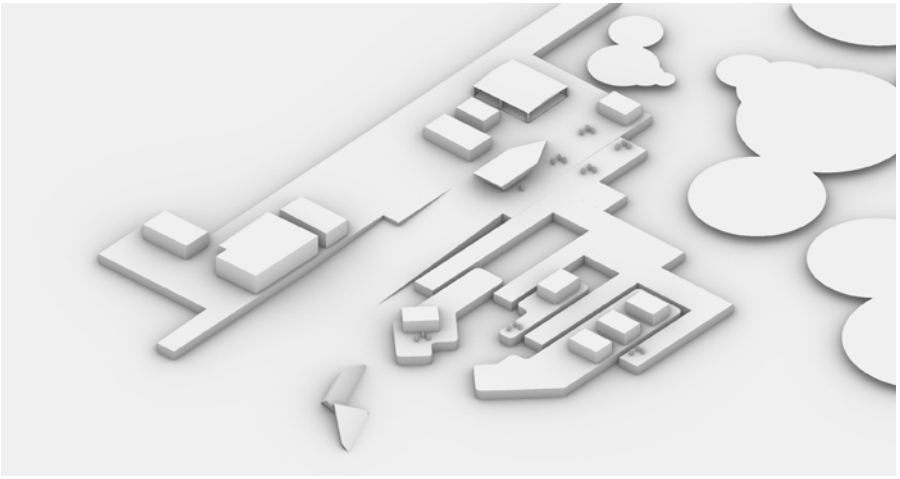


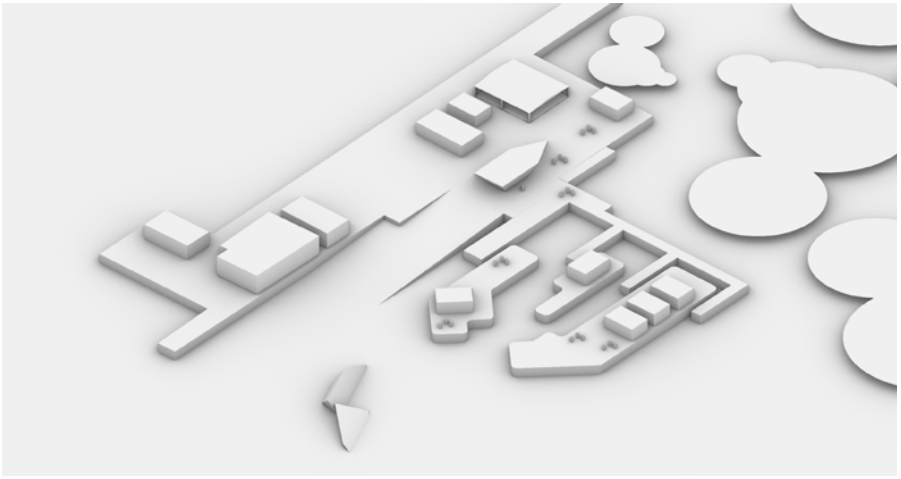
The program started to manifest almost immediately outside of the site boundary in an attempt to console the constraint to the ground that floating architecture tends to inform. The local use of floating structures was also in mind, as well as the adaptive nature to the tides and storm events. These rising and falling tides provide an opportunity for spaces that rise and fall and provide an interplay with canopies within planes of space and experience.







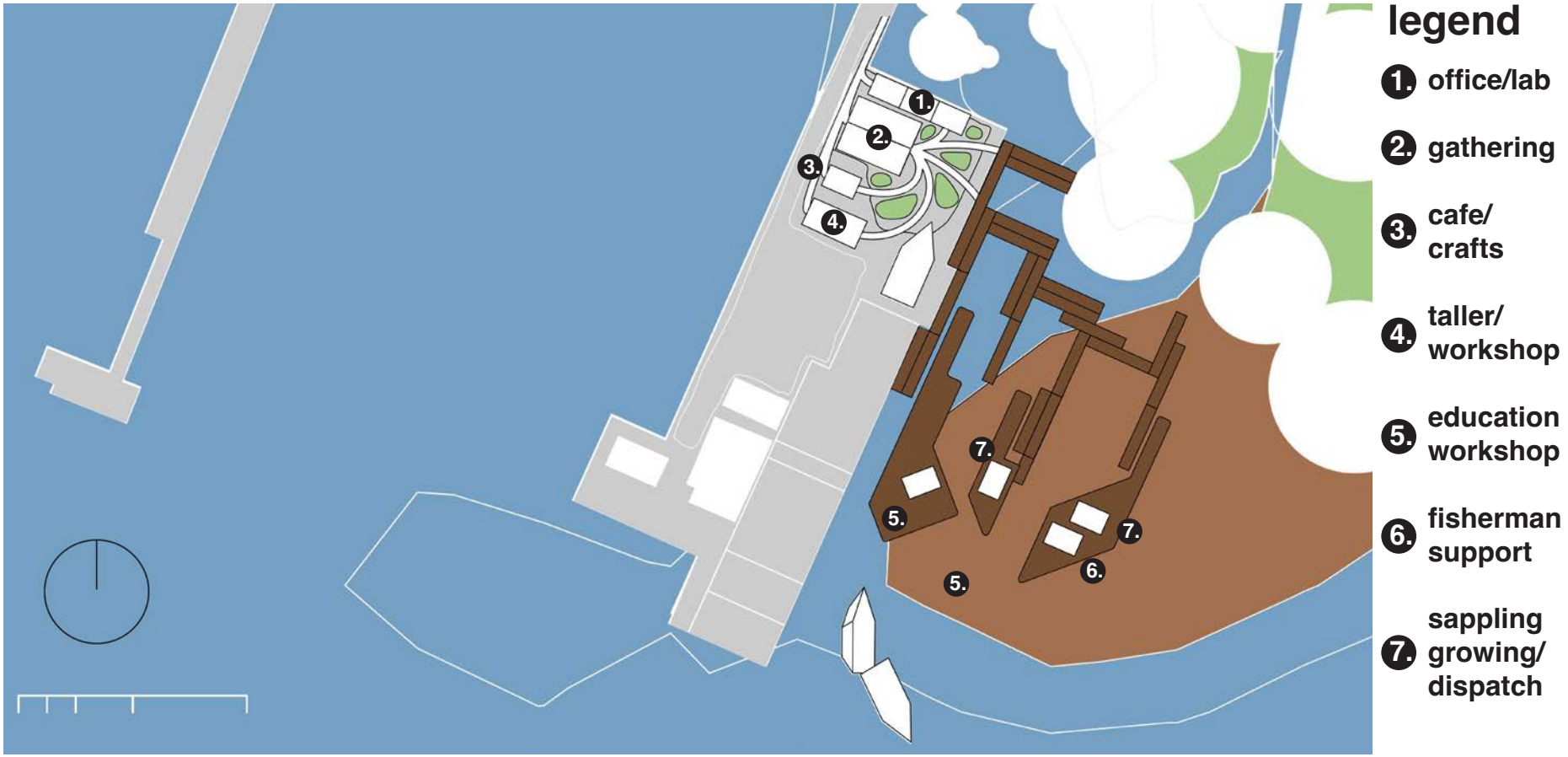




In an attempt to formalize the approach to landscape and circulation, a code was set up to try to establish defining characteristics. A stem and branch approach not only mimicked the nature of the site in terms of trees and estuary structures, but provided a solid circulation family that began to allow for experiential program allocation. This effort tries to encapsulate an experience within a what is now barren mud flat with artificial reinforced plantings. The simple stem and branch method led to a modular 10’ x 20’ and 30’ x 60’ explorations to grasp scale of boundary and plane within the organization of the modules. Two methods can be employed in terms of connection to mangrove experience. Artificial planting by reinforcing the mud fat to become less tidally active could increase mangrove buffer. This artificial approach could be seen as correcting a recessed mangrove state from rising sea levels and unrestricted boat speed limits.

With mangrove health in mind, approaches to the proximity of them to be able to enhance public appreciation and interaction were considered as well. This scheme seeks to take advantage of the separation of land-based program and water-based program to create a central hub for volunteer / tourist promulgation and gathering. The entry would comprise of public program such as a gathering space and cafe, while the mid program were work spaces, such as for research and boat repair. Lastly the water program houses education and mangrove growing, spaces that would be open to the public and encourage exploration about the site.

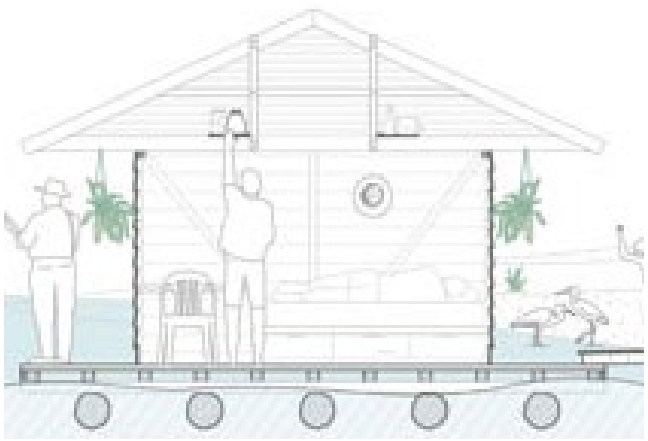
This second scheme engages more with the magrove root line in areas between trees where root disturbance is not possible. This scheme is similar in the process of user dispersion from a central gathering hub to correspoding program based on whether one is there for leisure or as a worker.



This last scheme is heavily drawn from the refinement of path from the previous iteration as well as its abilities to create interplays of docking and movement with the tides. Artificial planting can occur at small scales and without disturbing topsoil near existing mangroves, which would act as buffers and relieve coastal stresses on the existing mangrove line. The demonstration spaces would act as integrative community learning and gathering spaces essential to the community-based approach needed in successful mangrove restoration. Although, all program will have to be located on the main dock to prevent further coastal stress. The only program allowed to be on the mud flat after this schematic design phase may be planting which can happen on the mud flat level, and educational workshop spaces, which may be mobile to demonstrate off-site processes.

Low Tide

High Tide



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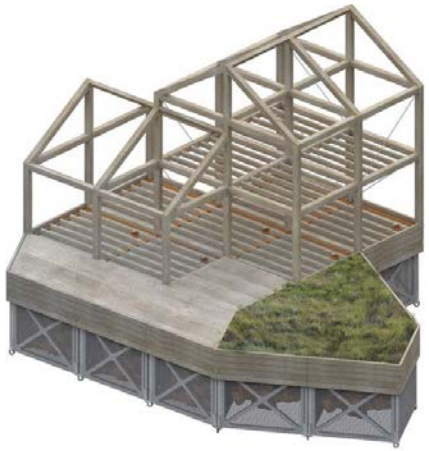

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Geological Society of America
Special Paper 375
2004

Adobe housing in El Salvador:
Earthquake performance and seismic improvement

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ABSTRACT

Adobe is the predominant housing material in rural El Salvador, due mostly to economic advantages and ease of construction. The high seismicity of El Salvador has repeatedly exposed the vulnerability of traditional adobe housing to the forces of earthquakes, as spectacularly demonstrated in the severe earthquakes of 2001. This paper presents the features of traditional adobe housing in El Salvador, including construction techniques and distribution, followed by a discussion of the performance of adobe buildings in recent earthquakes in El Salvador. The impact of the 2001 earthquakes is demonstrated by statistical data, which also reveal the severe housing deficit in El Salvador. Common damage patterns evident in earthquake-affected adobe buildings are detailed, with emphasis on the failure mechanisms and exacerbation features. These aspects are then linked to a presentation of improved seismic design and construction techniques: seismic retrofitting and damage repair systems for adobe structures are also considered. Finally, the obstacles to reducing damage to adobe houses are presented, and some key recommendations for adobe strengthening in El Salvador are discussed, which involve both social and technical solutions.

Keywords: adobe, housing, El Salvador, earthquake, performance, failure, resistance, mitigation, seismic improvement.

INTRODUCTION

The force of earthquakes can cause devastation and destruction to both infrastructure and lifestyle. The housing sector in developing countries is particularly vulnerable due to resource limitations and poor construction quality. Adobe (mudbrick) houses are one of the most severely affected types of building because of their extensive use, general poor quality, and inherently brittle nature. A history of severe earthquakes in El Salvador has exposed the deficiencies in traditional adobe housing, particularly in rural communities. Other devastating earthquakes in Peru, India, Afghanistan, Iran, and México in 2001 and 2002 have confirmed that the loss from earthquakes can be frequent, unpredictable, and global. Despite this key limitation, there is little doubt that adobe will continue to be the chosen construction material for a significant proportion of the population who simply cannot afford any alternative.

The capacity of an adobe house to resist earthquakes is dependent on individual adobe block characteristics, building location and design, and the quality of construction and maintenance. These factors are mutually dependent and should be considered when undertaking an adobe construction project. In recent times there has been an increased emphasis on the seismic improvement of adobe, and research has revealed various methods to improve the seismic resistance of simple adobe dwellings. Despite this ever-expanding body of technical knowledge, there are certain obstacles that are preventing the widespread application of this information. These obstacles relate to deficiencies in the promotion and support of improved adobe, as well as a shortage of skills and resources to facilitate improved construction. A combination of social and technical solutions is required to reduce the vulnerability of adobe structures, and local and international collaboration is necessary to realize these goals.

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Dowling, D.M., 2004, Adobe housing in El Salvador: Earthquake performance and seismic improvement, in Ross, W.I., Bommer, J.J., López, D.L., Carr, M.J., and Major, J.J., eds., Natural hazards in El Salvador: Boulder, Colorado, Geological Society of America Special Paper 375, p. 281–300. For permission to copy, contact editing@geosociety.org. © 2004 Geological Society of America

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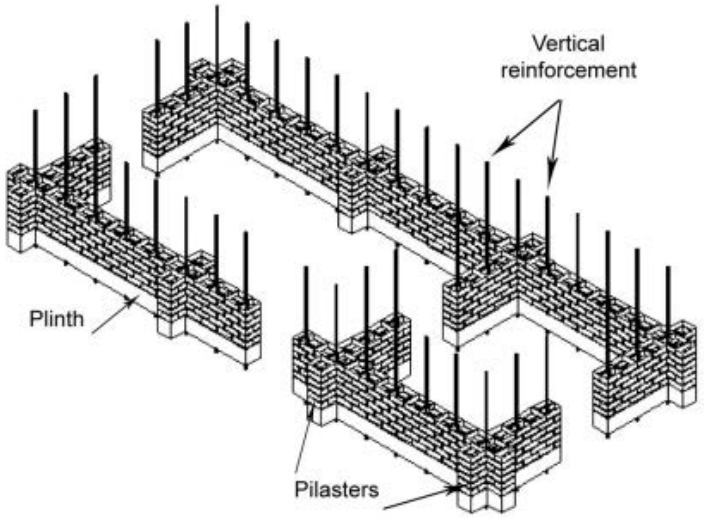


Figure 19. Sample placement of plinth, vertical reinforcement, and pilasters.

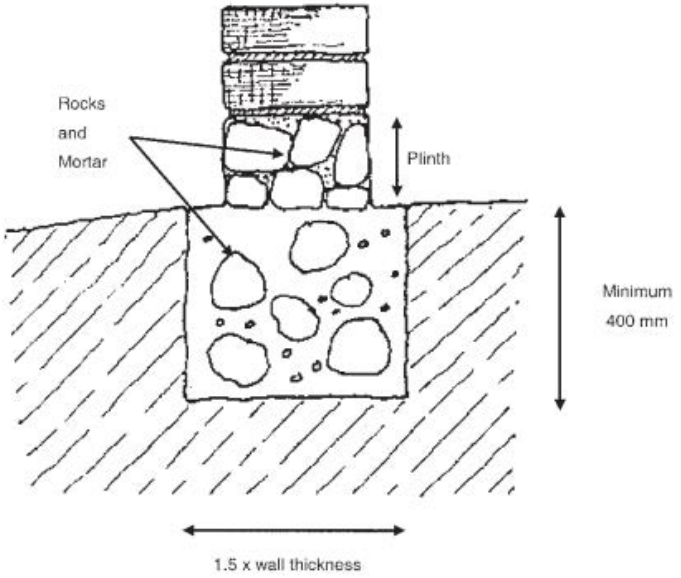


Figure 18. Foundation configuration (RESESCO, 1997).


social equity
cafe
research space
gathering
meeting room
administrative offices
int. boat workshop
economic viability
sapling growing
educational
environmental protection

Program:

- **Administrative/Research Center -**
  President of Directive
  Executive Director
  Agroecologic Project Coordinator
  Agroecologic Specialist
  Youth Program Coordinator
  Foundation Coordinator

  10'x10' offices: 6
  30'x20' meeting room / lobby: 1
  30'x20' educational space: 1
  Total Area: 1800 sq ft.

- **Agro-Ecologic -**
  1 Coordinator
  1 Specialist
  30 max. Volunteers

  10'x30' food greenhouses: 2
  20'x30' sapling greenhouse: 2
  20'x30' boating equip storage: 1
  20'X30' cafe: 1
  Total Area: 2700 sq ft.

- **Taller / Boat Workshop -**

  50'x30' warehouse workshop: 1
  60'x50' central covered gathering space: 1
  Total Area: 4500 sq ft

Total Min. Covered Area: 9000 sq ft.

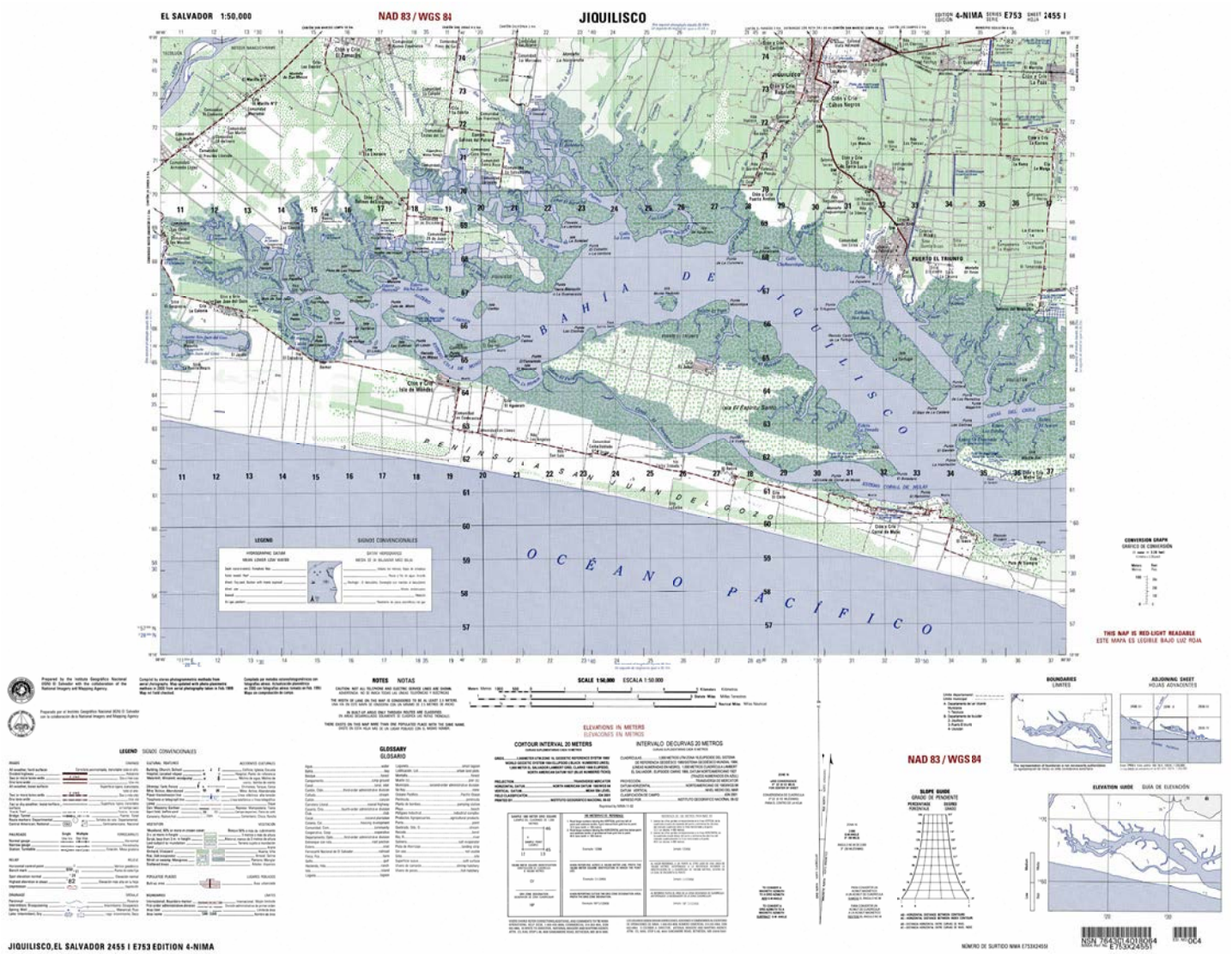
TABLE 1004.5 MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR[a]		
Accessory storage areas, mechanical equipment room	300 gross		
Agricultural building	300 gross		
Aircraft hangars	500 gross		
Airport terminal			
Baggage claim	20 gross		
Baggage handling	300 gross	Concourse	100 gross
Waiting areas	15 gross		
Assembly			
Gaming floors (keno, slots, etc.)	11 gross		
Exhibit gallery and museum	30 net		
Assembly with fixed seats	See Section 1004.6		
Assembly without fixed seats			
Concentrated (chairs only—not fixed)	7 net		
Standing space	5 net		
Unconcentrated (tables and chairs)	15 net		
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net		
Business areas	150 gross		
Concentrated business use areas	See Section 1004.8		
Courtrooms—other than fixed seating areas	40 net		
Day care	35 net		
Dormitories	50 gross		
Educational			
Classroom area	20 net		
Shops and other vocational room areas	50 net		
Exercise rooms	50 gross		
Group H-5 fabrication and manufacturing areas	200 gross		
Industrial areas	100 gross		
Institutional areas			
Inpatient treatment areas	240 gross		
Outpatient areas	100 gross		
Sleeping areas	120 gross		
Kitchens, commercial	200 gross		
Library			
Reading rooms	50 net		
Stack area	100 gross		
Locker rooms	50 gross		
Mall buildings—covered and open	See Section 402.8.2		
Mercantile	60 gross		
Storage, stock, shipping areas	300 gross		
Parking garages	200 gross		
Residential	200 gross		
Skating rinks, swimming pools			
Rink and pool	50 gross		
Decks	15 gross		
Stages and platforms	15 net		
Warehouses	500 gross		

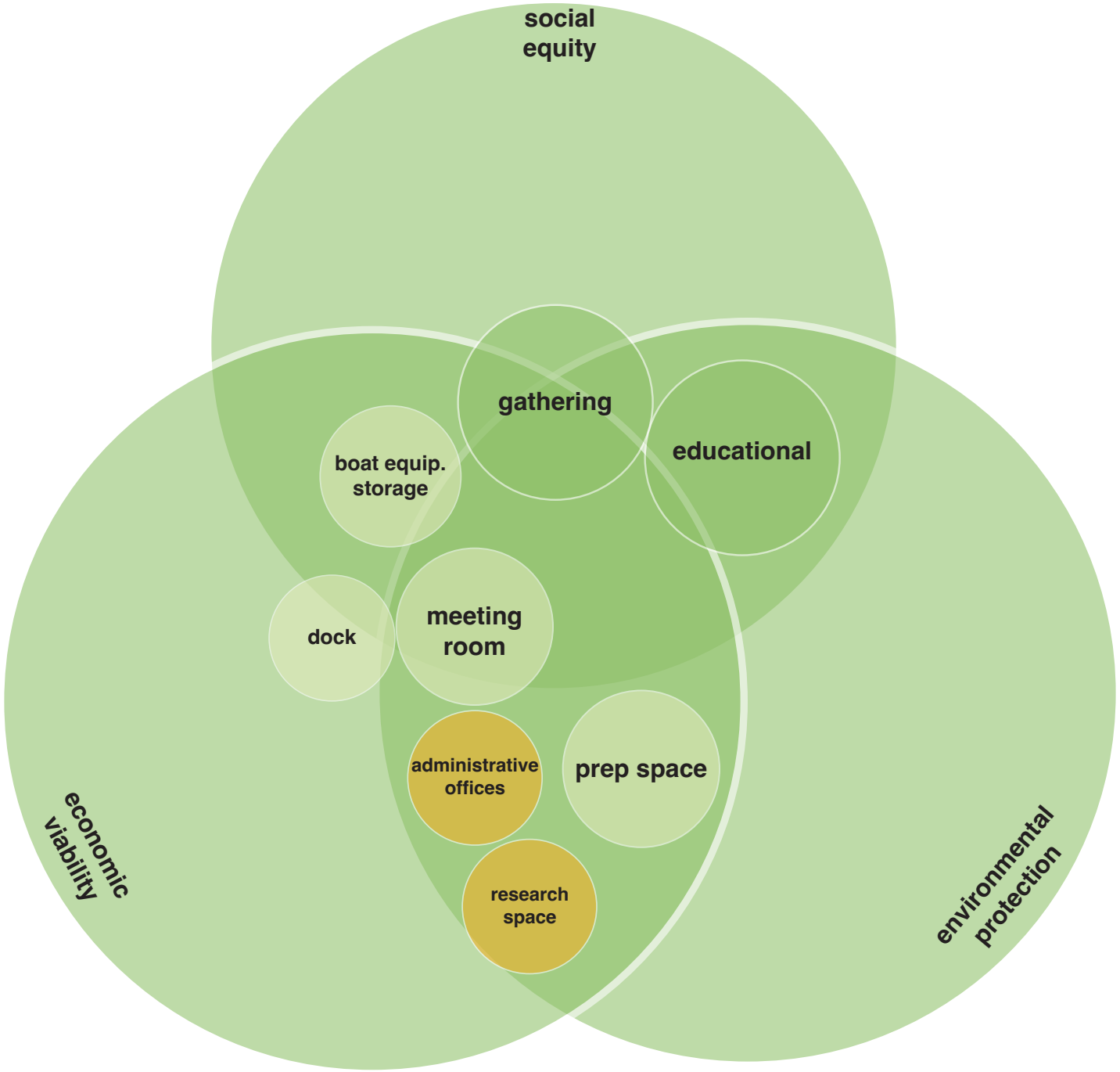
For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2.

a. Floor area in square feet per occupant.

Design Process

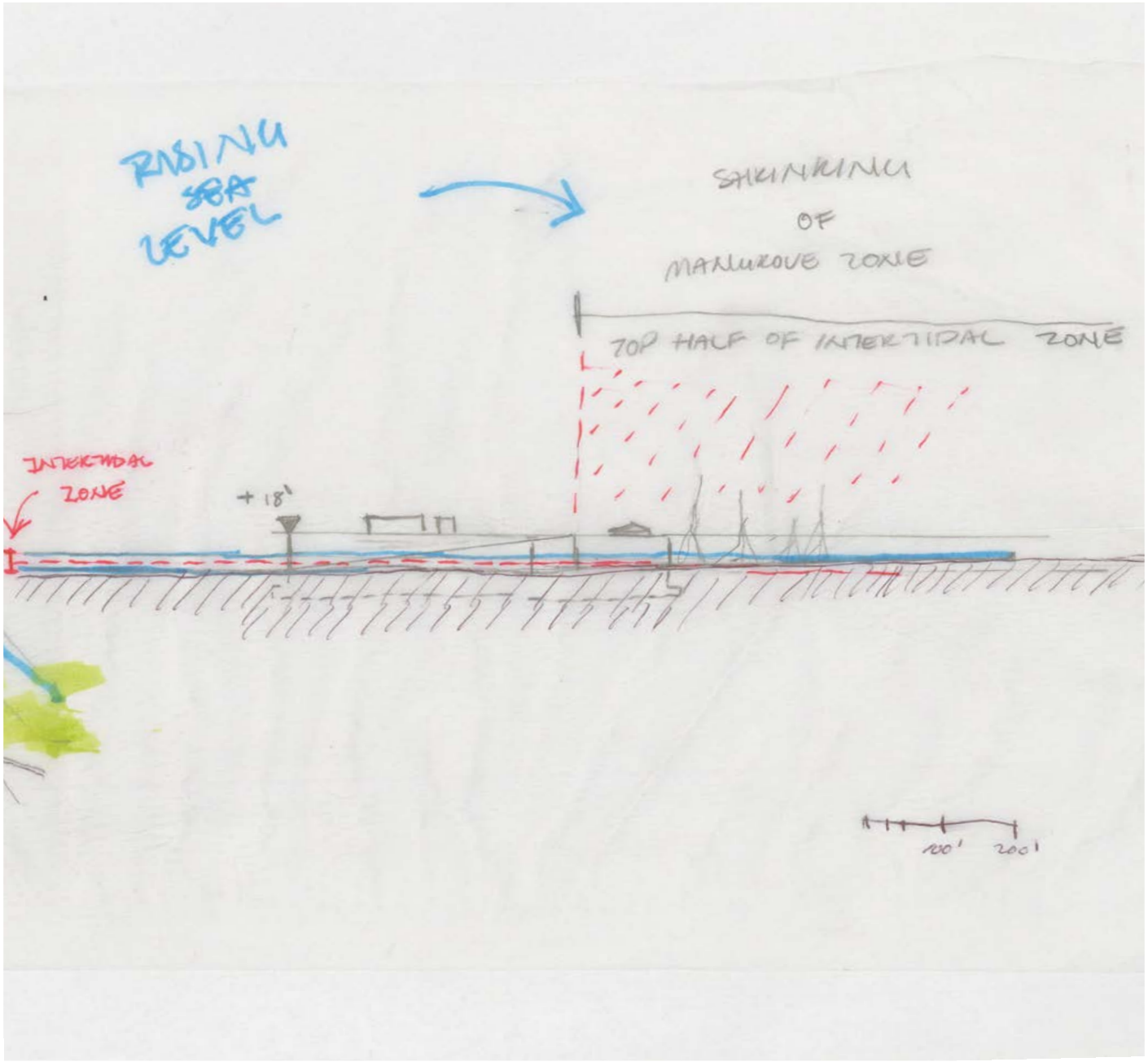


source: USGS

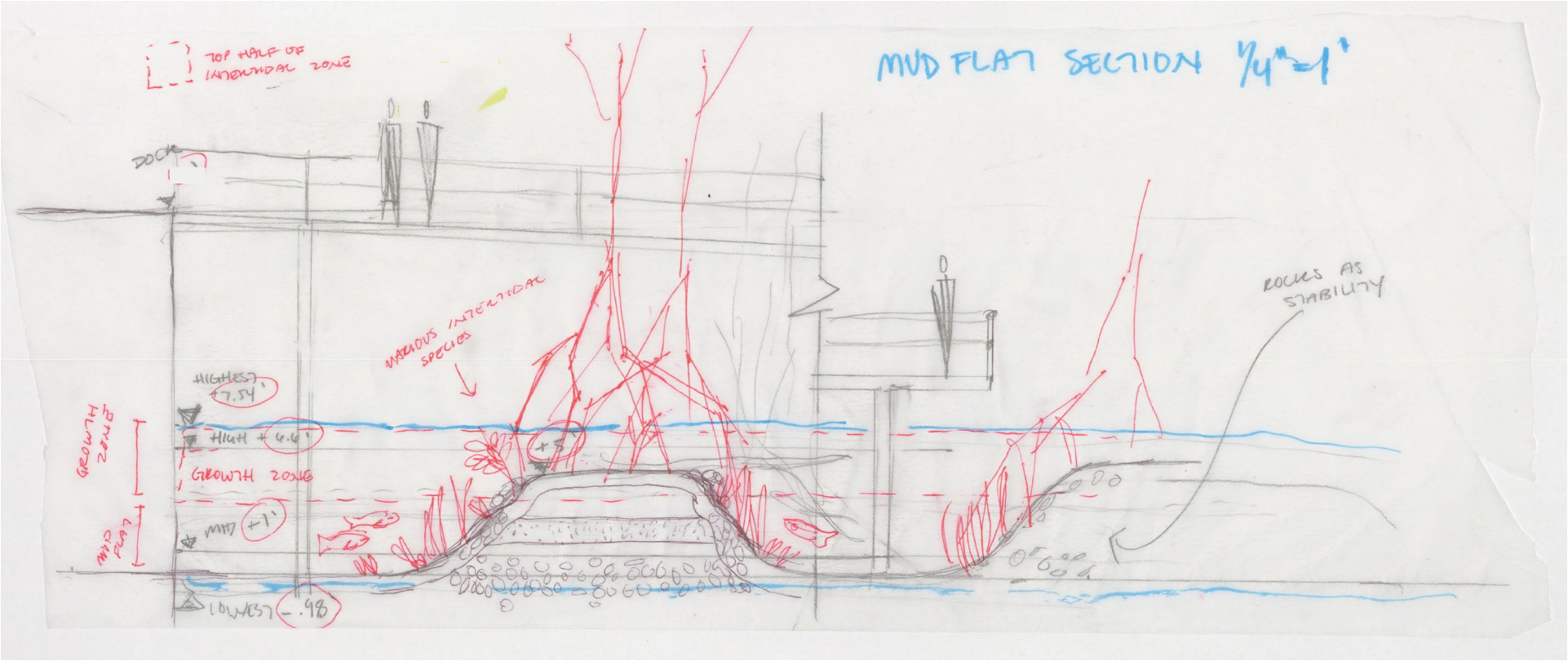

social
equity
gathering
boat equip.
storage
educational
dock
meeting
room
administrative
offices
prep space
research
space
economic
viability
environmental
protection

prevailing wind

sketch analysis

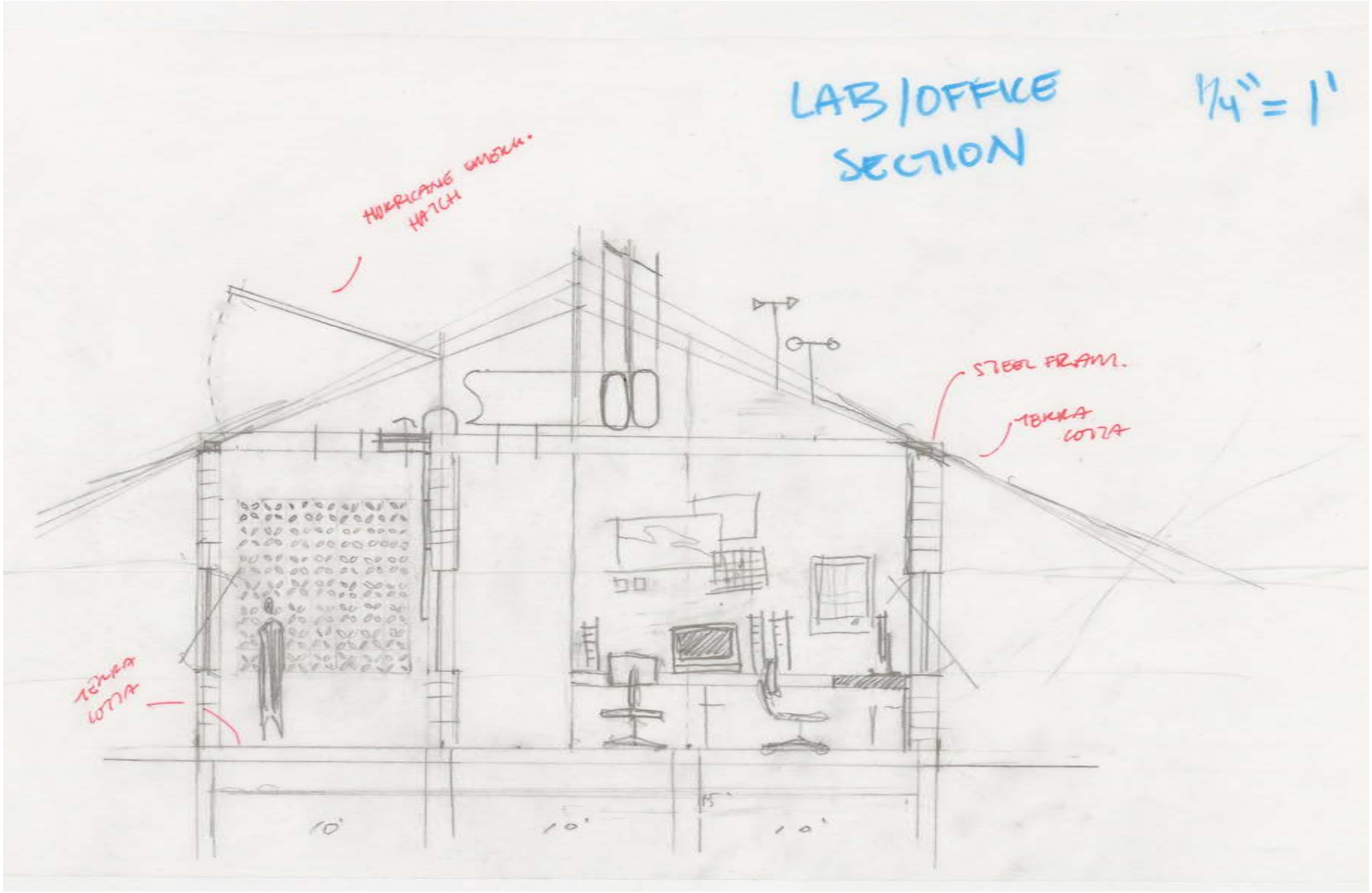


sketch sectional analysis

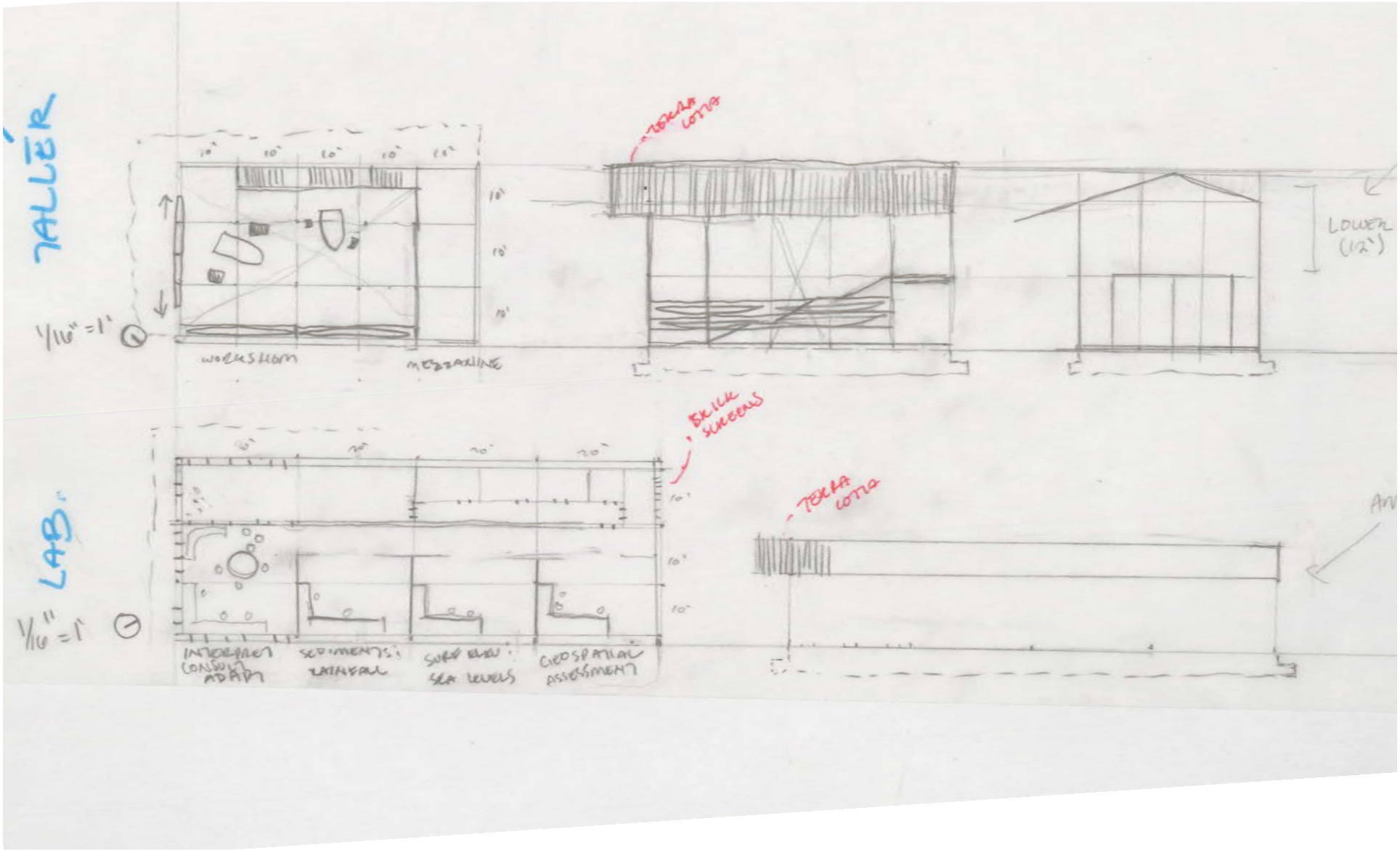


interactivity analysis

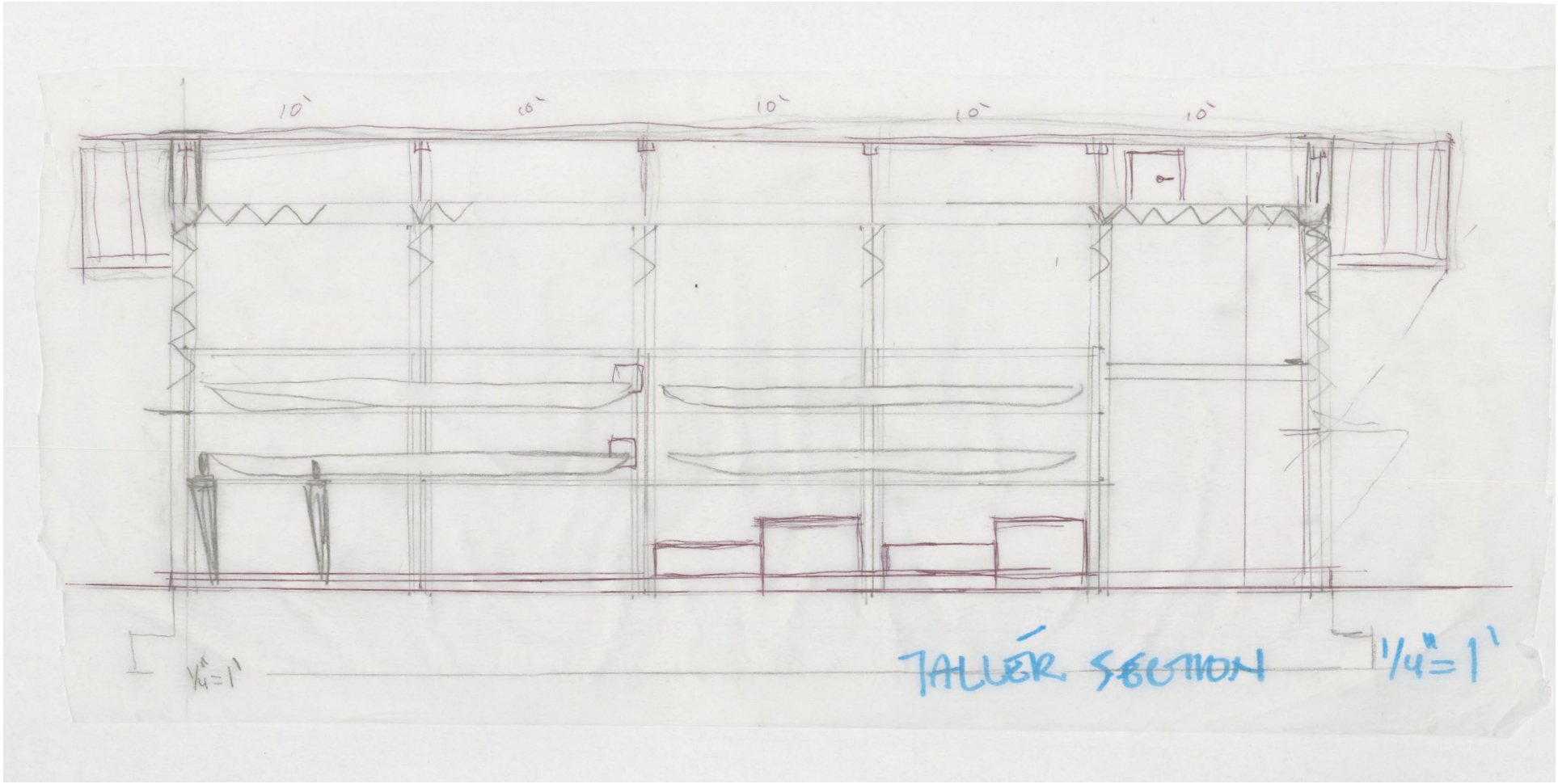
interactivity analysis



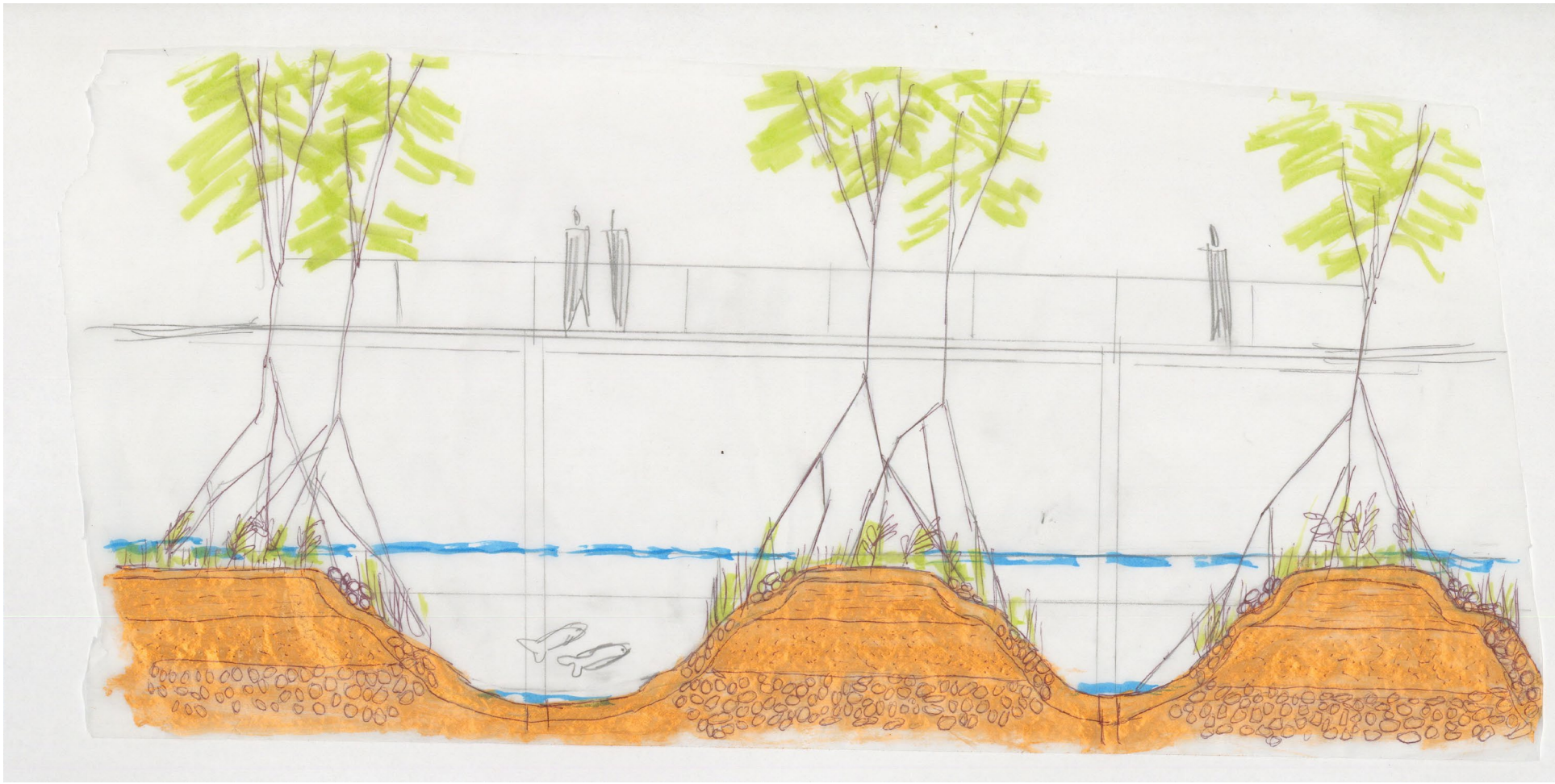
lab sketch study



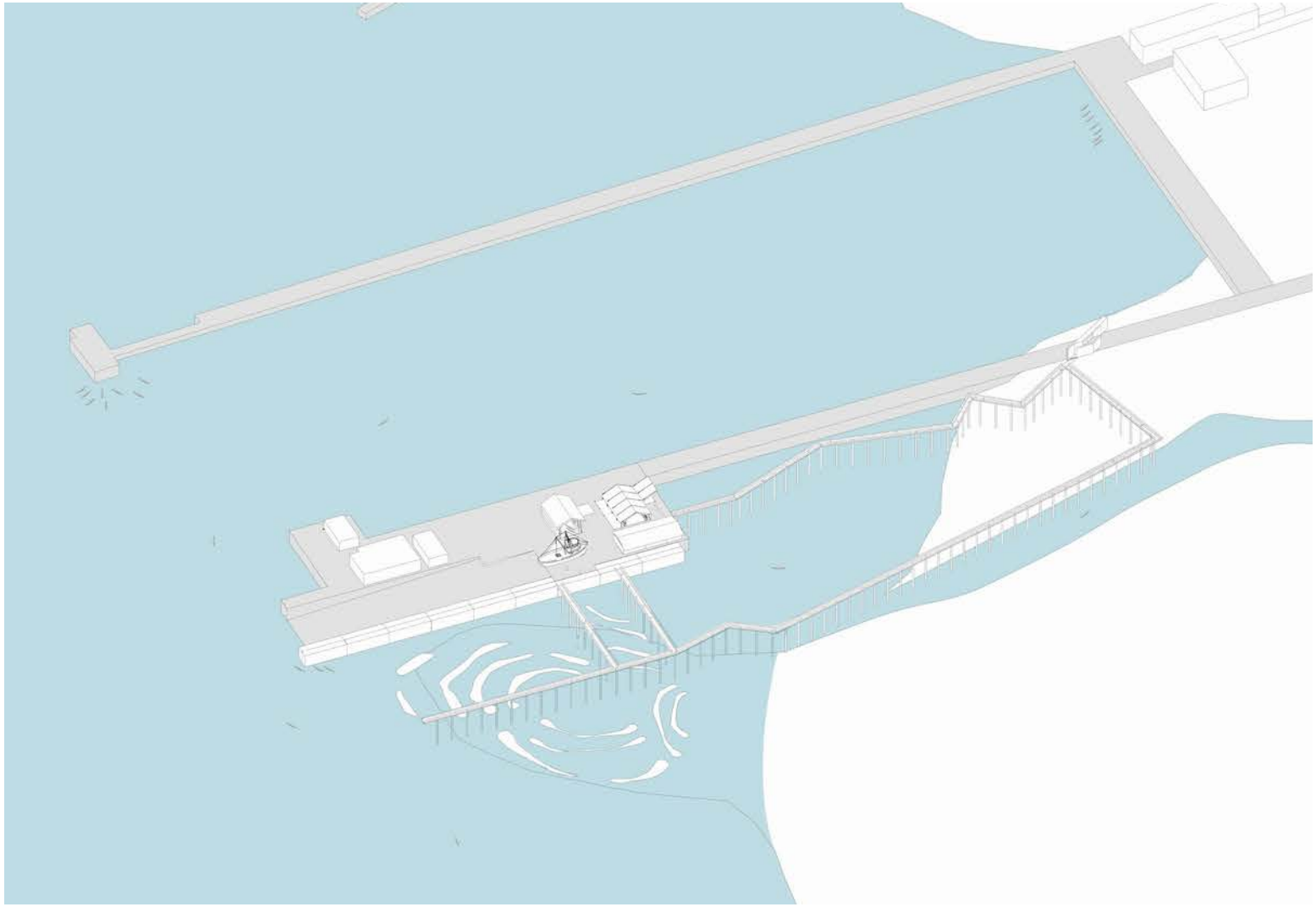
plan / elevation studies



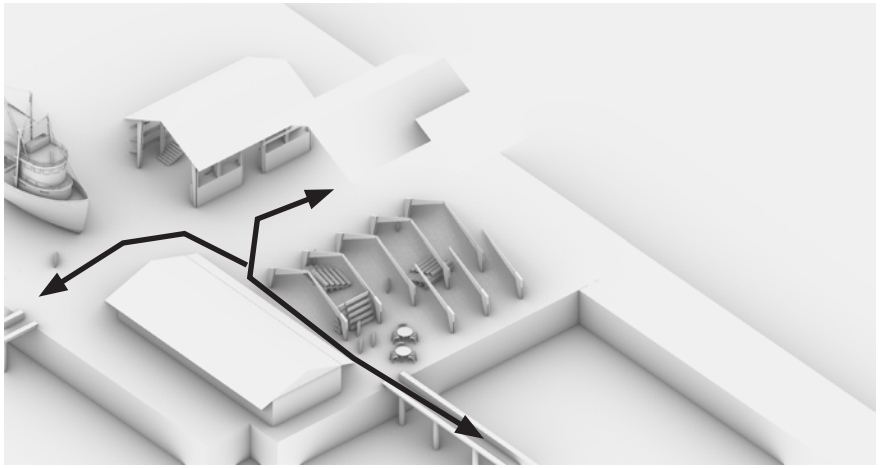
boat workshop sectional study

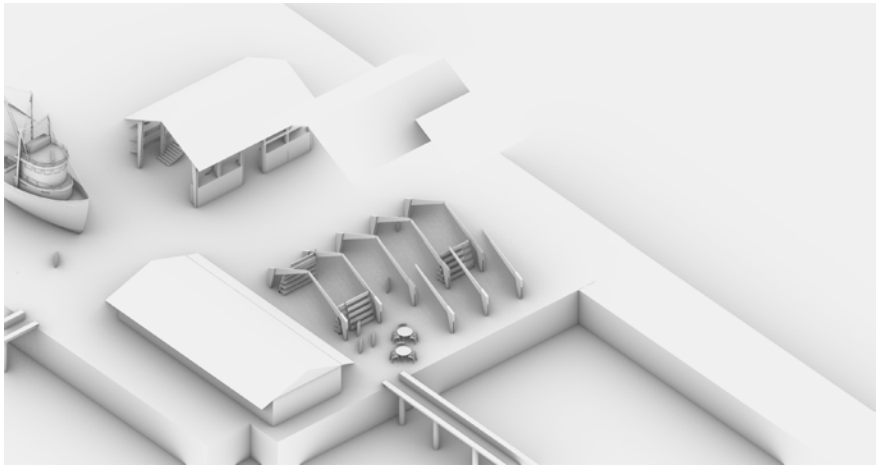


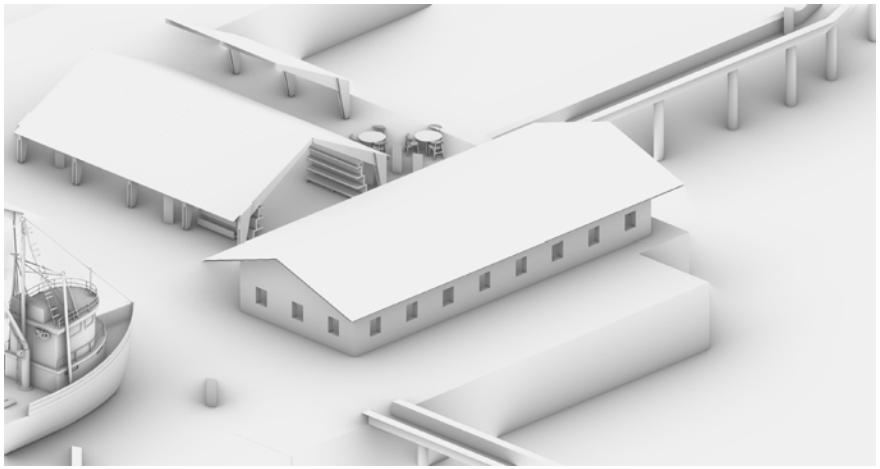
restoration mound study

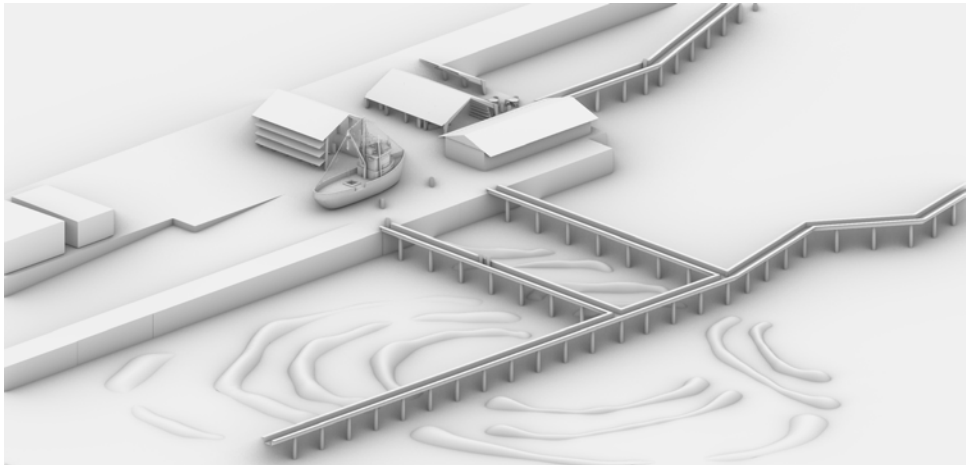


second iteration









The second iteration embraced the solidity of the existing infrastructure to avoid constructing on the mud flat. Taking advantage of pre-existing solidity allows for greater durability as well as anchor points for experiential walkways. These nature walks are seen all over the world, even in protected National forests such as in Costa Rica and Germany. Nature walks bring all walks of life together in the name of conservancy, learning, and physical well-being. The forms take inspiration from the local construction types, such as masonry. Instead of CMU however, the main lab articulates itself as a contemporary adobe configuration, allowing for air cavities behind the veneer and a reinforced adobe structural back wall. The outdoor gathering space and taller/workshop spaces have embraces newer cross laminated bamboo rigid frames that add lightness and transparency, aiding in the purpose of their program. The mounds are a researched method of mangrove restoration that acts as both a point of research and exploration for visitors. Intersections of these programs allow for a vibrant and active maritime center that engages in the traditional aquatic transit in the name of forest recovery, local education, and economic re-invigoration without disrupting housing affordabilty.

experiential studies

mound / walkway construction

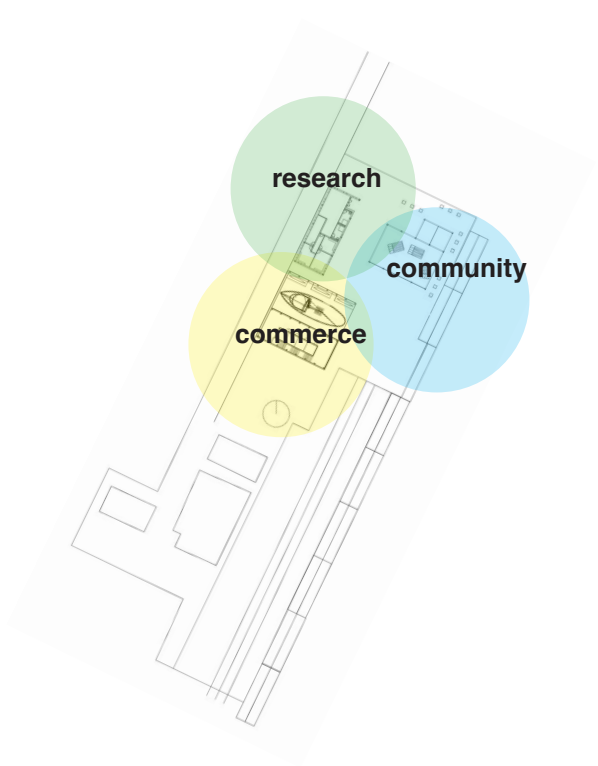
a few years later

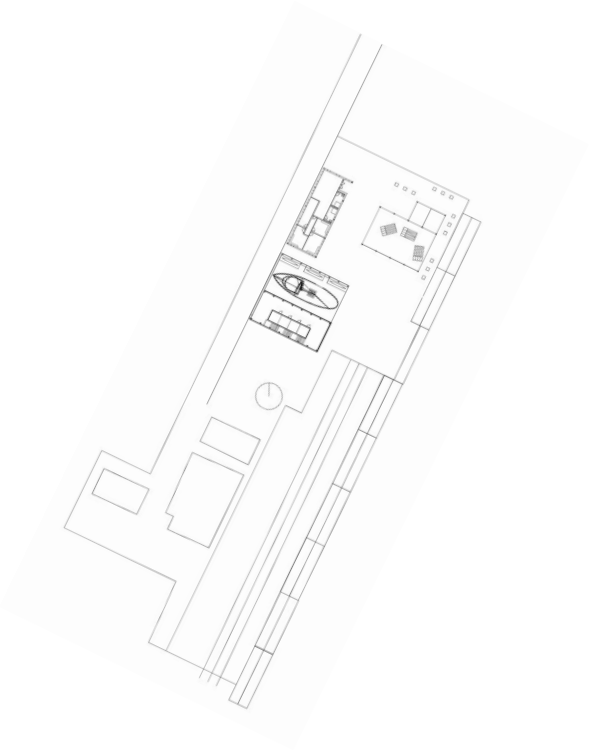
experiential studies

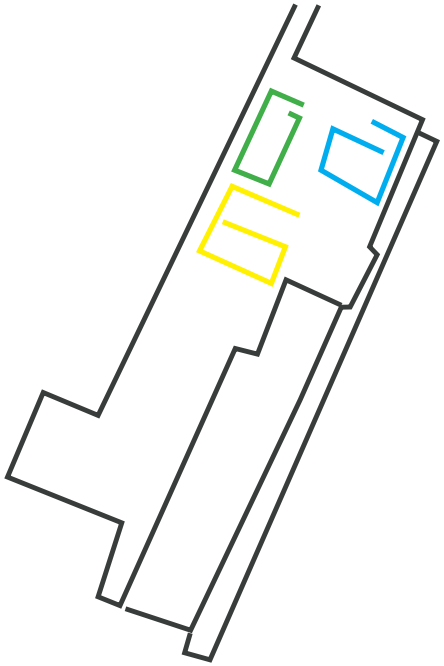
legend

1. **entry kiosk**
2. **gathering**
3. **cafe/ art**
4. **taller / office / workshop**
5. **education / labs**
6. **exist. fisherman support**
7. **eco boat tour dispatch**
8. **research vessel dock**

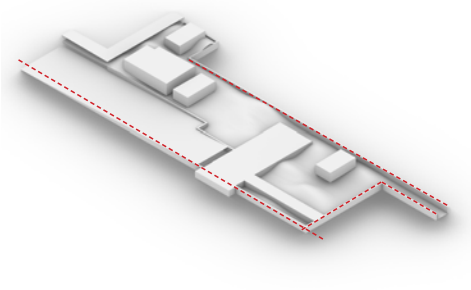
final iteration



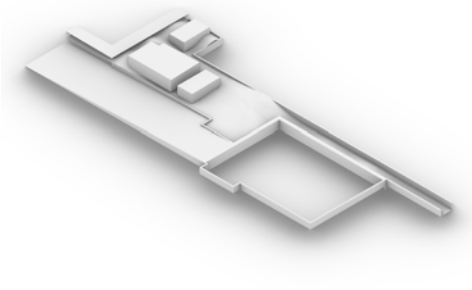




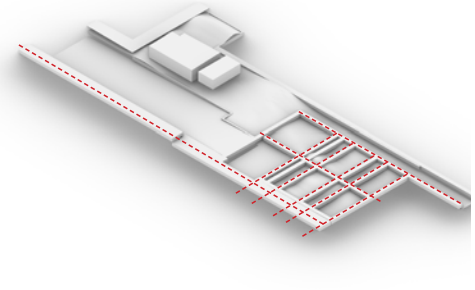
The final iteration solidifies, through study and intra personal interaction, how a walkway might interact with surrounding landscapes to create key points of meeting and observation that strengthen the conceptual approach of the program of the site. Allowing for maritime access invigorates the walkways as avenues of transit, points of rest, lanes of exercise, and as a tool for learning. The extension of the culture inherent in the site reflects in the program of the site, where crucial resources are researched in the lab and dialogue is reached within the environments of the workshop, while local vendors take advantage of the foot traffic, extending the touristic zone out to the dead mud flat, an area that can be restored to further invigorate local ecosystems and in turn, local nutritional and economic rehabilitation.



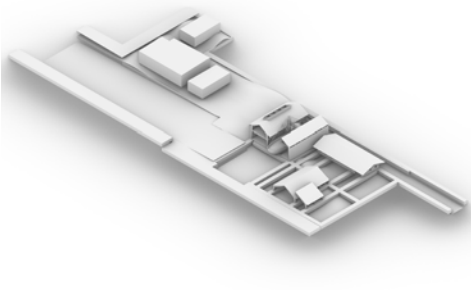
exisiting dock walls



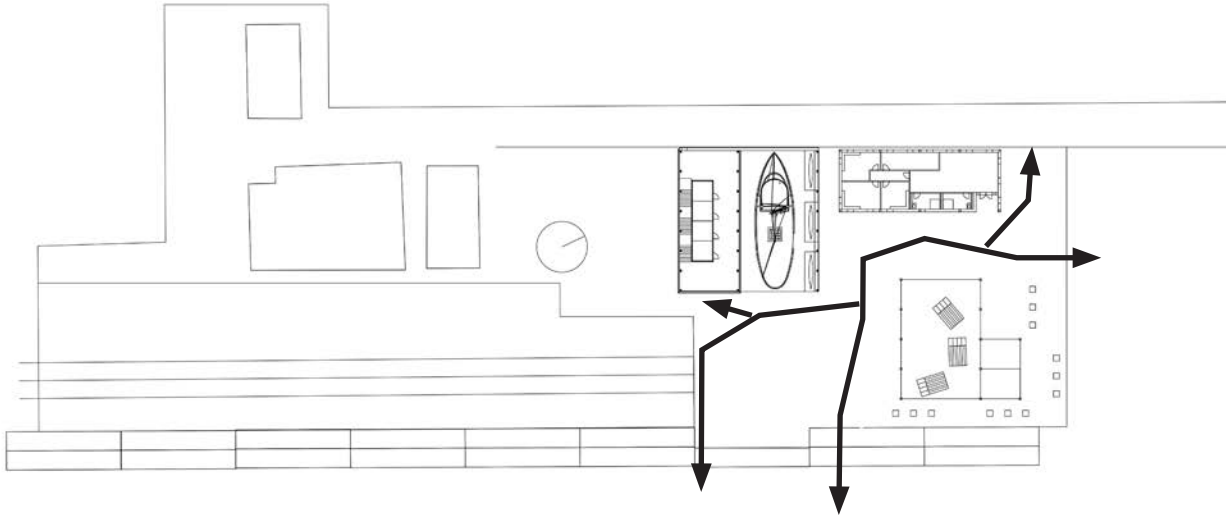
proposed excavation



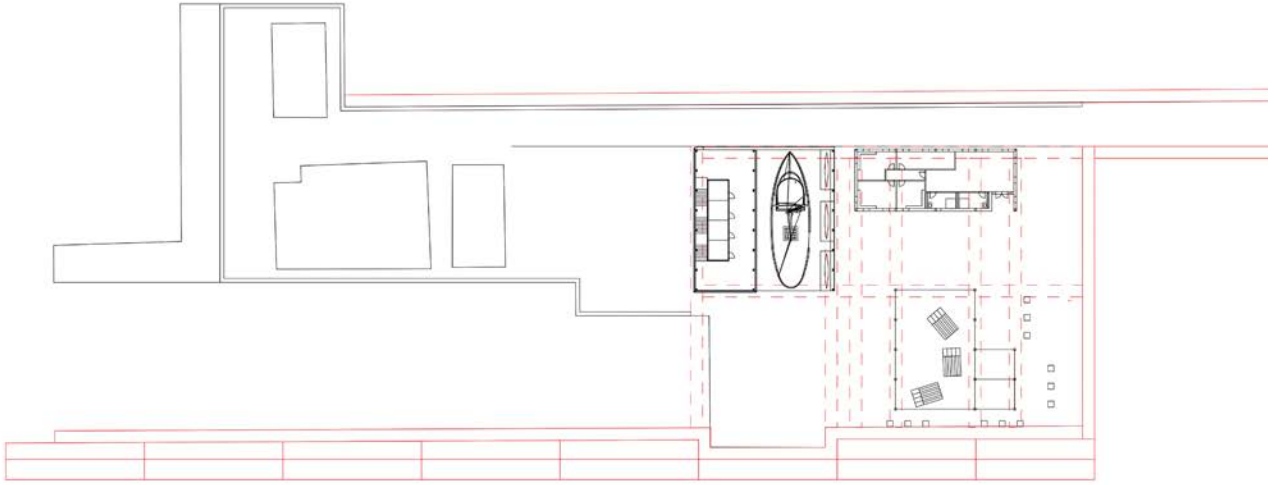
proposed dock support



increased stability



circulation

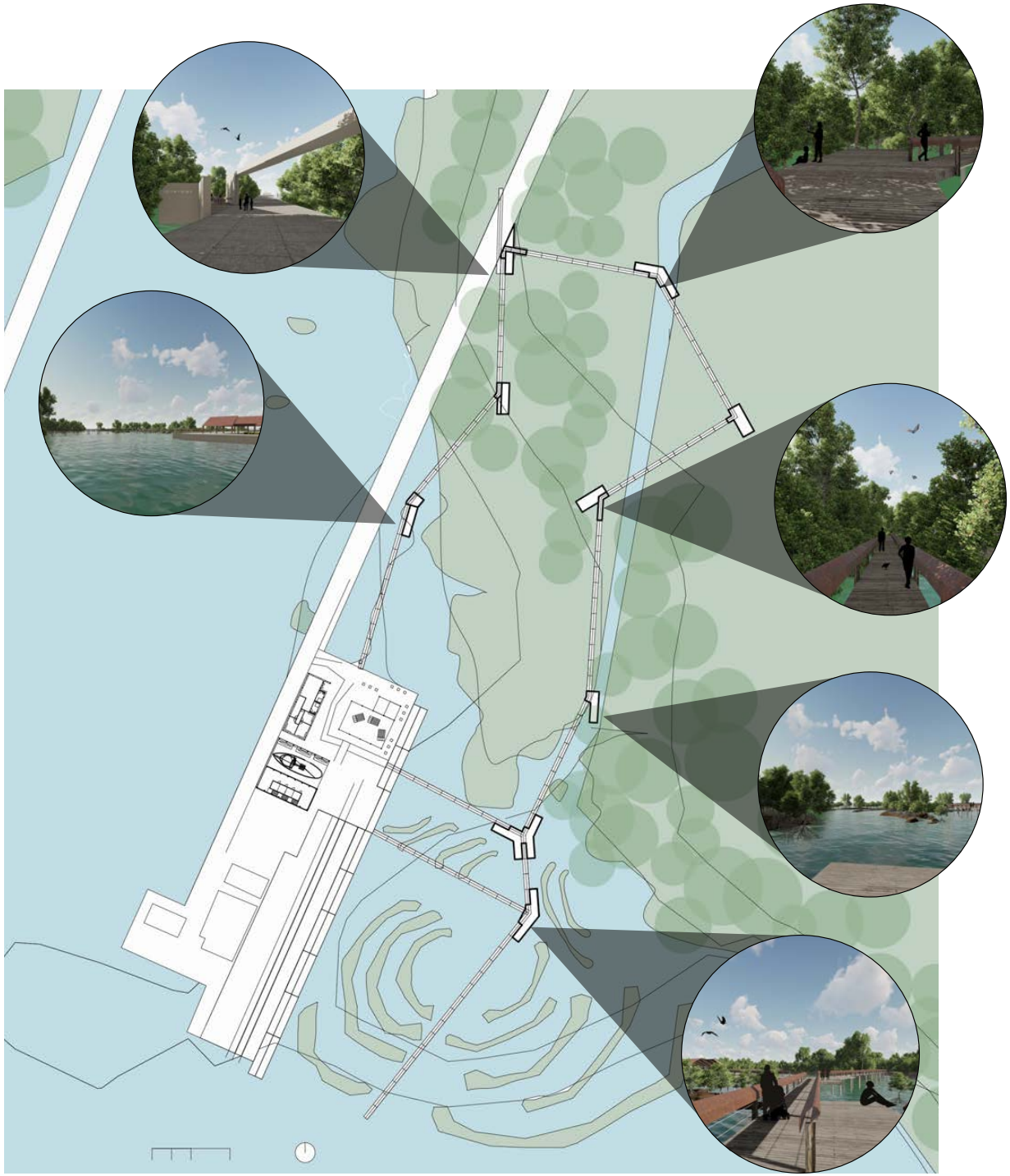


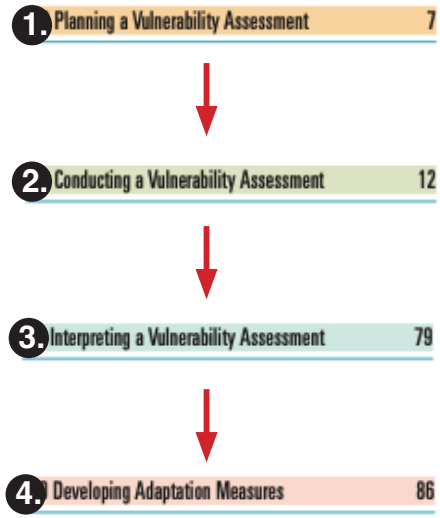
reinforced sub structure

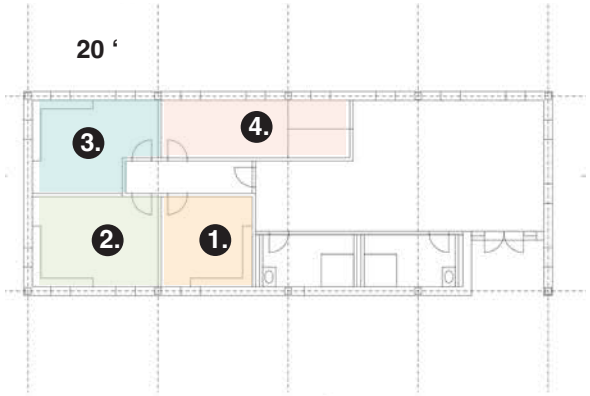

test a

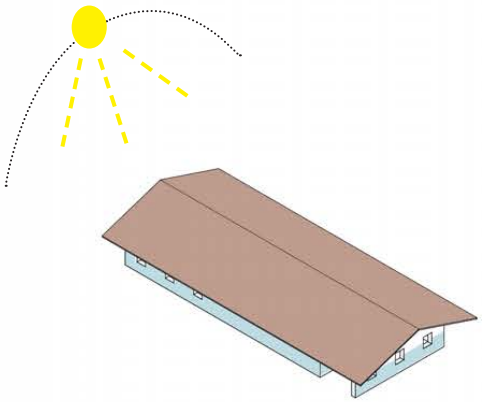

test b

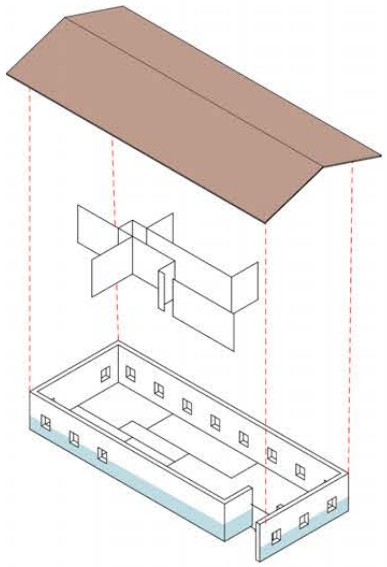

test c



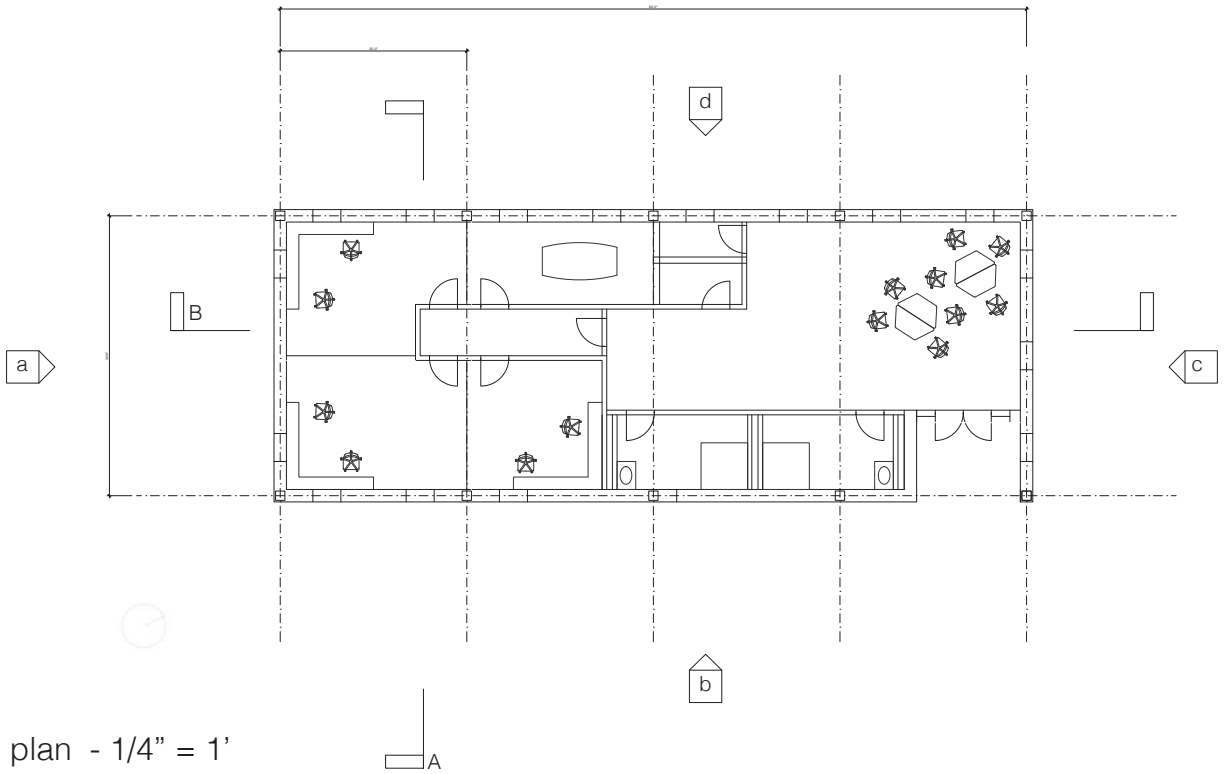




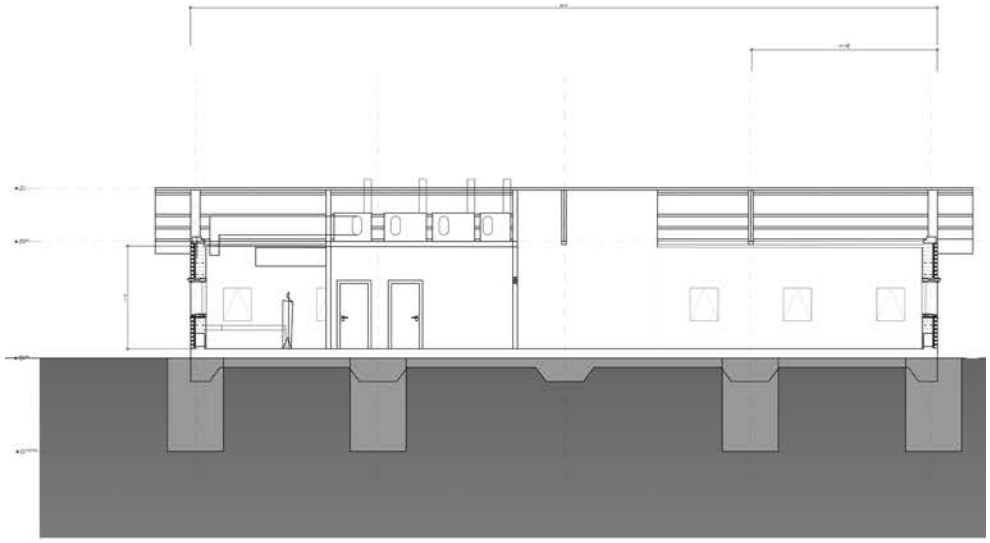




Asociacion Mangle uses real research from reputable sources as well as welcomes researchers to administer restoration programs. With research into the methodology of restoration, there are a set number of analytical steps to better approach a degraded mangrove site, especially since each is degraded for a variety of reasons. Therefore, the lab is divided into four small suites, each of which are meant for preliminary and eventually solidified planning approaches to tackle deforestation at any given site, whether inland or on the coast. The nature of restorative analysis proved to be relatively low tech, and as a non-profit organization, a smaller intervention is much more appropriate. The building uses adobe bricks reinforced with rebar as the main structural wall, using symmetry to its advantage since El Salvador is seismically active. The lab's intense ventilation needs are met by adapting the sloped roof space above as mechanical space that seals off the education space due to differing air filtration needs.



plan - 1/4” = 1’



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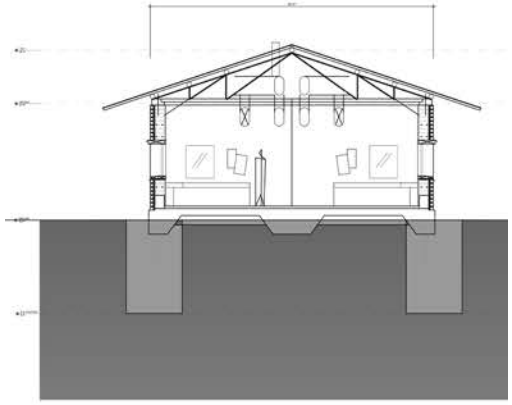
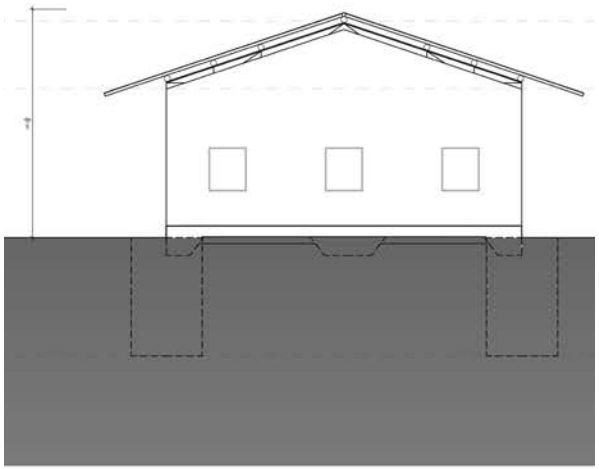
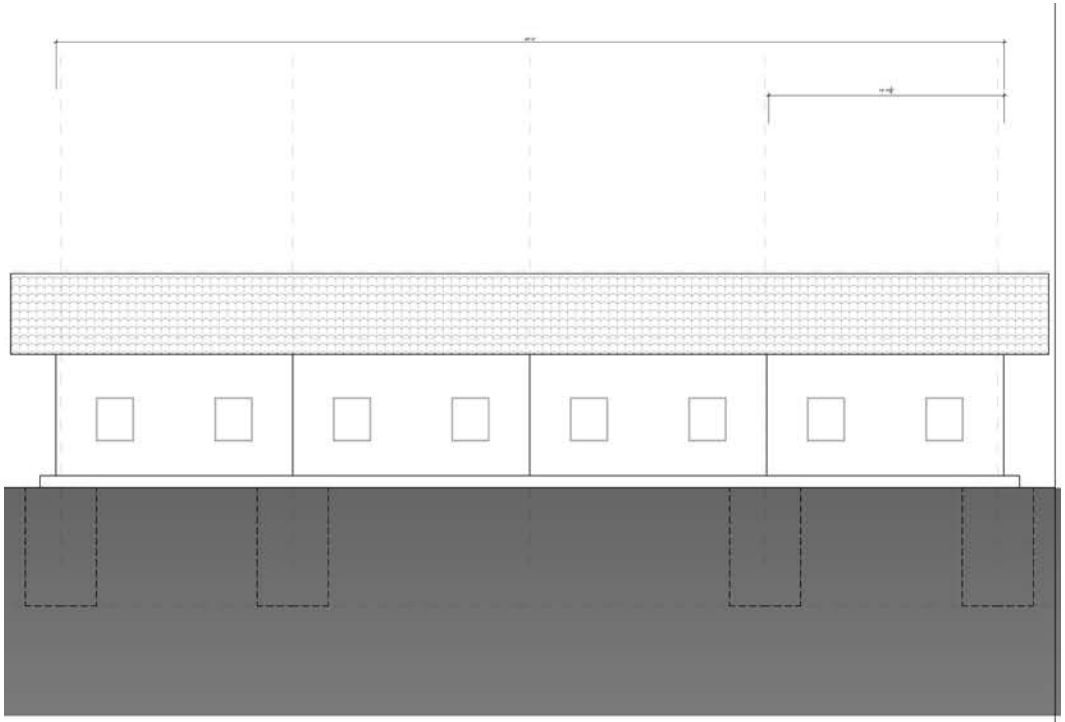


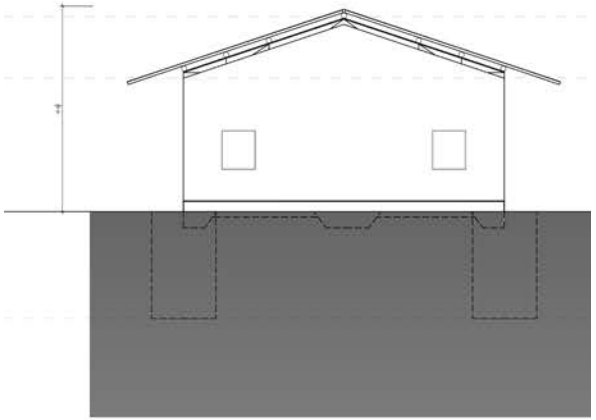
section A - 1/4” = 1’



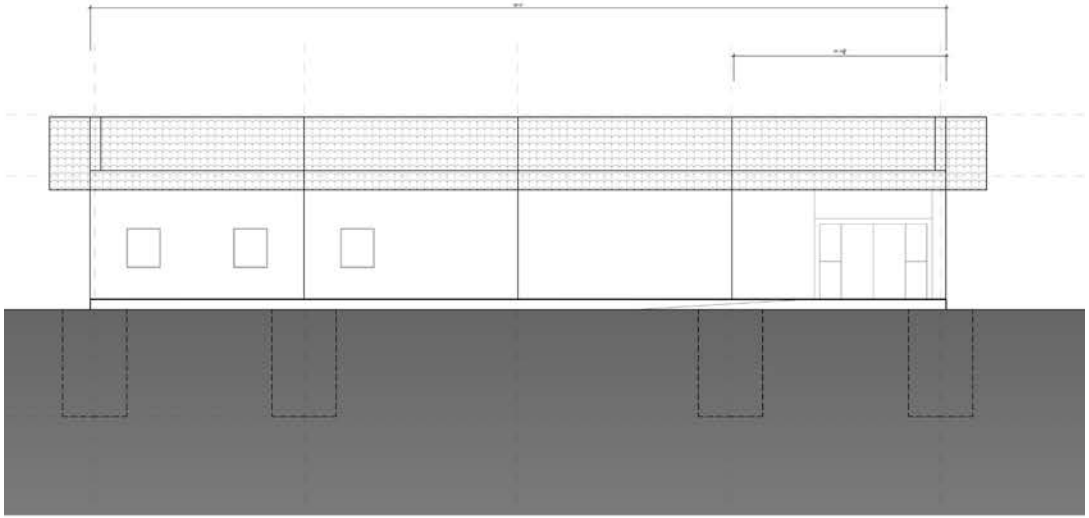
elevation c - 1/4” = 1’



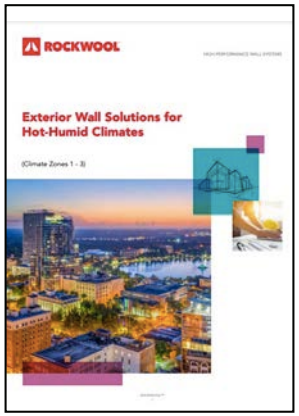
elevation d - 1/4” = 1’

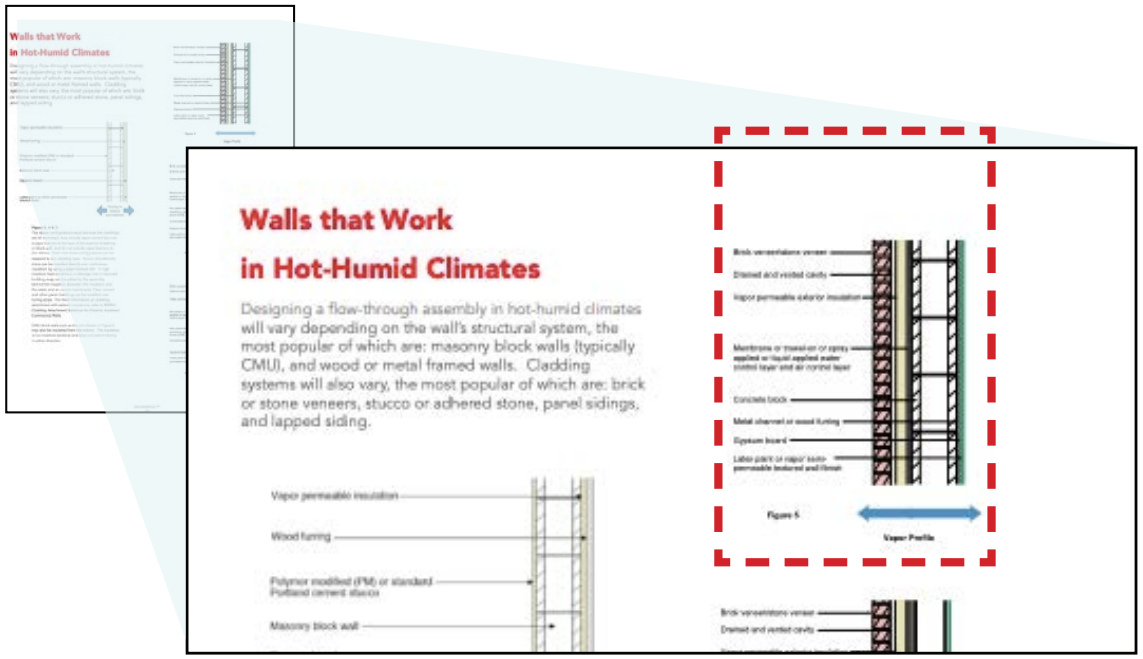


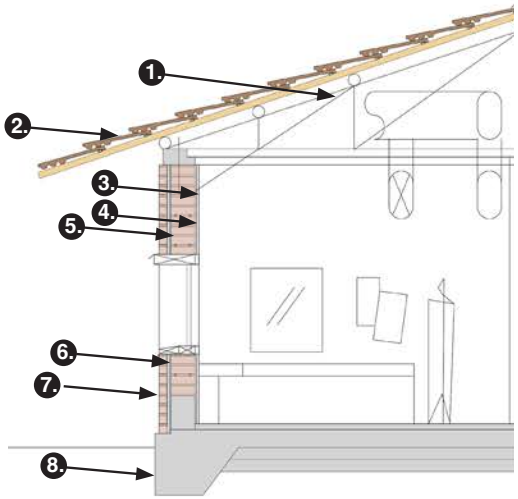
elevation a - 1/4” = 1’



elevation b - 1/4” = 1’

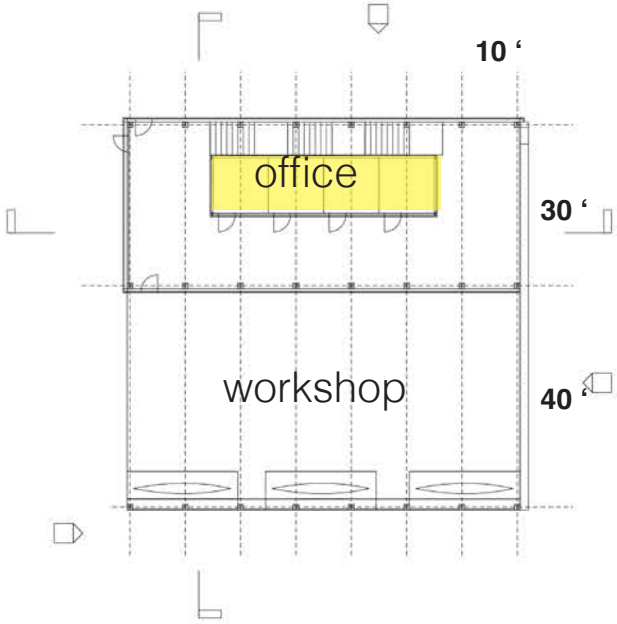


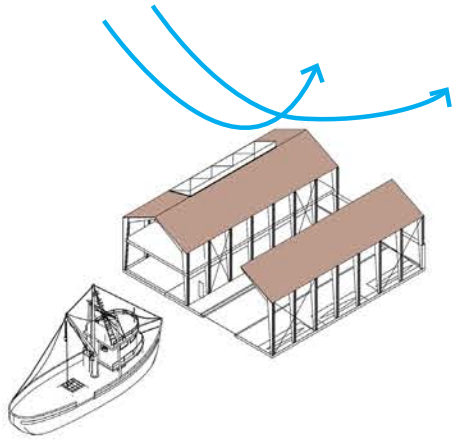


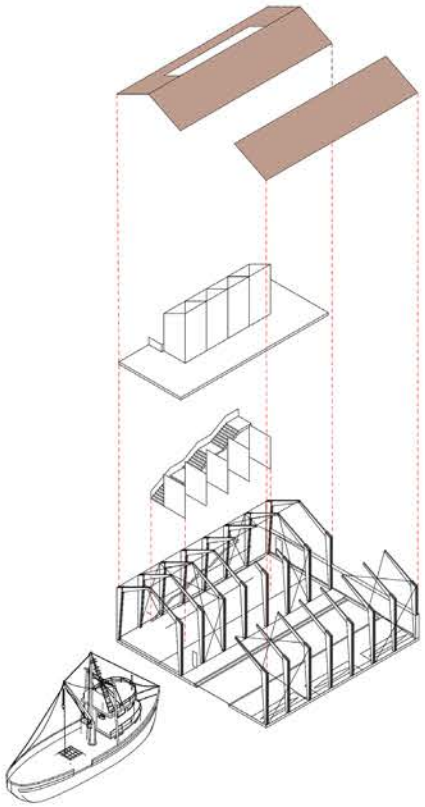


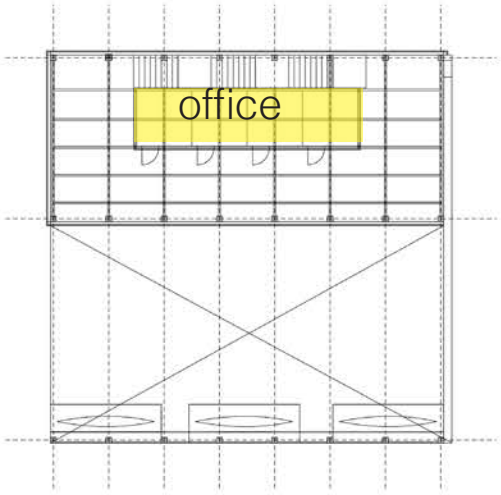
lab / education detail

1. roof truss
2. hurricane-reinforced polycarbonate roofing
3. gypsum + finish (ceramic tile in lab spaces)
4. furring
5. reinforced adobe brick wall
6. vapor permeable insulation + water/
7. air control layer air drain space + adobe brick veneer + stucco/ lime finish
8. monolithic slab on grade



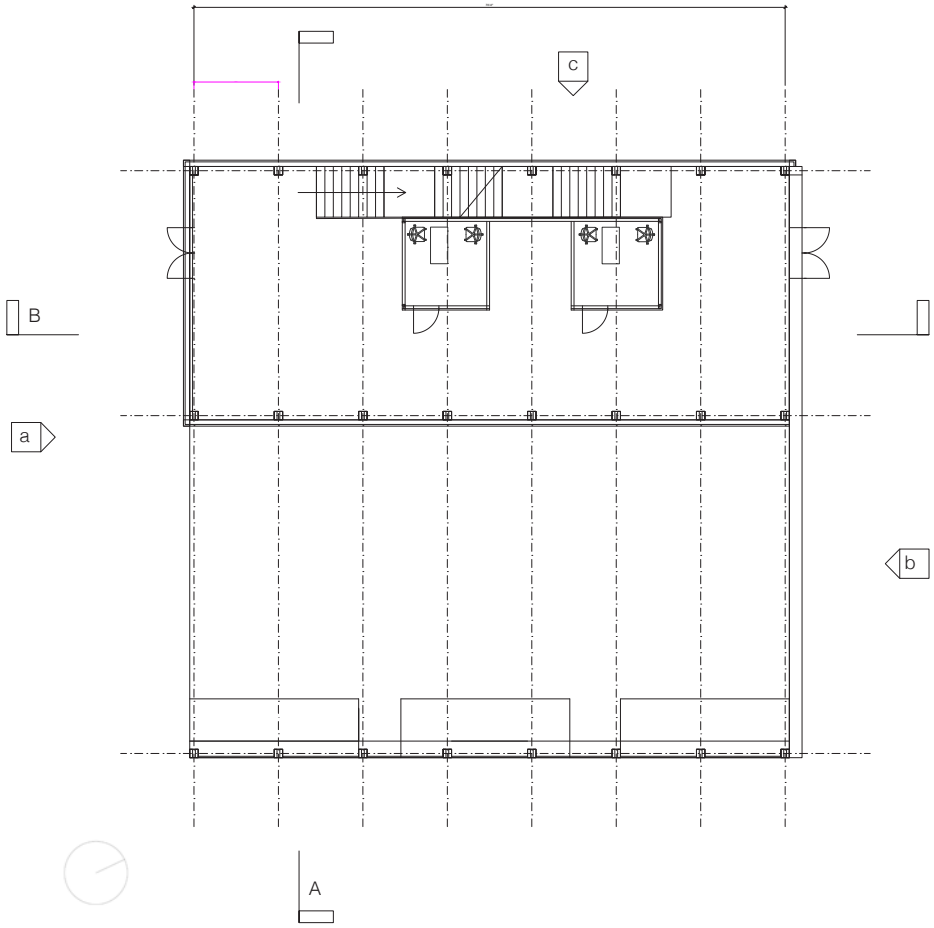




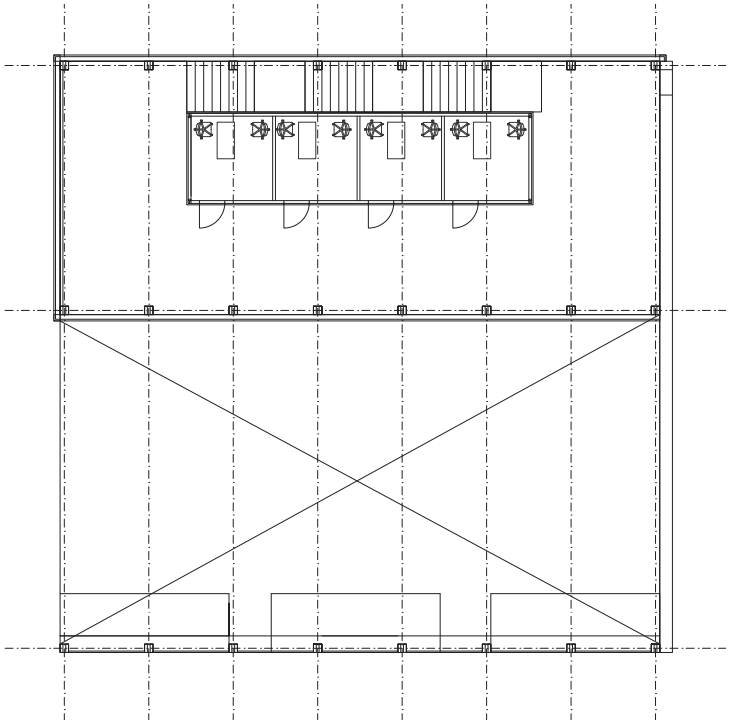


taller / workshop

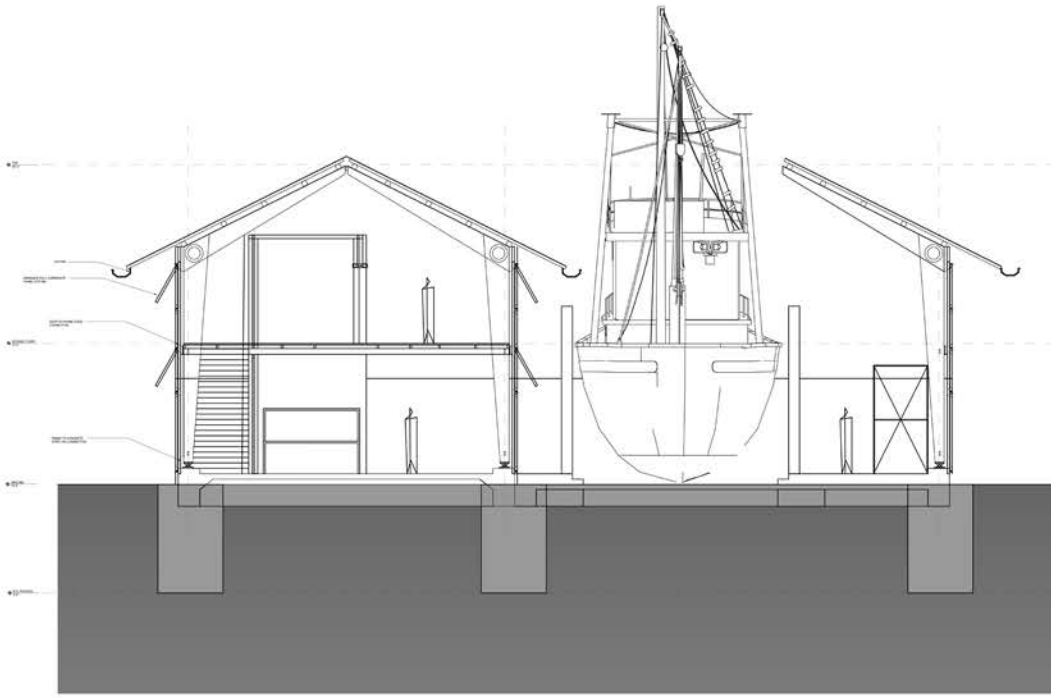
The taller operates as space to repair ‘launch’ boats and to store canoes. Larger fishing trolleys may also be moved into the workshop for extensive repairs. The main body has offices for fishing collectives as well as storage and workshop space. The above floor has office space for Asociacion Mangle as well as conference tables. This space is meant to house intensive work environments and place them in the intersection of direct work and collaboration. Merging program to save space is an extremely realistic problem to solve, and pertaining to the societal relationship between restorative/sustainable industry’s attitude toward the shrinking local fishing industry, is a common-sense opportunity to open and sustain healthy dialogue. The building takes advantage of wind and uses operable polycarbonate to allow for ventilation.



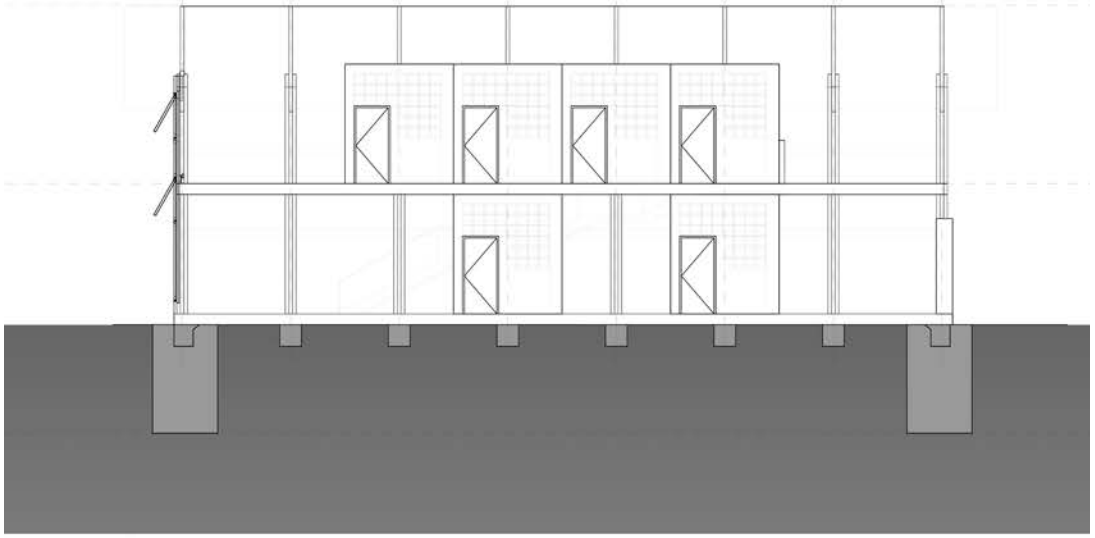
first floor plan - 1/4” = 1’



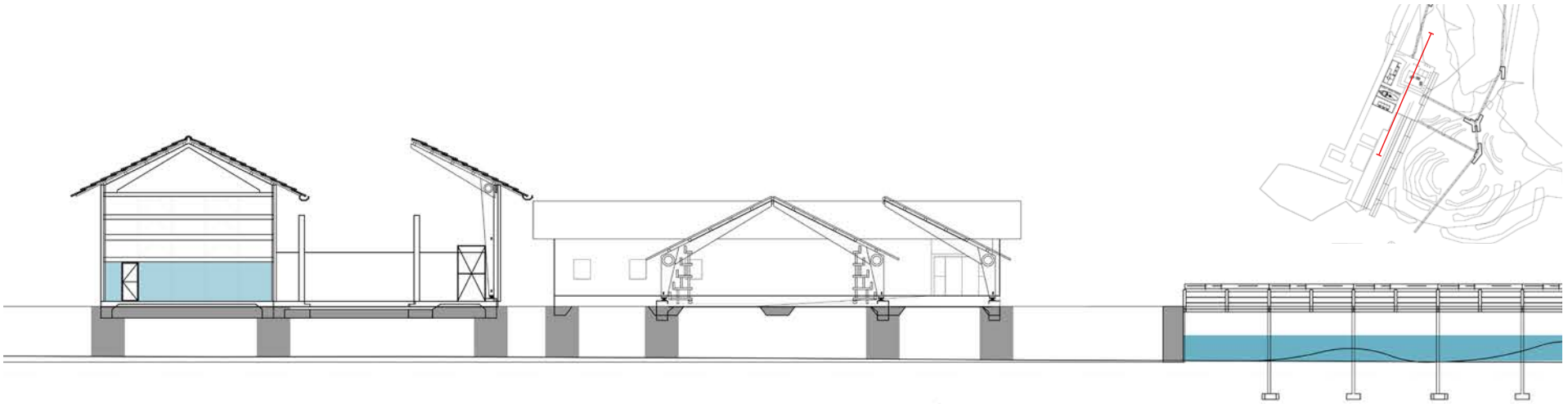
second floor plan - 1/4” = 1’



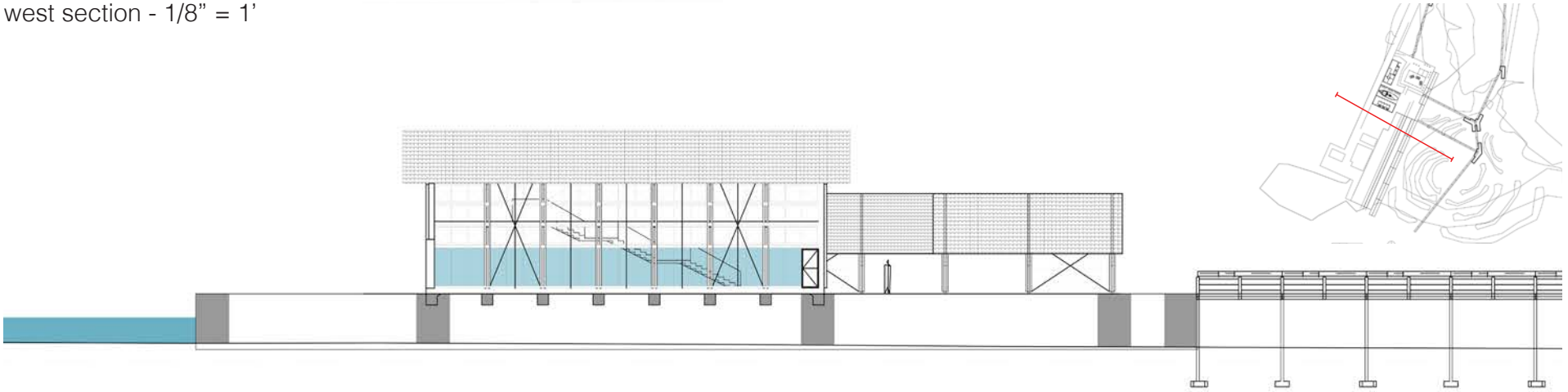
section A - 1/4” = 1’



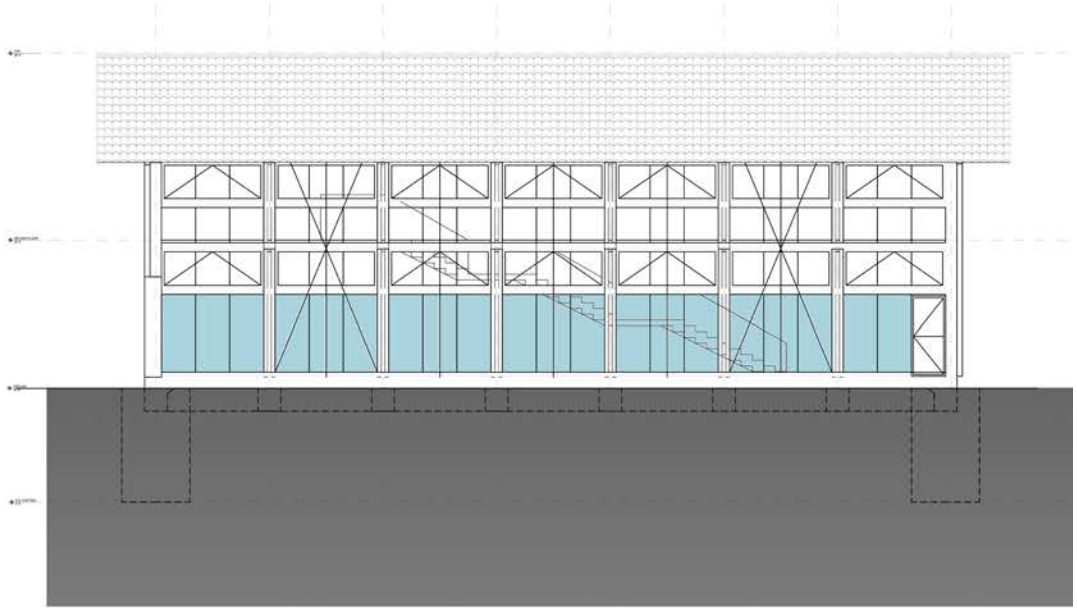
section B - 1/4” = 1’



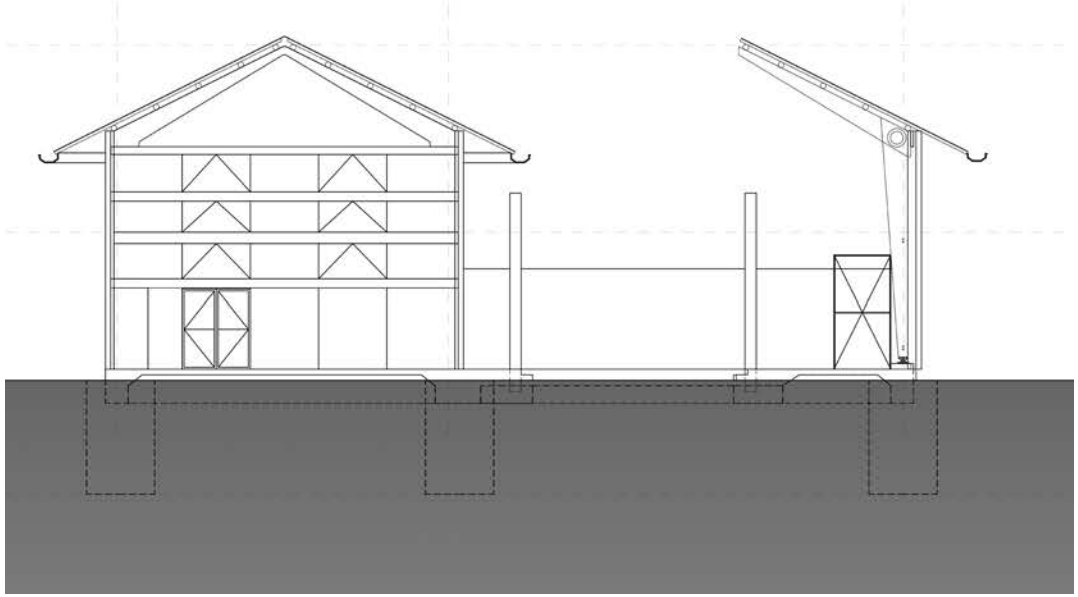
west section - 1/8” = 1’



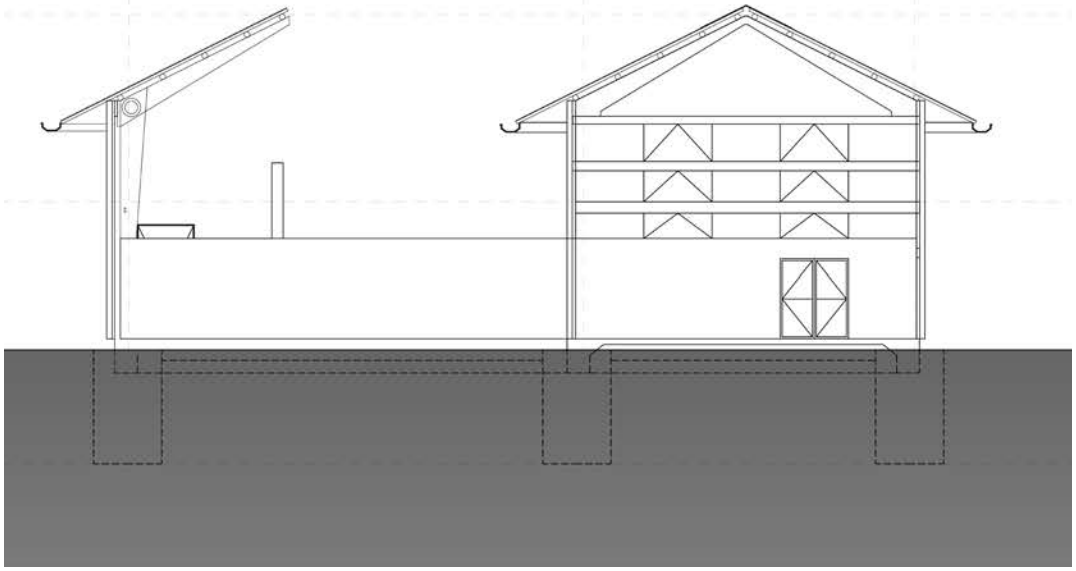
north section - 1/8” = 1’



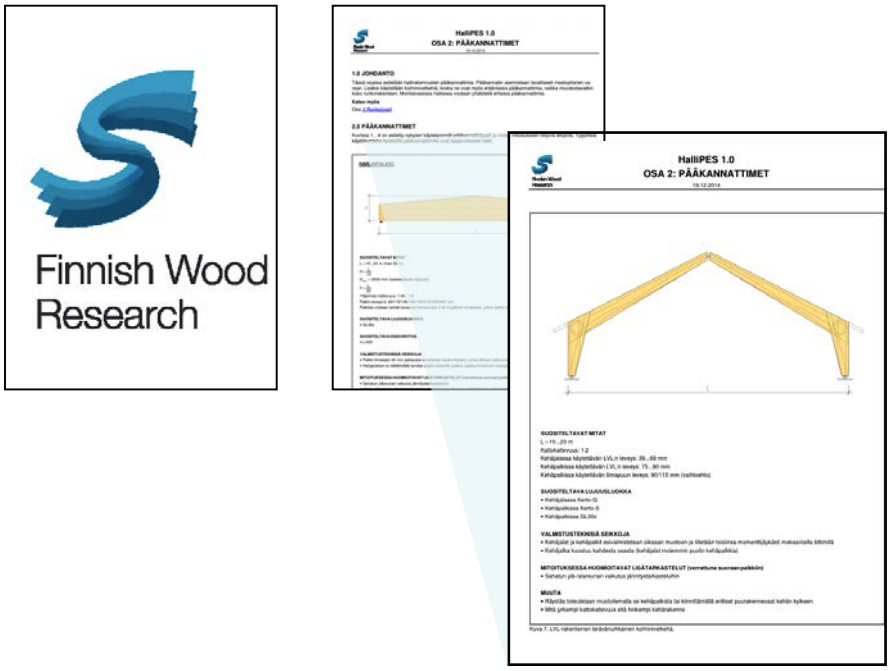
elevation b - 1/4” = 1’

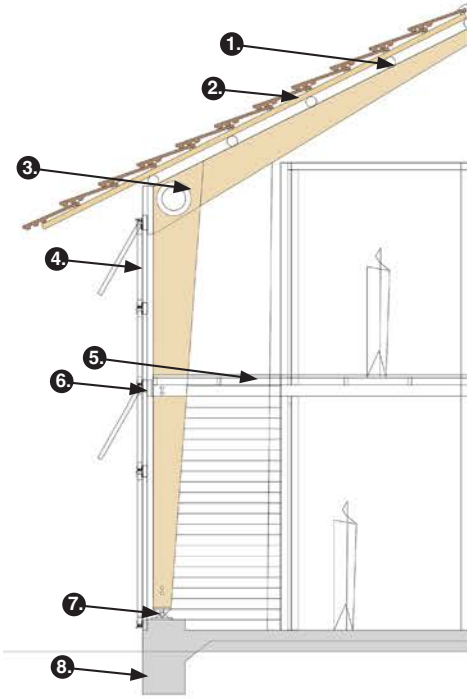


elevation a - 1/4” = 1’



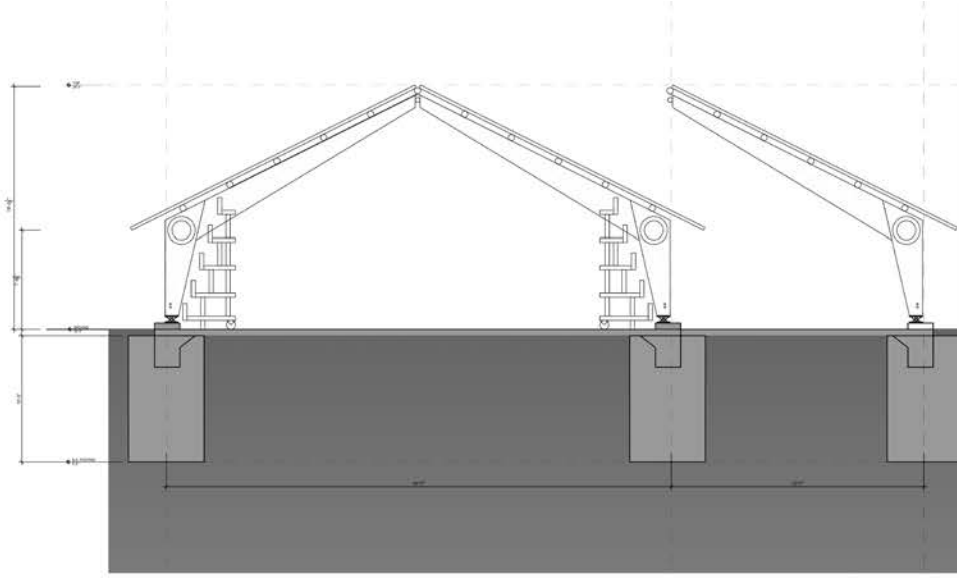
elevation c - 1/4” = 1’



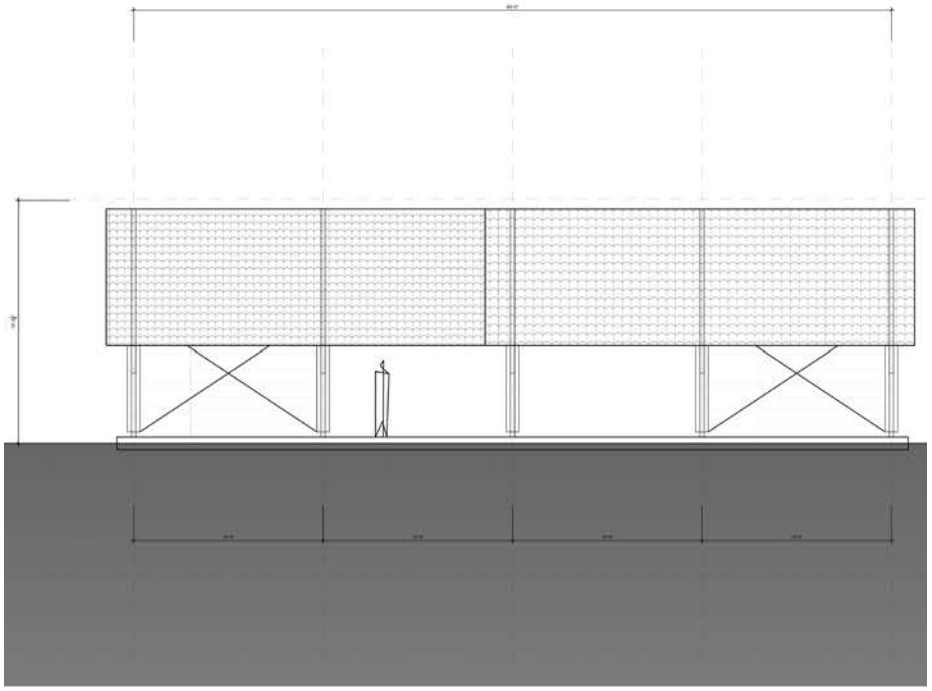


office / workshop detail

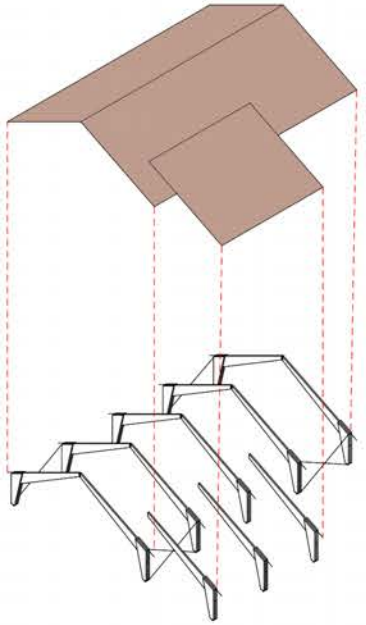
1. **bamboo purlin roof support system**
2. **hurricane-reinforced polycarbonate roofing**
3. **cross laminated bamboo rigid frame**
4. **polycarbonate Arcowall system**
5. **deck**
6. **deck and wall support steel connection**
7. **wood to concrete steel roller connection**
8. **monolithic slab on grade**



elevation a - 1/4” = 1’

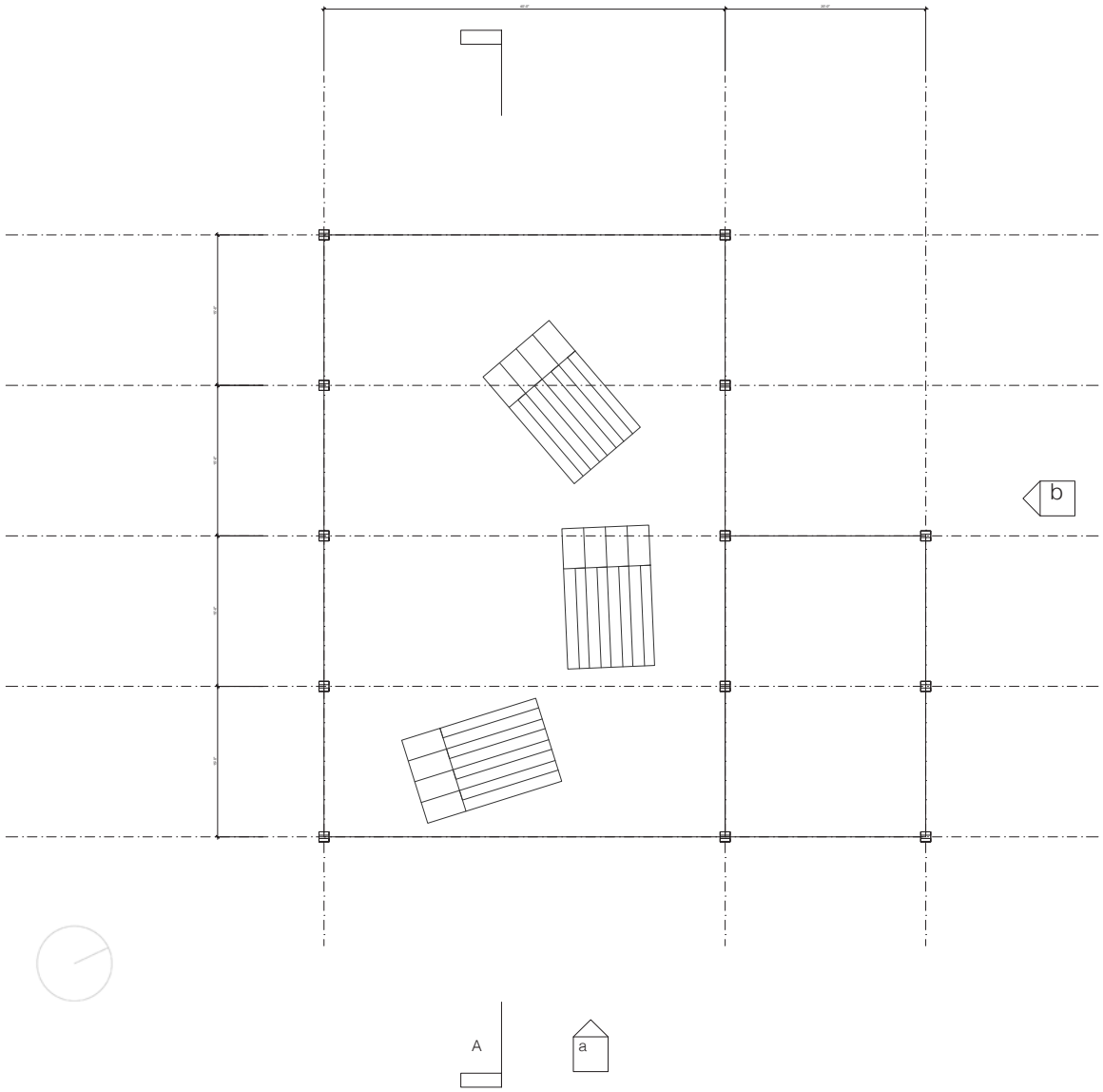


elevation b - 1/4” = 1’

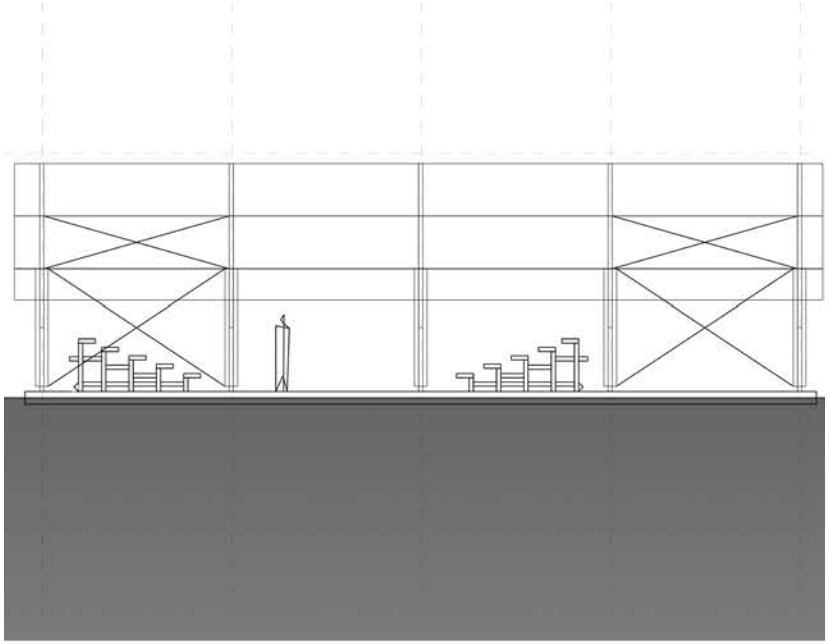


outdoor gathering area

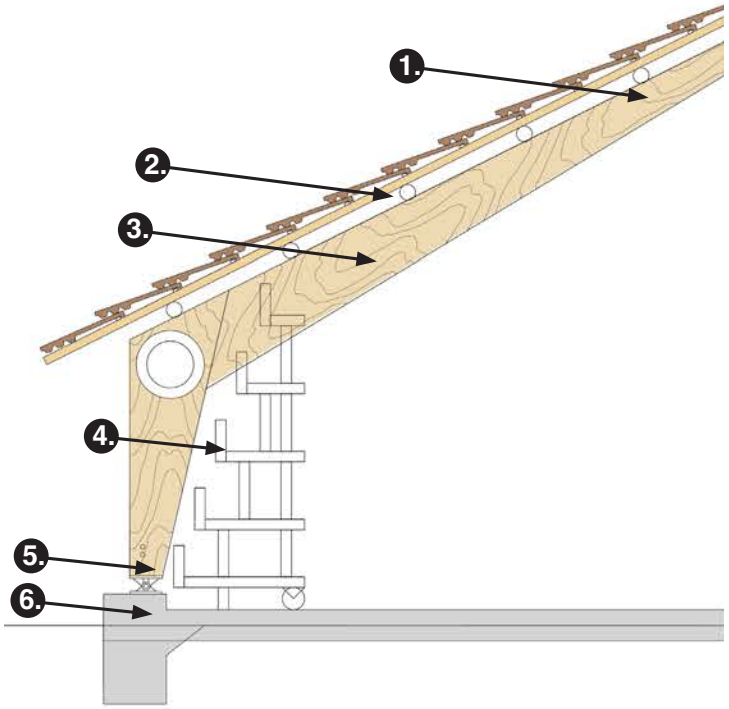
The outdoor gathering area is a direct inclusion of the present culture in El Salvador and anywhere else in the world. Covered areas near central plazas or parks have been a community staple of many Salvadoran villages. In a sense, the project acts as such, and need a central hub to both organize, gather and collect ideas and materials. It acts as a food and craft vending hub while allowing movable furniture to allow the user to better accommodate its use. The sloped roofs on each of the buildings are also a direct nod to local architecture as well as a functional need to shed rainwater as well as collect it via gutters and retainment systems that could be implemented underground or in above ground cisterns.



first floor plan - 1/4” = 1’

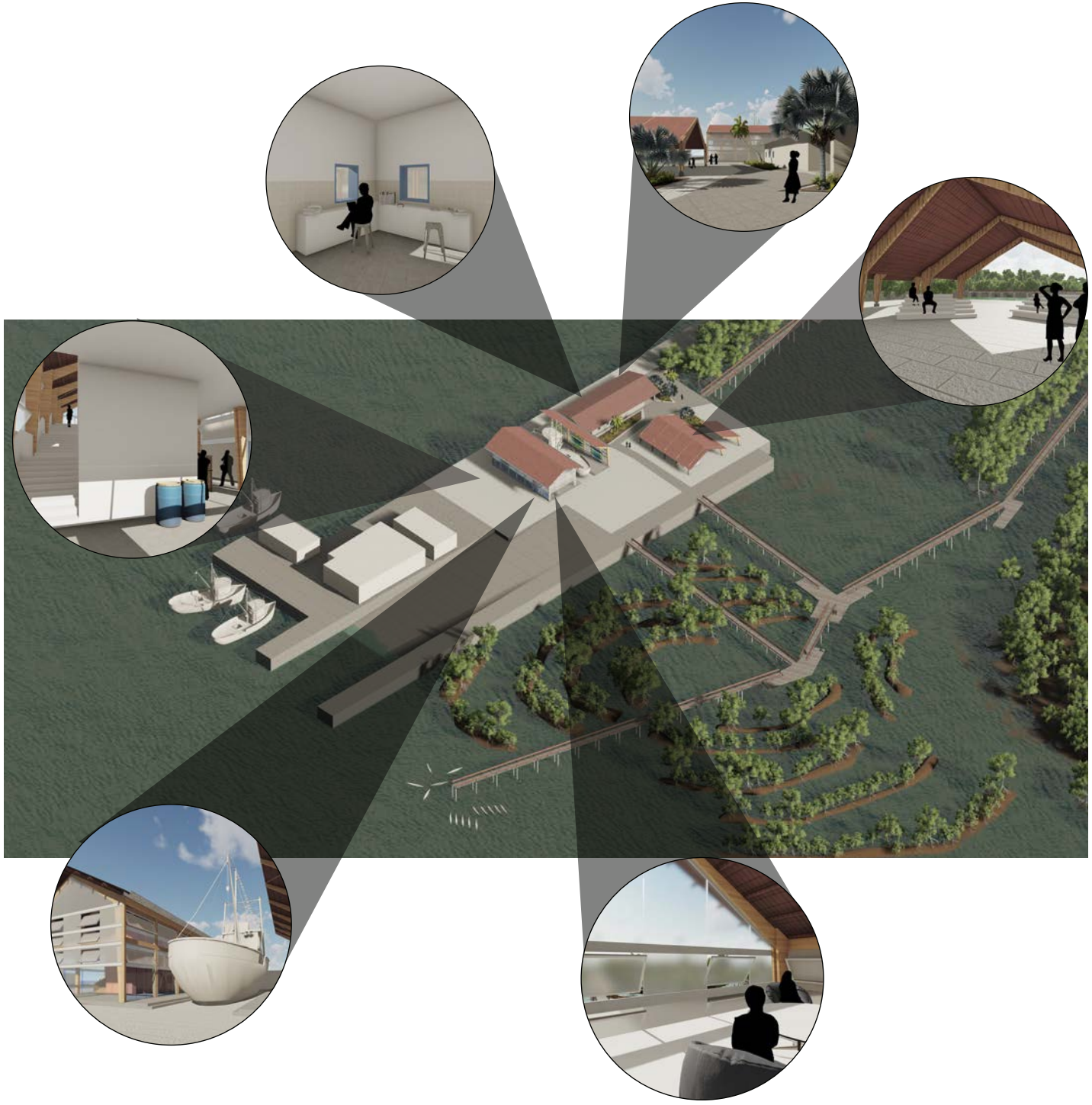


section A - 1/4” = 1’

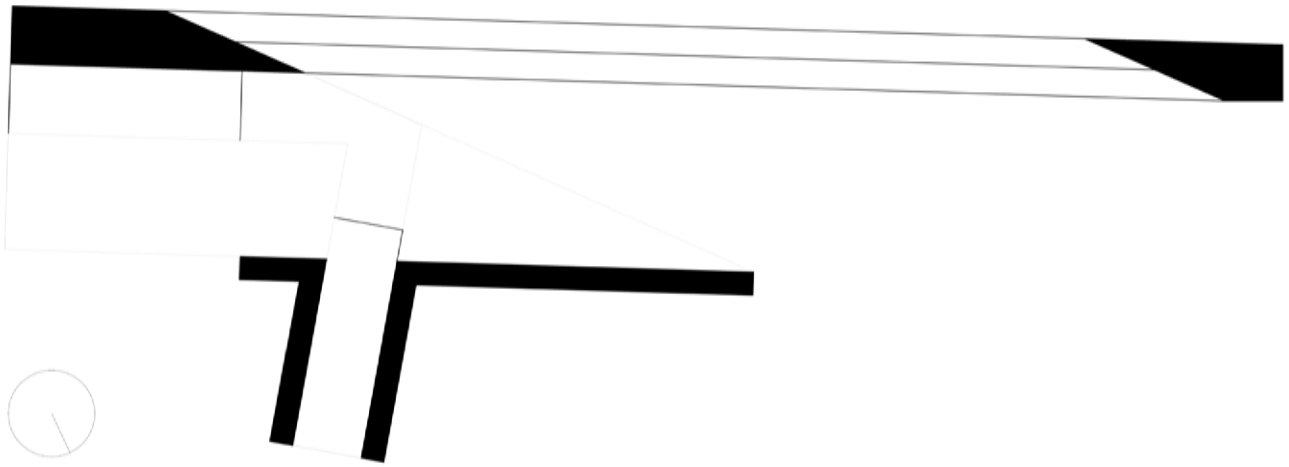


covered gathering space detail

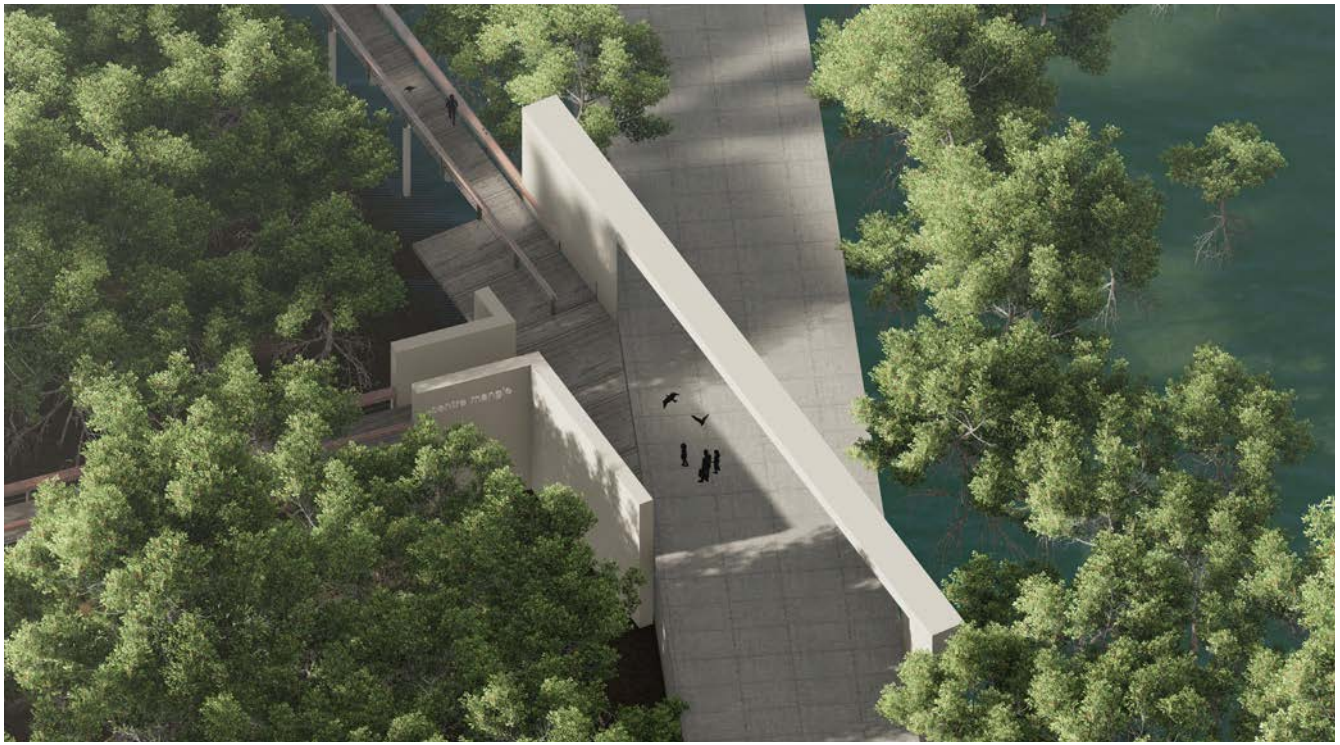
1. **bamboo purlin roof support system**
2. **hurricane-reinforced polycarbonate roofing**
3. **borate treated cross laminated bamboo rigid frame**
4. **foldable bleachers**
5. **wood to concrete steel roller connection**
6. **monolithic slab on grade**



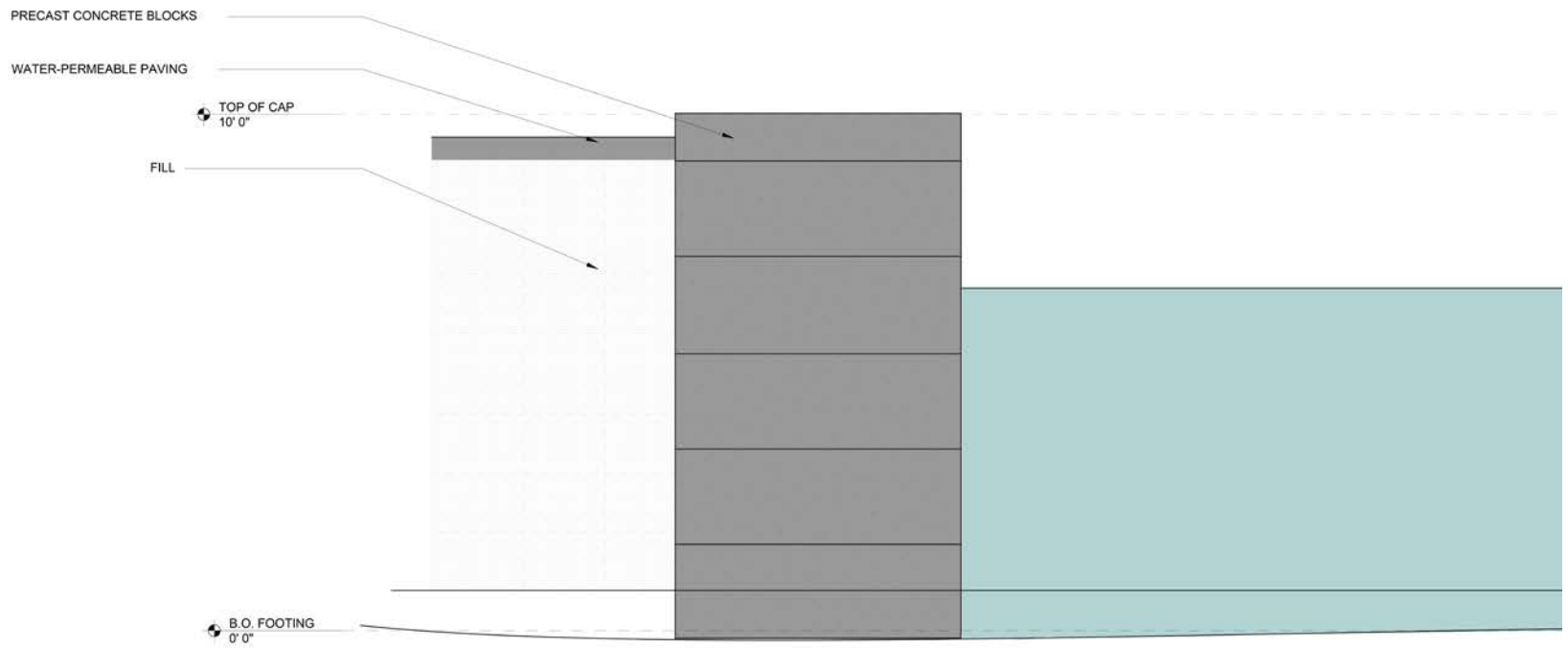
entry area



plan - 1/4” = 1’



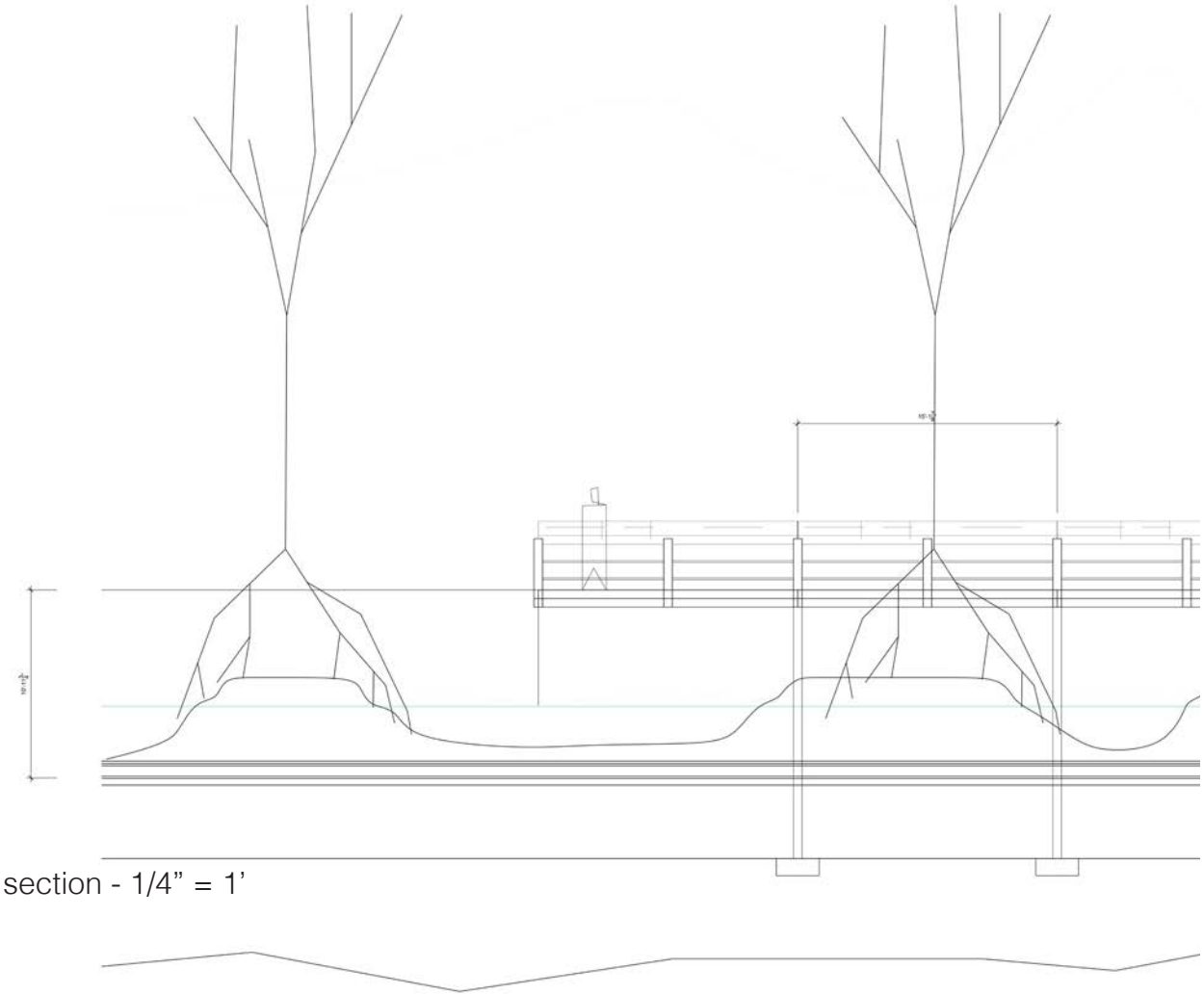
The entry kiosk acts as a point of separation from foot traffic and industrial traffic from the exisiting fishing support budilings. The platforms act as a careful and relaxing alternative avenue to arrive at the main site. The walls act as traffic dividers and allow for entry and exit flows for an area already experincing foot traffic from residential and touristic areas. The construction can be solid adobe block, aggregated with local volcanic ash, cement, local compressed sugarcane, and rebar. Rendered in a white finish, his entry then becomes a celebration of local knowledge in adobe masonry with properties allowing it to remain water resistant and durable.



detail section - 1” = 1’

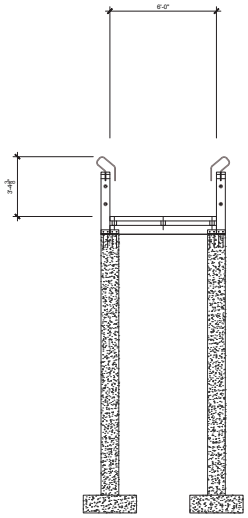
dock construction

As previously shown in diagrams, pre-exisitng dock infrastructure had to be improved to allow for a stronger implementation of structure, whether it is wood or masonry. The main precast concrete elements meet with the footings of each of the monolithic slabs of each of the buildings to create a hurrican-capable construction that can withstand variable weather conditions.

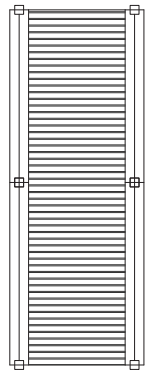


section - 1/4” = 1’

section - 1/4” = 1’



plan - 1/4” = 1’



platforms

The platform construction employs various materials to better reflect the materiality of the interventions on the site. The main supporting columns are made of sea-water resistant concrete, along with the main supporting beams. The deck is made of wood, a local wood known as Guanacaste is said to be resistant to water. The posts are also wood, while the railings are a bent metal shape that allows for a material connection to the brown bark of the trees, as well as the rusted metals of rotting ship hulls, and the deep red of the polycarbonate roofing tiles.

low tide - before and after

mid tide - before and after

high tide - before and after

low tide section

mid tide section

high tide section

Conclusion

Puerto El Triunfo holds an immensely powerful history, far too complex to address all at once. From treatment of the indigenous, to bustling fishing town, to struggles of labor and social dynamics, to war and violence, then mass exodus, and later, recovery. What remains is a strong population that has taken matters into their own hands. Community organization is truly key. Maintaining and supporting community organizations is key. Here and all over the world we see populations interested in creating vibrant local economies that are also ecologically aware of over-tourism, but at the same time have a need to integrate and adapt to community needs while restoring the environment. The mangrove being a marine habitat and natural storm protection is the perfect natural poem that design and programming can take inspiration from. Being mindful of the overall picture of various interconnected parts has become crucial, especially as it pertains to the very science of restoration. This project attempts to house truly inclusive interaction between all community members. The scientific community, the local community, and the fishing community have common ground and benefits that can be achieved through collaboration and team work. Integrating and reinforcing both fishing and restoration infrastructure is an investment in the future and wellbeing of professions that are crucial and traditional to the population. In turn, with the loss of mangroves from rising seas and intense farming, livelihoods could be affected without strong understandings between the issues and interests that face each group. Community, food, and financial resources are available from local non-profits, and these spaces can be extensions of that local involvement. El Salvador is in itself a celebration of various cultural intersection. Centro Mangle attempts to hone in on an intersection and establish areas of local enrichment as well as a hub for ecological restoration.

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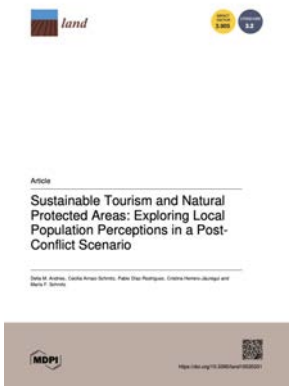
land

Article

Sustainable Tourism and Natural Protected Areas: Exploring Local Population Perceptions in a Post-Conflict Scenario

MDPI

[1] Andries, Delia M., Cecilia Arnaiz-Schmitz, Pablo Díaz-Rodríguez, Cristina Herrero-Jáuregui, and María F. Schmitz. 2021. “Sustainable Tourism and Natural Protected Areas: Exploring Local Population Perceptions in a Post-Conflict Scenario” Land 10, no. 3: 331. https://doi.org/10.3390/land10030331


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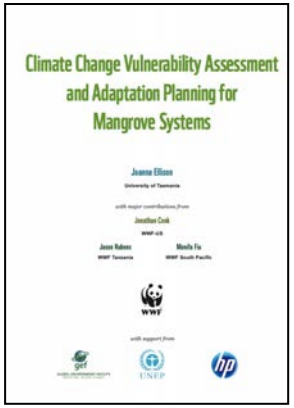

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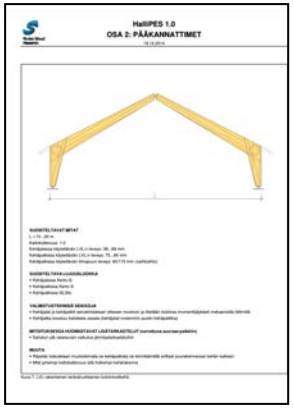

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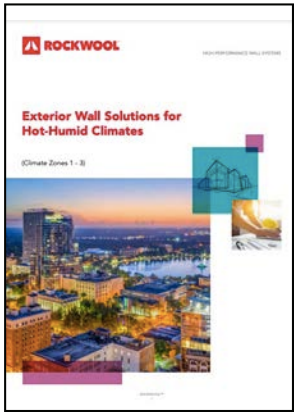

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